Cows and Fish Report

2011 Riparian Health Inventory Project: Westslope Cutthroat Trout Priority Streams

- A Summary of the Riparian Health Status and Habitat Improvement Needs for 20 Priority Westslope Cutthroat Trout Sites in the South Eastern Slopes of Alberta -

Alberta Riparian Habitat Management Society (Cows and Fish)
Report No. 041

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About the Alberta Riparian Habitat Management Society

The Alberta Riparian Habitat Management Society (known as "Cows and Fish") is a non-profit society that strives to promote improved management and stewardship of riparian areas. As the critical buffer zone between our uplands and our waterways, protection of riparian corridors and improved riparian health has benefits for filtration of stormwater runoff, reduced erosion and flood impacts, groundwater recharge, and fish and wildlife habitat. Cows and Fish has worked with landowners, land managers, livestock producers and community groups across Alberta since 1992 on riparian awareness, stewardship and monitoring projects.

Cows and Fish Supporters and Members: Producers and community groups, Alberta Beef Producers, Trout Unlimited Canada, Alberta Agriculture and Rural Development, Alberta Sustainable Resource Development, Alberta Environment and Water, Department of Fisheries and Oceans, Agriculture and Agri-Food Canada Agri-Environment Services Branch, Alberta Conservation Association, Canadian Cattlemen's Association

Working with producers and communities on riparian awareness

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Disclaimer

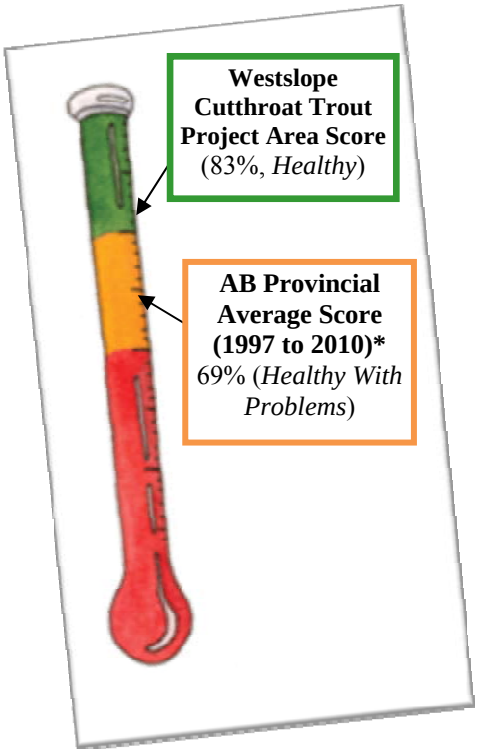
- *Riparian health inventories of small stream systems do not address any in-stream, hydrological parameters (i.e. issues associated with water flow regimes, water diversions, extractions, dam impacts). Water quality testing / monitoring is* ***not*** *conducted as part of riparian health inventories.*

- *The objective of completing riparian health inventories is to provide a coarse filter review of the status of riparian health within the project area. The riparian health scores provide a general status of riparian health, not an absolute one. Riparian areas are dynamic and are constantly changing. Because of this natural variability, the range of possible scores in each category is broad and one assessment is only an approximation of health. Inventories over a period of years at the same locations will provide a better picture of whether current management is maintaining, improving or negatively impacting riparian health.*

EXECUTIVE SUMMARY

Reduced to less than 20% of its historic range, Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisii*) are now mainly confined to a few, isolated headwater reaches in Alberta's eastern slopes. Recovery of this threatened native fish species is strongly reliant on the maintenance of suitable habitat conditions in remaining watersheds with genetically pure Westslope Cuthroat Trout populations in Alberta. Suitable habitat for this species is in large part dependent on maintaining healthy riparian ecosystems which contribute to thermal cover, bank stability, in-stream and streambank sheltering habitat, high water quality, and sustained groundwater recharge inputs into critical overwintering Westslope Cutthroat Trout habitats.

In 2011, the Alberta Riparian Habitat Management Society (Cows and Fish) conducted 15 riparian health inventories (RHIs) in foothills and montane streams with Westslope Cutthroat Trout populations in the Highwood River, Willow Creek, Callum Creek, Upper Oldman River and Castle River watersheds. RHI data was previously collected by Cows and Fish on 5 sites along streams containing Westslope Cutthroat Trout in the Ghost River and Oldman River watersheds in 2010 and 2005, respectively. An analysis of the results from these 20 RHI sites is presented in this report. This Westslope Cutthroat Trout project area includes 42.0 ha of riparian habitat along 13.8 km of streambank length in six Public Land Use Zones (formerly referred to as "Forest Land Use Zones") managed by Alberta Sustainable Resource Development (SRD) as multi-use lands. Primary land uses in the project area include recreation, livestock grazing, logging, and oil and gas exploration. Many of the sub-basins within the project area are popular with both non-motorized (horseback riding, hiking, biking) and motorized recreational users (various types of off-highway vehicles). Collection of baseline riparian health data will help to inform the ongoing joint federal and provincial recovery planning efforts for Westslope Cutthroat Trout by identifying habitat issues and concerns and informing land use management in priority conservation areas for this species. This project was conducted in collaboration with SRD, Fisheries and Oceans Canada, the Alberta Conservation Association (ACA) and Trout Unlimited Canada.



The average riparian health rating for the 20 stream systems evaluated as part of this project is 83% (*healthy*). The majority of sites (13 sites) (i.e. 65%) rate *healthy*, 6 sites (i.e. 30%) rate *healthy, but with problems* and only 1 site is in the *unhealthy* category. However, by area, only 37% (15.7 ha) of the riparian habitat extent evaluated is in the *healthy* category. The majority of healthy sites are steep-sided mountain streams with a very narrow and generally poorly accessible riparian area. Sites with health concerns generally represent wider, more gently sloping floodplains that are more easily accessible to recreational users and / or livestock or which have been impacted by roadway or industrial land uses. Cumulative impacts from these and other historical land use activities have contributed to elevated levels of invasive species and / or non-native disturbance-caused species in most sites in addition to physical site impacts such as soil compaction and bank alterations.

**Based on data collected by Cows and Fish in Alberta from 1997 to 2010 on 2056 riparian sites.*

Invasive plant species are present in 15 of the 20 sites. The most widespread and abundant invasive species in the project area are ox-eye daisy (*Matricaria perforata*), tall buttercup (*Ranunculus acris*), and Canada thistle (*Cirsium arvense*). Human-caused soil compaction and alterations in the floodplain are a concern in 10 sites, 4 of which have severe amounts of alterations (>15%) mainly due to recreational user impacts. Despite these impacts, the majority of sites have a wide diversity of native riparian plant species with multiple age classes and structural habitat layers, indicating self-sustaining native plant communities. The dominant riparian plant community in the project area is a native white (*Picea glauca*) spruce / willow (*Salix* spp.) Habitat Type that provides excellent overhead shelter and cover for trout and stable streambanks. With appropriate management there is high potential for recovery or improvement of many of the human-caused riparian health impacts in the project area.

Next steps and management recommendations for riparian health improvements are provided in Section 6 of this report. Recommendations include maintaining native plant communities, especially trees and shrubs, in addition to monitoring and controlling invasive weeds, carefully monitoring and managing recreational activities in and adjacent to sensitive riparian habitats, and continuing to appropriately manage and monitor livestock grazing impacts. Water quality monitoring is also suggested to aid in cumulative effects assessment and management planning of other watershed land use activities (e.g. logging / industrial developments / recreation) with potential to impact Westslope Cutthroat Trout and their habitat.

Since many of the sites we examined are in a healthy condition, a priority is to maintain these sites so further loss of quality riparian habitat does not occur. Ongoing and potential increasing land use activities may put these healthy sites at risk. Cohesive and collaborative efforts to plan and manage land uses in these areas will be important for improving riparian health and maintaining existing healthy sites in an ecologically functioning condition. Ongoing dialogue and collaboration with multiple user groups is a necessary part of this planning process. To assist with this effort, one of the components of the current project was to hold a multi-stakeholder workshop in early 2012 aimed at bringing together various land user groups and land managers in the Westslope Cutthroat Trout project area. The workshop intent was to broaden awareness of Westslope Cutthroat Trout habitat requirements and threats and to encourage collaborative beneficial land use practices to aid in the recovery of this species. In total, 60 participants from various government departments, private industry sectors and non-governmental organizations / community groups attended the workshop and participated in facilitated discussion groups. Key messages and next steps from this workshop will be summarized in a separate cover report.

1 BACKGROUND

1.1 Project Overview

In 2011, the Alberta Riparian Habitat Management Society (Cows and Fish) conducted riparian health inventories (RHIs) along streams and rivers with known Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisii*) populations in the south eastern slopes of Alberta. The Westslope Cuthroat Trout is a threatened native fish species in the province. This project was initiated by Cows and Fish in collaboration with Alberta Sustainable Resource Development (SRD), Fisheries and Oceans Canada (DFO), the Alberta Conservation Association (ACA) and Trout Unlimited Canada (TUC). Funding for this project was provided through grants administered by ACA and Environment Canada's Habitat Stewardship Program as well as grant and in-kind support from SRD, Alberta Environment and Water (AEW) and the Alberta Beef Producers and other Cows and Fish members and supporters. The main intent of the project is to assess the current condition of priority Westslope Cutthroat Trout riparian habitat and offer suggestions to land managers for ways to maintain or improve this habitat. This initiative is the first phase of a larger project aimed at assessing priority habitat for genetically pure Westslope Cutthroat Trout throughout its remaining range in Alberta. This initiative has and will continue to involve close collaboration with fish biologist experts and coordination of multi-stakeholder workshops aimed at building awareness about the threats facing Westslope Cutthroat Trout, identifying solutions and encouraging collaborative management actions to promote habitat improvement.

This report describes the riparian health results for the 15 Westslope Cutthroat Trout sites assessed during the 2011 field season in addition to 5 other sites previously assessed by Cows and Fish in the Ghost River and Oldman River watersheds known to have pure Westslope Cutthroat Trout populations. Individual site scores and details are provided in individual RHI summary reports submitted to SRD and grazing allotment holders as part of this project.

RHIs provide comprehensive information about the diversity, structure and health of plant communities and physical site integrity within the project area. This information will assist SRD, ACA, TUC and DFO in recovery planning for Westslope Cutthroat Trout by:

- creating a baseline of riparian habitat status in priority reaches;
- identifying habitat degradation issues and concerns; and
- providing land managers and other stakeholders with an engagement tool to promote awareness and take action toward habitat improvement.

1.2 Westslope Cutthroat Trout Backgrounder

Species Description, Range and Limiting Factors

The Westslope Cutthroat Trout, named for the red-orange streak below its jaw, is a small bright coloured black-speckled fish that is native to the Bow and Oldman River watersheds in Alberta. Once plentiful in Alberta, the historic range of this species extended from the upper headwaters of the Bow

watershed above Bow Lake in Banff National Park, downstream to the plains below Calgary (Costello 2006). In the Oldman watershed, original native range extended from the headwater falls below Cache Creek downstream to the plains, including all of the major tributaries to the Oldman River (the Livingstone, Crowsnest, Castle and Belly rivers and Willow Creek) (Costello 2006). There has since been a dramatic decline in the abundance and distribution of Westslope Cutthroat Trout in Alberta due to the cumulative effects of over fishing, introduction of non-native trout, habitat loss and degradation (e.g. from road construction, agriculture, mining, off-highway vehicle [OHV] impacts, damming / dewatering, urbanization etc.), and eutrophication or water pollution of cuthroat trout-bearing streams. In a significant portion of their original range, Westslope Cutthroat Trout have hybridized (cross-bred) with introduced rainbow trout (*Oncorhynchus mykiss*) or have been out-competed by non-native species like brook trout (*Salvelinus fontinalis*). Today, genetically pure native populations occur in less than 20% of the species' historical range. Most of the remaining habitat lies within federal or provincial Crown land. Native stocks of Westslope Cutthroat Trout are presently listed as *Threatened* in Alberta under the *Wildlife Act* (awaiting legislative amendment), and have also been recommended by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) for listing as *Threatened* under the federal *Species At Risk Act* (listing is pending). Joint provincial and federal recovery planning is in progress.

Westslope Cutthroat Trout *Photo Credit: Shane Petry, DFO*

Habitat Requirements and Biology

Westslope Cutthroat Trout have strict aquatic habitat requirements, making them extremely sensitive to anthropogenic disturbance, non-native species introduction, waterway fragmentation and land use changes in a watershed. This species is adapted to cold, nutrient poor (oligotrophic) freshwater environments. Their preferred temperature range is from 9^{o}C to 12^{o}C. Spawning takes place from May to August generally in small, low gradient streams with cold, well-oxygenated water and clean, unsilted, unconsolidated gravels that are easily moved by spawning females to create redds (spawning 'nests') (Costello 2006). Spawning females often seek out the downstream edge of deep pools with proximity to cover (e.g. in-stream woody debris, boulders, undercut banks or overhanging vegetation cover). Without adequate cover in spawning sites, mortality rates due to predation are typically high (Costello 2006). Eggs incubate for six to seven weeks before hatching. Young-of-the year fry disperse to shallow riffle or backwater habitat. During winter months, Westslope Cutthroat Trout congregate in slow flowing, sheltered, deep pools where there is groundwater influx and available cover.

Riparian Habitat Importance to Westslope Cutthroat Trout

Riparian edge habitat along streams and rivers provides 'essential elements' to Westslope Cutthroat Trout habitat (Costello 2006). Riparian areas are the portions of the landscape strongly influenced by water and are recognised by water-loving vegetation along rivers, streams, lakes, springs, ponds and seeps (Figure 1). Riparian areas can be described as the "green zones" around lakes and wetlands and bordering rivers and streams.

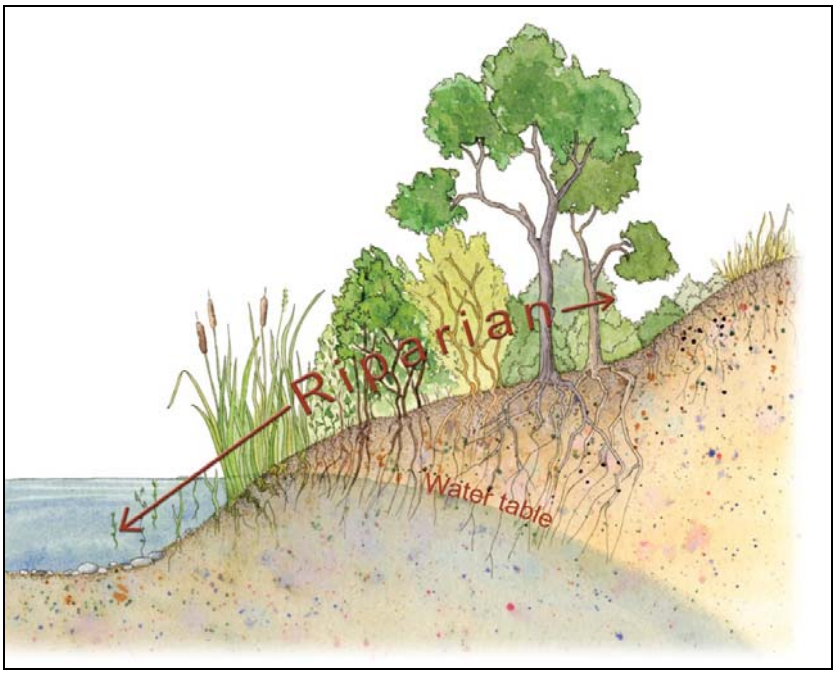


Figure 1. Diagrammatic Representation of a Riparian Area.

When in a properly functioning condition or *healthy* state, riparian areas provide many ecological functions that are beneficial to Westslope Cuthroat Trout. In particular, native riparian vegetation (e.g. sedges, rushes, alders, willow and poplars) helps to:

- stabilize the streambank and prevent accelerated rates of bank erosion;
- create and maintain deep, narrow channels with undercut banks, root wads and a source of instream woody debris (i.e. instream trout habitat);
- improve and maintain water quality by filtering out sediment, contaminants and nutrients from overland runoff;
- provide overhead cover from predators;
- maintain low stream temperatures through shading; and
- provide inputs of terrestrial insects, a significant source of food for Westslope Cutthroat Trout.

Healthy riparian areas also help to absorb and store water, buffer the impacts of floods, recharge groundwater supplies, and sustain groundwater inputs that help to maintain year-round flows in small trout tributaries and overwintering pools. These and other functions of healthy riparian areas such as sustainable forage production are also of benefit to sustaining many other wildlife species, livestock and humans on the landscape.

2 PROJECT AREA DESCRIPTION

2.1 Westslope Cutthroat Trout 2011 Project Area and RHI Site Selection

RHI locations for this project were identified and selected in consultation with a collaboration of fisheries experts from SRD, DFO, ACA and TUC. It was agreed that RHI sites would be primarily chosen on watercourses where scientific studies have confirmed the presence of genetically pure (95% purity or higher) Westslope Cutthroat Trout populations. To assist with site selection, SRD Fish & Wildlife provided Cows and Fish with a database of Westslope Cutthroat Trout population surveys and genetic purity for the Southern Rockies. Final site selection was determined based on access considerations, field scouts and / or consultation with the appropriate regional SRD Fisheries Biologist and SRD Public lands, Rangeland Agrologist.

In total 15 sites were assessed from July to September, 2011, on 12 watercourses in Public Land Grazing Allotments in the Highwood River, Willow Creek, Callum Creek, Upper Oldman River and Castle River watersheds (Table 1, Figure 2). A total of 11.8 km of stream length and 37.1 hectares of riparian habitat were assessed as part of this project in 2011 (Table 1).

Table 1. Westslope Cutthroat Trout 2011 Project Area RHI Sites.

RHI Site ID	Watercourse	2011 RHI Assessment Date	Land Management Unit	Streambank Length Inventoried (m)	Approximate Riparian Area Inventoried (ha)	ACA/SRD Record No.	WSCT Purity
Highwood River Watershed							
DEE1	Deep Creek	September 21	GRL 35696	1130.0	1.8	J-H11	>=0.99
ZEP1	Zephyr Creek			550.0	1.0	J-H18	>=0.99
Willow Creek Watershed							
COL1	Corral Creek	August 3	Willow Creek Allotment	690.0	2.5	J-C1	≥.99
COL2	Corral Creek			450.0	1.1	D-W4	≥.99
JOH3	Johnson Creek	August 2		890.0	3.6	D-W2	<0.95
JOY1	Unnamed Tributary to Johnson Creek			660.0	0.9	D-W1	<0.95
WIL15	Willow Creek	August 4		730.0	3.3	No data point	N/A*
Callum Creek Watershed							
SHA1	Sharples Creek	July 21	Sharples Creek Allotment	890.0	0.5	D-O3	>=0.99
Upper Oldman River Watershed							
HID1	Hidden Creek	September 22	Lower Livingstone Allotment	750.0	1.9	AFW-HC	>=0.99
HID2	Hidden Creek	September 22		690.0	1.6	above D-04	>=0.99
OLD37	Oldman River (above falls)	September 22		930.0	1.6	AFW-Ora	>=0.95 but <0.99
Castle River Watershed							
LST1	Lost Creek	July 26	Castle River Allotment	870.0	5.5	AFW-LoC	>=0.95 but <0.99
LYX1	Lynx Creek	July 27		880.0	1.1	ACA-83	>=0.99
LYX2	Lynx Creek	July 26		1000.0	8.1	AFW-LyC	>=0.99
NLS1	North Lost Creek	July 26		670.0	2.7	ACA-51	>=0.99

Sites are listed based on geographic location from north to south.

* The WIL15 site is upstream from confirmed ≥0.99 Westslope Cutthroat Trout (WSCT) populations on Corral Creek.

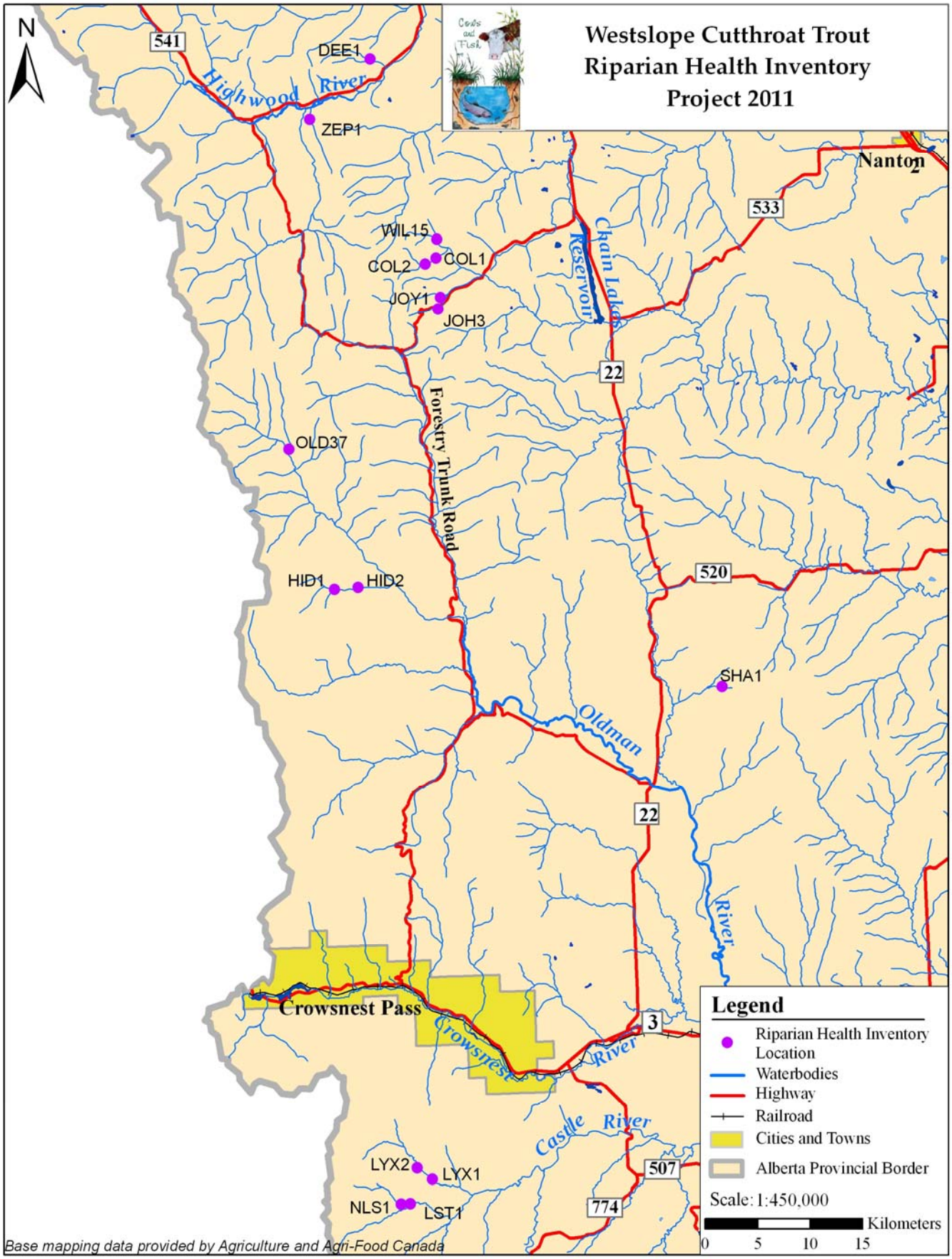


Figure 2. Westslope Cutthroat Trout 2011 Riparian Health Inventory Locations.

Detailed maps of each of the watershed sub-basins where RHIs were conducted in 2011 are provided in Appendix A. UTM coordinates of the RHI upstream and downstream end points are given in Appendix B.

2.2 Pre-2011 RHI Overlap with Pure Westslope Cutthroat Trout Habitat

Using ArcGIS, a detailed proximity analysis was done to determine overlap between past Cows and Fish RHI locations and 2006 – 2010 ACA and SRD Westslope Cutthroat Trout genetic sampling points. RHI sites within 1 km upstream or downstream of >95% purity WSCT sampling sites were selected for inclusion in the overall riparian health database for this project.

From this analysis, six overlapping RHI sites were identified (Table 2). Only those RHI sites located in Public Land (for which permission could be obtained to use this data for this project) are shown in Table 2.

Table 2. Westslope Cutthroat Trout Pre-2011 RHI Sites.

RHI Site ID	Watercourse	RHI Assessment Date	Land Management Unit	Streambank Length Inventoried (m)	Approximate Riparian Area Inventoried (ha)	ACA/SRD Record No.	WSCT Purity
Waiparous Creek Watershed							
WAZ1	Unnamed tributary to Waiparous Creek (otherwise referred to as "Margaret Creek")	2010	Ghost River Allotment	560.0	0.3	J-G3	>=0.99
JON1	Johnson Creek			1000.0	4.0	AFW-JC	>=0.99
WAI9	Waiparous Creek		Village of Waiparous	300.0	0.2	AFW-WC	>=0.99
Oldman River Watershed							
BLC1	Blairmore Creek	2005		90.0	0.1	BCA	0.95-0.99
CRT1	Carbondale River Tributary	2005	Castle River Allotment	50.0	0.2	D-C4	>=0.99

Sites are listed based on geographic location from north to south.

Results for the above listed sites are included in the overall Westslope Cutthroat Trout project area RHI dataset discussed in this report.

Of note, an extensive RHI project was done in the Ghost / Waiparous watershed in 2010 and 2011 in collaboration with the Ghost Watershed Alliance Society (Figure 3). Only those RHI sites within 1 km of ACA/SRD Westslope Cutthroat Trout sampling points are shown in Table 2. Extensive RHI sampling was done further upstream of these sampling points along Waiparous Creek and along several other Waiparous Creek tributaries that may also contain pure WSCT populations. For a detailed review of the Waiparous Watershed RHI results refer to Halawell *et al.* 2011.

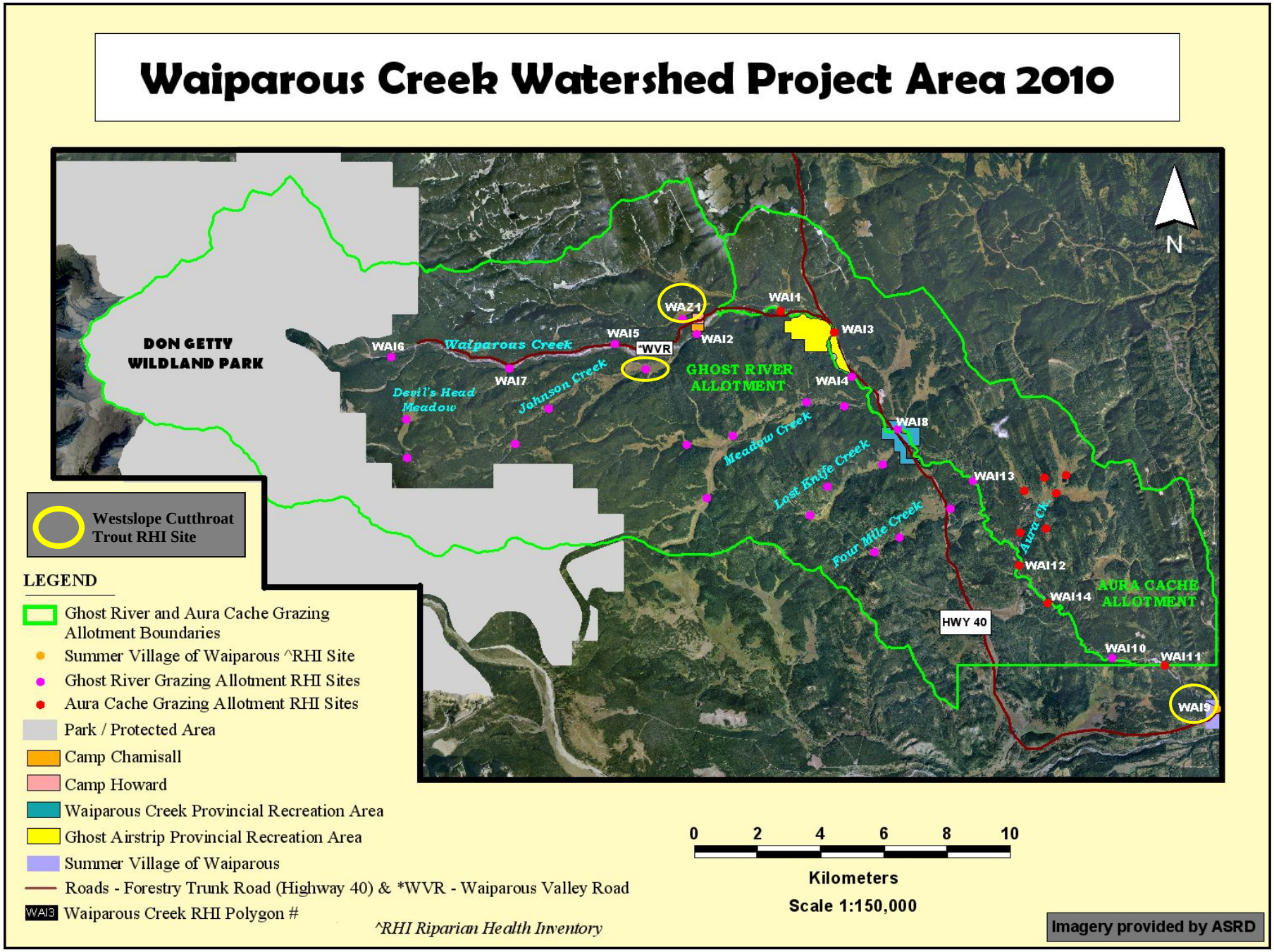


Figure 3. Waiparous Creek Watershed, Westslope Cutthroat Trout Riparian Health Inventory Locations (2010).

2.3 Land Use and Land Management

All of the priority Westslope Cutthroat Trout RHI sites included as part of this project are located in headwater stream/river reaches in Alberta Forest Reserve lands, managed by SRD. Like most Alberta Forest Reserve land, the area is considered to be multi-use. The project area is used for livestock grazing, logging, oil and gas exploration and recreation. Many of the sub-basins within the project area are popular with both non-motorized (horseback riding, hiking, biking) and motorized recreational users (various types of off-highway vehicles). Several of these activities have increased in recent years (recreation) or are likely to increase (i.e. logging and oil and gas development). The need for comprehensive management planning in these headwater reaches is critical to ensure these uses may continue in a planned way while ensuring the protection of riparian health, Westslope Cutthroat Trout habitat, water quality and other ecological goods and services that those in the watershed and downstream rely on.

The Project Area encompasses six Gazing Allotments (Table 3) managed by SRD, Public Lands, Rangeland Management Division. Logging within the Waiparous Creek watershed is facilitated through a Forest Management Agreement (FMA) with Spray Lakes Sawmill, Cochrane, Alberta. Much of the remainder of the Project Area is encompassed by the C5 Forest Management Unit (FMU). A new 20-year forest management plan (FMP) (May 2006 to April 2006) was recently developed for the C5 FMU (Government of Alberta 2010). The focus of the FMP is on timber harvest within the C5 FMU forested landbase. Under the FMP:

> *"All forest management and timber harvesting operations must consider the multiple use benefits associated with the net forest landbase, as well as the non-timber resources values present in the FMU. Emphasis will be placed on sustainable forest management that considers all known non-timber resource values, ecological processes, land uses and human activities that are present on the landscape. Land and resource management actions within the C5 FMU will not be designed to maximize single use at the expense of other resource values, land uses and activities."*
>
> - Government of Alberta 2010, page 12

A limitation of the FMP is that "it is not intended to provide detailed direction for managing all non-timber values and resources found in the forest management unit" (Government of Alberta 2010, page 12). "Non-timber values and resources" include oil/gas exploration and development, mining, coalbed methane, livestock grazing, tourism opportunities, recreational motorized access, fish and wildlife, threatened species and historical resources.

The Westslope Cutthroat Trout Project Area encompasses six Public Land Use Zones (formerly referred to as "Forest Land Use Zones") (Table 3). A Public Land Use Zone (PLUZ) "*is an area of public land to which legislative controls apply under authority of the Forests Act, Forest Recreation Regulation (343/1979) to assist in the management of industrial, commercial, and recreational land uses and resources*"[1]. Access management maps and guidelines for recreational use activities are

[1] http://srd.alberta.ca/RecreationPublicUse/RecreationOnPublicLand/PublicLandUseZones/Default.aspx

available for some of the PLUZ areas. A multi-stakeholder committee, the Ghost Stewardship Monitoring Group assisted with the development and implementation of the Ghost Waiparous Operational Access Management Plan (SRD 2005) for the Ghost PLUZ.

Table 3. Public Land Use Zones (PLUZ) within the Project Area.

RHI Site ID	Watercourse	Land Management Unit	PLUZ Zone / Access Management Plan / Watershed Stewardship Group	Natural Region (NR) and Subregion (SR)
Waiparous Creek Watershed				
WAZ1	Unnamed tributary to Waiparous Creek (otherwise referred to as "Margaret Creek")	Ghost River Allotment	Ghost PLUZ	Foothills NR, Upper Foothills SR
JON1	Johnson Creek			
WAI9	Waiparous Creek	Village of Waiparous		Rocky Mountain NR Montane SR
Highwood River Watershed				
DEE1	Deep Creek	GRL 35696	Kananaskis Country	Parkland NR, Foothills Parkland SR
ZEP1	Zephyr Creek			Rocky Mountain NR Montane SR
Willow Creek Watershed				
COL1	Corral Creek	Willow Creek Allotment	Cataract Creek Snow Vehicle PLUZ (north of Hwy 532)	Rocky Mountain NR Montane SR
COL2				
JOH3	Johnson Creek		Willow Creek PLUZ (south of Hwy 532)	
JOY1	Unnamed Tributary to Johnson Creek[4]		Cataract Creek Snow Vehicle PLUZ (north of Hwy 532)	
WIL15	Willow Creek			
Callum Creek Watershed				
SHA1	Sharples Creek	Sharples Creek Allotment	N/A	Rocky Mountain NR Montane SR
Upper Oldman River Watershed				
HID1	Hidden Creek	Lower Livingstone Allotment	N/A	Rocky Mountain NR, Subalpine SR
HID2	Hidden Creek		N/A	
OLD37	Oldman River (above falls)		N/A	
BLC1	Blairmore Creek	-	N/A	Rocky Mountain NR Montane SR
Castle River Watershed				
LST1	Lost Creek	Castle River Allotment	Castle Special Management Area PLUZ (Designated summer and winter trails maps are available)	Rocky Mountain NR Montane SR
LYX1	Lynx Creek			
LYX2	Lynx Creek			
NLS1	North Lost Creek			
CRT1	Carbondale River Tributary			

3 METHODS

3.1 Riparian Health Inventory Protocol

The riparian health inventory methodology used in this project was developed by Cows and Fish in collaboration with Dr. Paul Hansen and William Thompson (formerly of University of Montana's Riparian and Wetland Research Program), currently of Ecological Solutions Group LLC. The intent of the method is to determine if a riparian site is performing certain ecological functions (e.g. sediment trapping, water filtration, biological diversity and primary production) through examination of parameters that provide indirect evidence of these ecological functions.

3.2 RHI Site Delineation

For streams and small river systems like those in the project area, RHI sites encompass both sides of the watercourse. RHIs are always done within land units with consistent land use and / or land management; inventory reaches do not cross fencelines, roads or other management boundaries.

For representative RHIs on smaller streams, the length of the reach assessed generally includes at least two channel meander cycles (Figure 4). A complete meander cycle has equal inside and outside curvature. *For this project, reach lengths were confined within the known upper and lower limits of pure Westslope Cutthroat Trout populations based on genetic sampling locations*.

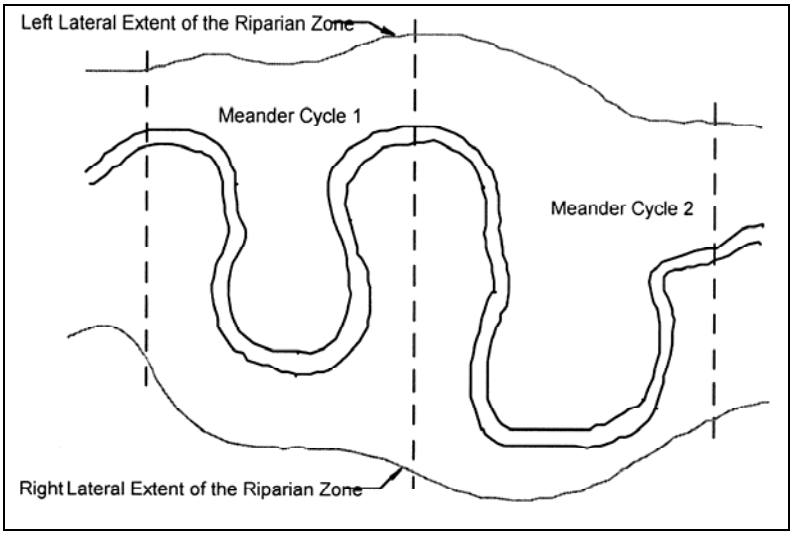


Figure 4. Stream Meander Cycle Diagram.[2]

A hand-held Garmin GPS60™ Global Positioning System (GPS) receiver is used to record the locations of the upstream and downstream ends of the riparian site. Where possible, the upstream and downstream site boundaries are placed at distinct locations or landmarks such as a bridge or stream confluence for ease of future monitoring. For monitoring purposes, benchmark photographs facing

[2] Source: Fitch *et al.* 2001.

upstream and downstream are taken at each end of the site. Additional photographs are taken where warranted to document features of interest or concern (e.g. weed infestations, bank erosion etc.).

The lateral extent (outer boundary) of the riparian area is determined in the field and traced by hand on an airphoto. The **inner RHI edge** includes the portion of the wetted channel with persistent emergent vegetation (e.g. cattails and sedges). For those situations where there is no emergent vegetation, the wetted channel (aquatic zone) is not included in the assessment. A combination of indicators including vegetation changes, topographic breaks and flood evidence are used to delineate the **outer boundary** of the riparian area (Figure 5).

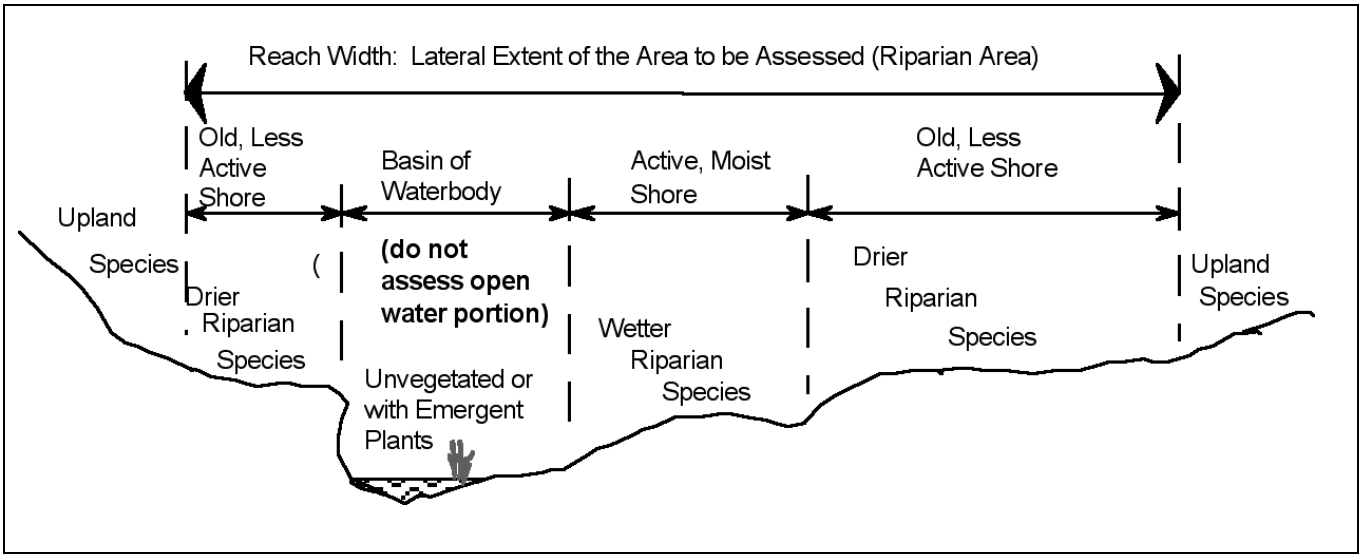


Figure 5. Cross Section Profile of Riparian Area Extent Adjacent to a Stream Channel.

The outer edge of the riparian zone generally exists where[3]:

- vegetation changes from plants responding to or requiring abundant water (i.e. hydrophytic plants) to drier, upland plant species;
- topographic changes like terraces, cutbanks, steep banks or valley slopes signal a clear line between the greener, lusher or denser vegetation and the upland;
- old channels or meander scars exist that show movement patterns of the stream and may still indicate a high ground water table; and
- flood water reaches seasonally, or on a regular basis, as high water breaks out of the stream channel.

Where available, local knowledge of historical flood events is used to help discern the extent of the flood prone zone. For small streams, the flood prone zone may be determined by measuring the bankfull channel depth, doubling this depth measurement and then projecting a line outward from this height (Figure 6).

[3] Fitch *et al.* 2001

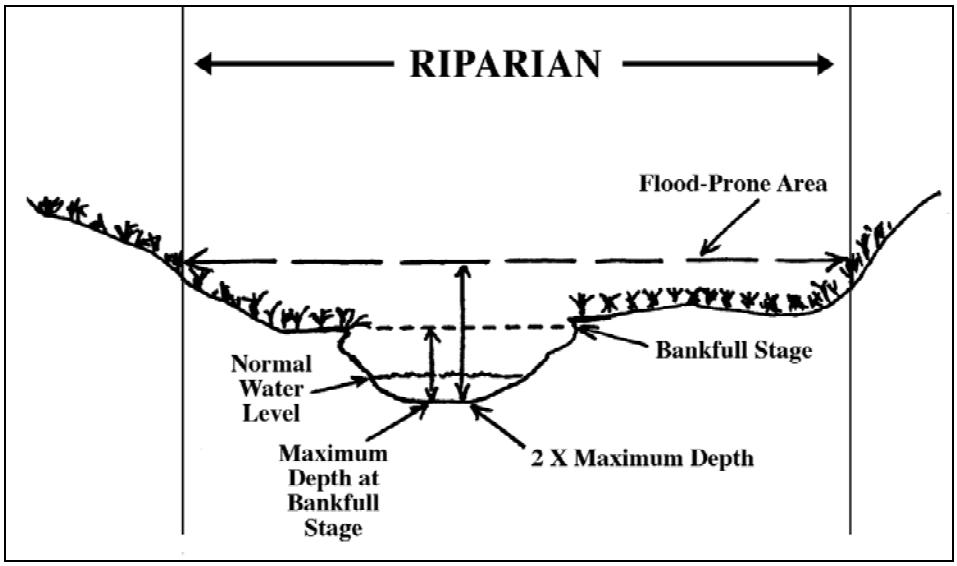


Figure 6. Flood-Prone Area Diagram for Small Stream Systems.[4]

3.3 Riparian Health Inventory Data

Detailed vegetation and physical site information is collected as part of a Cows and Fish Riparian Health Inventory (Table 4). This information is entered into a provincial riparian health FileMaker Pro database developed by the Ecological Solutions Group LCC for Cows and Fish.

Table 4. Vegetation and Physical Site RHI Data.

VEGETATION DATA	
Tree and Shrub Parameters	- Tree species canopy cover (%) and percent age group (e.g. seedling / sapling / mature and dead)
	- Browse utilization of tree seedlings / saplings by species
	- Total canopy (%) of trees and shrubs removed by human or beaver cuttings
	- Shrub species canopy covers (%), age / size groups and browse utilization of individual species
	- Total canopy cover of all woody species (%)
Herbaceous Species Parameters	- Herbaceous species (i.e. graminoid and forb) canopy covers (%)
	- Invasive species canopy cover and density distribution by individual species and combined totals
	- Disturbance–caused species combined canopy cover
Total Vegetation Cover and Plant Community Structure Parameters	- Plant group canopy cover by height layer (i.e. tree, shrub, graminoid and forb canopy covers in three height layers: >6 ft; 1.5 – 6 ft; 0-1.5 ft)
	- Total canopy cover by life form of trees, shrubs, graminoids and forbs;
	- Total canopy cover by all vascular plant life forms (%);
	- Riparian Plant Habitat Types and Community Types (*see Section 3.6*);
General	- General comments about riparian vegetation health, including discussion of human use impacts.

[4] Source: Fitch *et al.* 2001

PHYSICAL SITE DATA	
Channel and Bank Substrate and Channel Profile	- Channel bottom characterization by particle size breakdown (approximate estimates) (e.g. 50% coarse gravel, 40% sand, 10% silt / clay);
	- Streambank material characterization by particle size breakdown;
	- Average non-vegetated stream channel width (m);
	- Number, location and average height of headcuts (if present);
	- Percent of the stream with a braided channel type (if applicable);
	- Percent of the stream with evidence of active downcutting (i.e. downward erosion of the channel bed);
	- Channel incisement description;
Bank Stability	- Percent of the bank length with evidence of lateral erosion (i.e. outward erosion of the channel);
	- Percent of the bank length with evidence of unstable banks (expressed as one of four categories 0-5%, 6-25%; 26-50%, >50%);
	- Percent of the bank length with deep, binding root mass (expressed as one of four categories 0-35%, 36-65%; 65-85%; or >85%);
Bank Alterations	- Percent of the bank length with evidence of human-caused alterations and break-out of alteration type (i.e. construction, recreation, grazing, mining, logging, cultivation or "other"- described) and kind of alteration (i.e. vegetation removal, hoof shear / trampling, roads, trails, berms, rip-rap, or "other"-described);
Riparian Area Alterations	- Percentage of human-caused alterations in the riparian area, not including the bank, and breakdown of alteration types and kind of alteration as describe above for streambank alterations;
Riparian Site Characteristics	- Percent of the riparian area with sufficient fine material to hold water and act as a rooting medium;
	- Description of the number and location of springs / seeps within the riparian area;
	- Description of the type and amount of beaver utilization in the riparian area (if applicable);
	- Percentage of exposed soil surface (bare ground) and breakdown of human versus naturally caused bare ground;
	- Non-vegetated ground cover type (%) (e.g. rock, litter, moss, human-impervious surface, wood, open water);
	- Description (yes / no) of point bar revegetation in the riparian area and woody debris source on the system;
	- General physical site comments and description of land use impacts.

3.4 Riparian Health Parameters and Scoring

Riparian health ratings are derived in FileMaker Pro by evaluating six key vegetation health parameters and five soil/hydrology parameters (Table 5). **A more detailed description of each of these parameters and how they are scored is described in Appendix F.** Riparian health scores (ratings) are expressed as a percentage and a health category (*healthy*, *healthy, but with problems*, or *unhealthy*) (Table 6).

3.5 What Makes a Riparian Area "Healthy"

Riparian areas are like a jigsaw puzzle and each individual piece or component is important to the successful function of the entire system. How the individual pieces function together affects the health of the riparian ecosystem including the stream, its watershed, and overall landscape health and productivity.

Healthy riparian areas have the following *pieces* intact and functioning properly:

- an abundance and diversity of plant cover;
- successful reproduction and establishment of seedling, sapling and mature trees and /or shrubs;
- streambanks with deep-rooted plant species (e.g. willows, sedges);
- very few, if any, invasive plants (e.g. Canada thistle [*Cirsium arvense*]) and disturbance-caused plants (e.g. dandelion [*Taraxacum officinale*] and Kentucky bluegrass [*Poa pratensis*]);
- minimal structurally altered or eroded streambanks; and
- the ability of regular flood events (i.e. approximately every 1-3 years) to access a floodplain appropriate to stream or river size.

When riparian health degrades it usually means that one or more of the pieces has been impacted by natural or human-caused disturbances such as development, recreation, grazing, flooding or fire. As the rate and intensity of disturbance increases, the severity of health degradation can reach a point when the riparian area fails to perform its functions properly and becomes *unhealthy*. Riparian areas with moderate levels of impacts will typically fall within *the healthy, but with problems* category, while those with very few or no impacts will normally be rated as *healthy*.

Table 5. Riparian Health Score Parameters.

Riparian Health Parameters	
Vegetation Health Parameters	Total vegetation cover
	Invasive plant species cover and density distribution (e.g. *noxious* and *prohibited noxious* weeds)
	Disturbance-caused undesirable species cover (e.g. Kentucky bluegrass, dandelion)
	Preferred tree/shrub regeneration
	Preferred tree/shrub browse utilisation by livestock and wildlife and removal other than browsing (i.e. beaver or human cuttings)
	Dead/decadent woody material
Soil / Hydrology (Physical) Health Parameters	Root mass protection
	Human-caused bare ground
	Human-caused alterations to the streambank
	Human-caused alterations to the floodplain
	Stream channel incisement

Table 6. Description of Riparian Health Ratings.

Health Category		***Score Ranges***	***Description***
Healthy		*80-100%*	little to no impairment to any riparian functions
Healthy, but with problems		*60-79%*	some impairment to riparian functions due to management or natural causes
Unhealthy		*<60%*	severe impairment to riparian functions due to management or natural causes

3.6 Classification of Riparian Plant Communities

With the exception of three sites in the Foothills (WAZ1 and JON1) and Parkland (DEE1) Natural Regions, the majority of the Westslope Cutthroat Trout Project Area occurs within the Rocky Mountain Natural Region of Alberta (Table 3) (Natural Regions Committee 2006). Where appropriate, the *Riparian Classification for the Parkland and Dry Mixedwood Natural Region* (Thompson and Hansen 2003) and / or SRD's *Range Plant Community Types for the Montane Subregion* (Willoughby *et al.* 2005) was used to classify the riparian plant communities in the project area.

Using the Thompson and Hansen Riparian Plant Classification guides, riparian plant communities are described as either "Habitat Types" or "Community Types". "Habitat Types" represent 'climax plant communities' or, final state plant communities that are self-perpetuating and in dynamic equilibrium with their environment. "Community Types" represent 'seral plant communities', or interim plant communities that are replaced by another community or species as succession progresses. Like SRD's range plant community types, naming of Thomspson and Hansen's Habitat Types and Community Types is based on the dominant overstory species (listed first) separated by a slash from the dominant or most diagnostic indicator of the undergrowth vegetation. An example is the beaked willow (*Salix bebbiana*) / awned sedge (*Carex atherodes*) Habitat Type. Some riparian plant communities may only have a single layer of vegetation, which is then considered the overstory (e.g. the awned sedge Habitat Type).

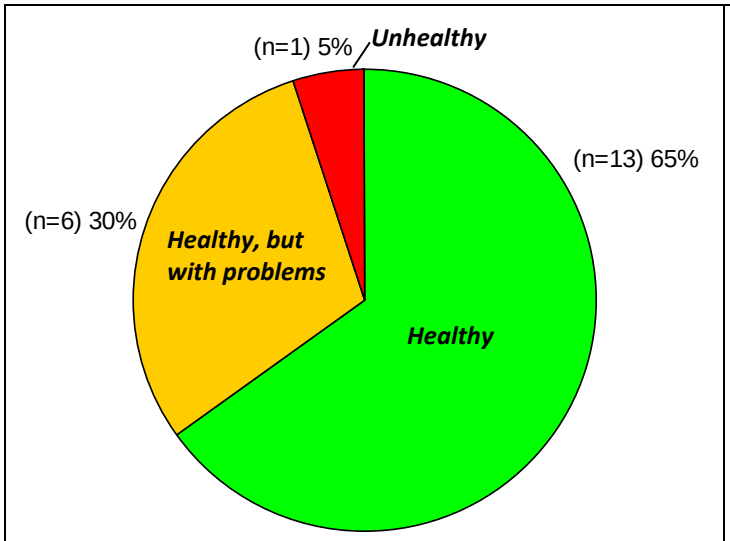
3.7 Additional Westslope Cutthroat Trout Habitat Data

For the purpose of this project, more detailed and frequent channel width and channel bottom substrate measurements were taken to better document in-stream habitat characteristics that may be important for Westslope Cutthroat Trout. Measurements of non-vegetated channel width and channel bottom substrate composition were taken at the upstream and downstream ends of each RHI site and at 100 m (straight-line distance) intervals. Straight-line distance intervals were determined firstly from the upstream or downstream waypoint coordinate (depending on the direction of travel) and then from successive waypoints taken at each of the measurement stations. Photographs facing up and downstream were also taken at each of the measurement stations. Non-vegetated channel width was measured to the nearest 0.1 m using a hand-held tape measure. Additional photographs and waypoints were also taken to document any potential barriers to fish movement (e.g. headcuts >50 cm vertical height, hanging culverts etc.) encountered along the entire RHI assessment reach.

4 RESULTS AND DISCUSSION

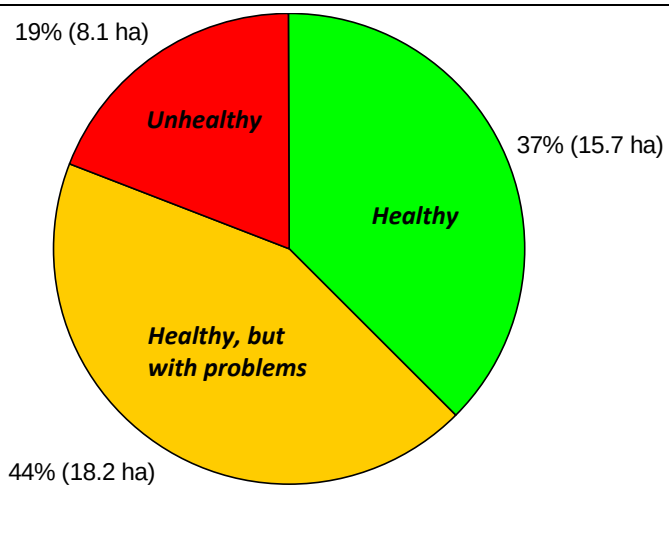
4.1 Overview of Riparian Health Results

Including the five priority Westslope Cutthroat Trout RHI sites assessed prior to 2011 (Section 2.2), the average riparian health rating for the 20 stream sites evaluated as part of this project is 83% (*healthy*). The majority of sites (13 sites) (i.e. 65%) rate *healthy*, 6 sites (i.e. 30%) rate *healthy, but with problems* and only 1 site is in the *unhealthy* category (Figure 7, Table 7). The total project area encompasses 42.0 ha of riparian habitat along 13.8 km of stream length.



Pie chart showing proportion of RHI sites in each health category

Figure 7. Westslope Cutthroat Trout Project Area Riparian Health Results.



Pie chart showing proportion of the RHI project area (ha) by health category

Figure 8. Westslope Cutthroat Trout Project Area Riparian Health Results By Area.

Most of the *healthy* sites represent steep-sided mountain streams with a very narrow riparian area. By contrast most of the sites in the *healthy, but with problems* and *unhealthy* categories are more easily accessible to livestock or humans due to more gently sloping terrain and wider floodplains. This difference is represented in Figure 8 which shows the proportion of the total project area in each health category. By area, only 37% (15.7 ha) of the riparian habitat extent evaluated is in the *healthy* category (Figure 8). The area-weighted riparian health score for the 20 stream sites is 76% (*healthy, but with problems*). Further explanation of riparian health scores is provided in Sections 4.3 to 4.4.

Table 7. Riparian Health Result Summary.

RHI Site ID	Watercourse	RHI Date	Natural Region and PLUZ	ACA/SRD Record No.	WSCT Purity	Vegetation Health Rating	Soil / Hydrology Health Rating	Riparian Health Rating
Waiparous Creek Watershed								
WAZ1	Unnamed tributary to Waiparous Creek	2010	Foothills NR, Upper Foothills SR [Ghost PLUZ]	J-G3	>=0.99	93% (H)	83% (H)	88% (H)
JON1	Johnson Creek			AFW-JC	>=0.99	77% (HWP)	80% (H)	78% (HWP)
WAI9	Waiparous Creek		Rocky Mountain NR Montane SR [Ghost PLUZ]	AFW-WC	>=0.99	100% (H)	90% (H)	95% (H)
Highwood River Watershed								
DEE1	Deep Creek	2011	Parkland NR, Foothills Parkland SR [Kananaskis Country]	J-H11	>=0.99	83% (H)	83% (H)	83% (H)
ZEP1	Zephyr Creek		Rocky Mountain NR Montane SR [Kananaskis Country]	J-H18	>=0.99	90% (H)	93% (H)	92% (H)
Willow Creek Watershed								
COL1	Corral Creek	2011	Rocky Mountain NR Montane SR [Cataract Creek / Willow Creek PLUZ]	J-C1	≥.99	73% (HWP)	80% (H)	77% (HWP)
COL2	Corral Creek			D-W4	≥.99	73% (HWP)	100% (H)	87% (H)
JOH3	Johnson Creek	2011		D-W2	<0.95	73% (HWP)	93% (H)	83% (H)
JOY1	Unnamed Tributary to Johnson Creek			D-W1	<0.95	73% (HWP)	100% (H)	87% (H)
WIL15	Willow Creek	2011		No data point	N/A*	67% (HWP)	67% (HWP)	67% (HWP)
Callum Creek Watershed								
SHA1	Sharples Creek	2011	Rocky Mountain NR Montane SR	D-O3	>=0.99	77% (HWP)	90% (H)	83% (H)
Upper Oldman River Watershed								
HID1	Hidden Creek	2011	Rocky Mountain NR, Subalpine SR	AFW-HC	>=0.99	97% (H)	100% (H)	98% (H)
HID2	Hidden Creek	2011		above D-04	>=0.99	93% (H)	100% (H)	97% (H)
OLD37	Oldman River (above falls)	2011		AFW-Ora	>=0.95 but <0.99	93% (H)	77% (HWP)	85% (H)
BLC1	Blairmore Creek	2005	Rocky Mountain NR Montane SR	BCA	0.95-0.99	85% (H)	100% (H)	93% (H)
Castle River Watershed								
LST1	Lost Creek	2011	Rocky Mountain NR Montane SR [Castle Special Management Area PLUZ]	AFW-LoC	>=0.95 but <0.99	63% (HWP)	83% (H)	73% (HWP)
LYX1	Lynx Creek	2011		ACA-83	>=0.99	83% (H)	93% (H)	88% (H)
LYX2	Lynx Creek	2011		AFW-LyC	>=0.99	63% (HWP)	50% (UN)	57% (UN)
NLS1	North Lost Creek	2011		ACA-51	>=0.99	70% (HWP)	87% (H)	78% (HWP)
CRT1	Carbondale River Tributary	2005		D-C4	>=0.99	74% (HWP)	83% (H)	79% (HWP)

H = Healthy; HWP = Healthy, but with Problems; UN = Unhealthy

4.2 Riparian Plant Communities in the Project Area

Tree Communities

The majority of the project area (75%) is comprised of a white spruce (*Picea glauca*) / willow (*Salix* spp.) Habitat Type[5] (Photo a, page 21) (Table 8, Figure 9). This Habitat Type is considered particularly important for providing hiding, thermal cover, debris recruitment and streambank stability for fish (Thompson and Hansen 2003). It is usually associated with mesic to subhygric brunisols, luvisols or regosol soils with a thick organic layer of partially decomposed humus (Thompson and Hansen 2003). Drummond's willow (*Salix drummondiana*) is the dominant willow in the understory of this Habitat Type in our project area. Other common understory shrubs include river alder (*Alnus tenuifolia*), beaked willow (*Salix bebbiana*) and / or bog birch (*Betula glandulosa*).

Table 8. Plant Community Types in the Project Area.

Plant Community*	Thompson and Hansen 2003 Classification	RHI Sites Where Found	Frequency of Occurrence in RHI Sites	Area Occupied	Area Occupied (%)
Tree Communities					
White Spruce / Common Horsetail	Habitat Type	BLC1, CRT1, JOY1, SHA1	20%	0.6 ha (1.6 ac)	1.5%
White Spruce / Willow	Habitat Type	COL1, COL2, DEE1, HID2, JOH3, JON1, JOY1, LST1, LYX1, LYX2, OLD37, SHA1 WAI9, WAZ1, WIL15, ZEP1	85%	31.4 ha (73.5 ac)	74.7%
White Spruce / Thimbleberry	N/A	NLS1	5%	2.5 ha (6.0ac)	5.9%
White Spruce / Moss	N/A	ZEP1	5%	0.2 ha (0.5ac)	0.5%
Balsam Poplar / Red-Osier Dogwood	Community Type	LYX2, NLS1	10%	1.9 ha (4.6 ac)	4.5%
Balsam Poplar	Community Type	LST1	5%	0.2 ha (0.4 ac)	0.4%
Shrub Communities					
Flat-leaved Willow / Water Sedge	Habitat Type	WAZ1	5%	0.3 ha (0.6 ac)	0.6%
Herbaceous Communities					
Smooth Brome	Community Type	JOH3	5%	0.1 ha (0.3 ac)	0.3%
Disturbance-Caused Herbaceous, Unclassified	Community Type	JON1, LST1, LYX2, SHA1, WIL15	25%	4.8 ha (11.7 ac)	11.4%

**Based on Thompson and Hansen 2003 or Willoughby et al. 2005.*

[5] ***Note:*** The "white spruce / willow Habitat Type" corresponds with Thompson and Hansen's "white spruce / low-bush cranberry Habitat Type". Willow rather than low-bush cranberry (*Viburnum edule*) is the dominant understory shrub in our project area, therefore it is noted as the understory shrub species in the Habitat Type name; however, other characteristics of this Habitat Type are correspondent. As indicated in Thompson and Hansen (2003) the characteristic understory shrub species of a white spruce / low-bush cranberry Habitat Type are low-bush cranberry, red-osier dogwood (*Cornus stolonifera*) or willow (*Salix*) species, individually or in combination, with at least 1 percent canopy cover or balsam poplar (*Populus balsamifera*) with at least 15% canopy cover.

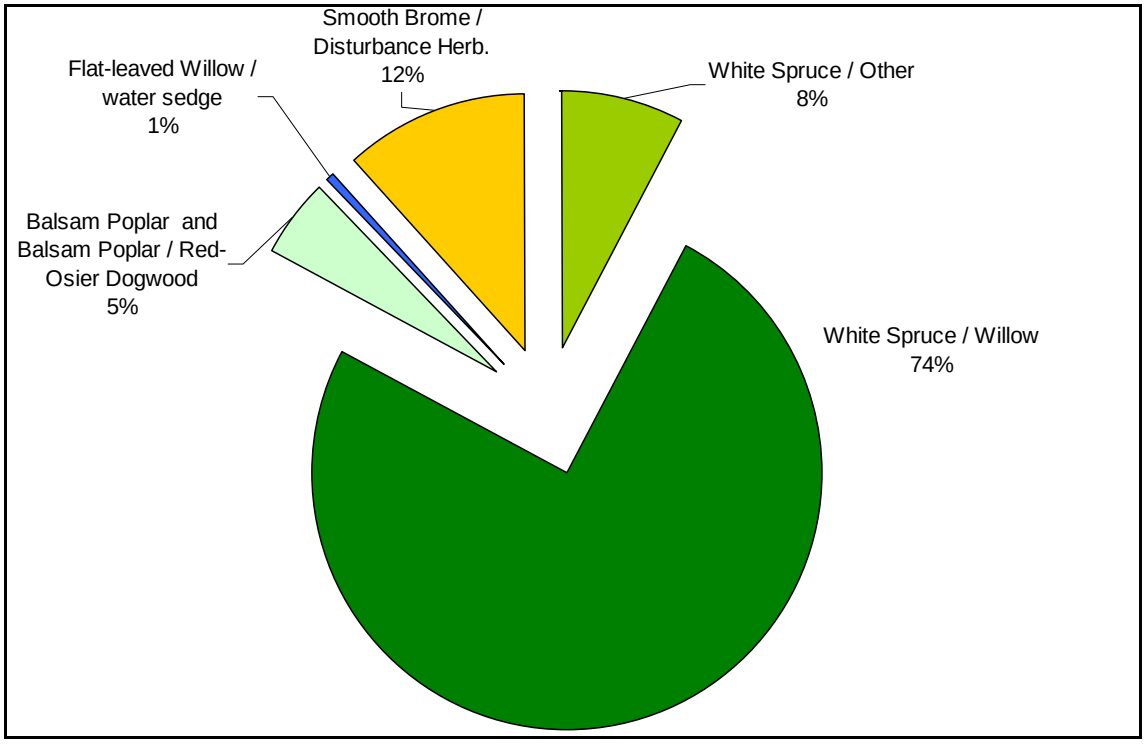


Figure 9. Dominant Plant Community Types in the Project Area.

Three other white spruce community types collectively comprise 8% of the project area (Table 8, Figure 9). These types have either an understory of common horsetail (*Equisetum arvense*), moss (Photo b, page 21), or thimbleberry (*Rubus parviflorus*). Coniferous communities with a moss or horsetail understory provide very little herbaceous forage for livestock and are generally considered 'non-use' community types. Moss and horsetail understory vegetation is sensitive to high intensity land uses (e.g. OHV use or frequent trampling by livestock). Deciduous tree communities (e.g. balsam poplar [*Populus balsamifera*] types) provide higher amounts of preferred forage for livestock and wild ungulates but only comprise about 5% of the project area (Table 8).

Shrub Communities

Lush, beaver modified wet meadow habitat along a tributary to Waiparous Creek (WAZ1) is characterized by a flat-leaved willow (*Salix planifolia*) – water sedge (*Carex aquatilis*) Habitat Type (Photo c, page 21). This Habitat Type is unique to this site in our project area. This Habitat Type is particularly susceptible to soil compaction impacts from livestock or recreational uses due to fine textured and saturated soil conditions.

Herbaceous Communities

Non-native disturbance-caused herbaceous community types (Photo d, page 21) are fairly abundant, making up almost 12% of the project area (Table 8, Figure 9). These communities mainly occur in disturbed open meadows that have been impacted by historical or ongoing cumulative land uses (e.g. grazing, forestry, recreation, industrial development etc.). These communities are generally dominated by a mix of introduced (i.e. non-native) and / or weedy species such as Kentucky bluegrass, timothy (*Phleum pratense*), quack grass (*Agropyron repens*), smooth brome (*Bromus inermis*), alsike

clover (*Trifolium hybridum*) and common dandelion.

Plant Species Diversity in the Project Area:

Overall there is an excellent diversity of plant species in the project area. Greater plant species diversity creates more robust and steady primary productivity over the long term and enhances resilience to changes in the environment due to natural year-to-year fluctuations, climate change, pest outbreaks, disease, etc.

- 8 tree species and 51 shrub species were recorded in the project area (Appendix C). All of these are native species with the exception of yellow clematis (*Clematis tangutica*), an invasive ornamental vine that was found in trace amounts in the WAI9 site along Waiparous Creek near the Village of Waiparous. Dominant trees and shrubs include: white spruce, balsam poplar, lodgepole pine (*Pinus contorta*), Drummond's willow, river alder, beaked willow, bog birch, flat-leaved willow, prickly rose (*Rosa acicularis*) and Canada buffaloberry (*Shepherdia canadensis*).
- 68 species of grasses and grass-like plants (58 of which are native) and 177 species of forbs (broad-leaved flowering plants) (150 of which are native) were recorded in the project area (Appendix C). Dominant grass / grass-like species (listed in order of decreasing abundance) include Kentucky bluegrass, timothy, quack grass, bluejoint (*Calamagrostis canadensis*), hairy wild rye (*Elymus innovatus*), smooth brome, tufted hair grass (*Deschampsia cespitosa*), water sedge and wire rush (*Juncus balticus*). Dominant forbs include common horsetail, alsike clover, ox-eye daisy (*Chrysanthemum leucanthemum*), common fireweed (*Epilobium angustifolium*), common dandelion (*Taraxacum officinale*) and cow parsnip (*Heracleum lanatum*). A diversity of native orchids (e.g. the Sparrow's-egg lady's slipper [*Cypripedium passerinum*]) and other wildflowers (e.g. common red paintbrush [*Castilleja miniata*]) are also present but generally only in small amounts.

Sparrow's-egg lady's-slipper

Common red paintbrush

C. Wood, RHIP01HID006

Photo a: A white spruce / willow Habitat Type is the characteristic plant community along most of the Westslope Cutthroat Trout mountain streams in the project area.

D. White, RHIP01ZEP013

Photo b: A dense, shaded white spruce / moss community occurs along the upper reaches of Zephyr Creek. This community has low herbage production value for livestock, but it does offer suitable habitat conditions for Westslope Cutthroat Trout.

C. Ball, RHIP01WAZ002

Photo c: The beaver modified lush meadow habitat along a tributary to Waiparous Creek (WAZ1) is characterized by a Flat-leaved Willow / Water Sedge Habitat Type.

K. Hull, MONT01LST0002

Photo d: Disturbed meadow habitats associated with old roadways, OHV trails, random campsites or in areas with heavy livestock use are characterized by disturbance-caused herbaceous community types with high cover from introduced grasses and / or weedy species.

EXAMPLES OF RIPARIAN PLANT COMMUNITY TYPES IN THE PROJECT AREA

4.3 Vegetation Health Parameter Results

The average vegetation health rating for the Westslope Cutthroat Trout RHI sites is 80% (*Healthy)*. With some exceptions, most sites have more than 95% vegetation cover in the riparian area, healthy levels of establishment and regeneration of native trees and shrubs, low levels of woody vegetation removal by beavers or humans, and low levels of dead and decadent trees and shrubs (Figure 10). Of concern are invasive and non-native disturbance-caused species which are fairly widespread in some sites. As well, five sites have moderate to heavy levels of woody browse (Figure 10).

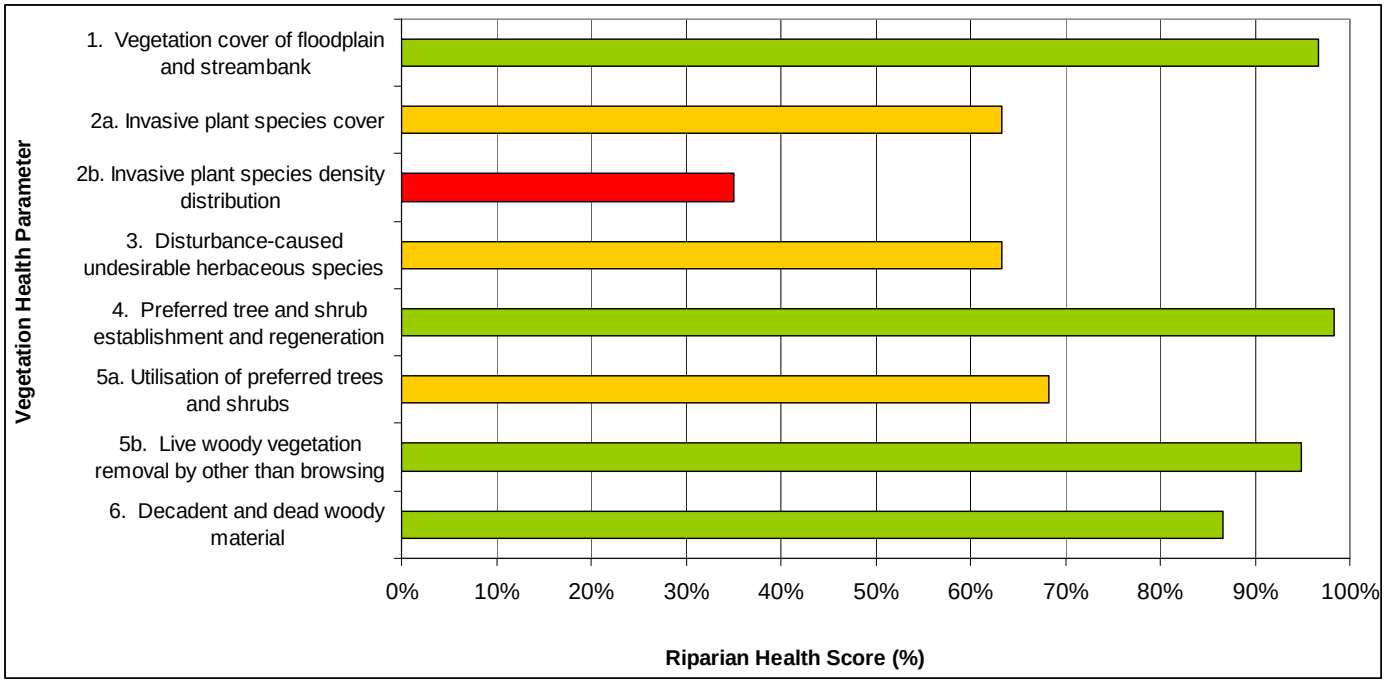


Figure 10. Vegetation Health Parameter Results.

Herbaceous (Non-Woody) Riparian Health Parameters

Disturbance-caused undesirable herbaceous species as well as invasive species are prevalent in the project area. Disturbance plants are typically non-native grasses and forbs that aggressively displace native plants once the soil surface has been disturbed. Invasive plants are introduced species that are listed on Alberta's *Weed Control Act* as **prohibited noxious and noxious** weeds and others known to be problematic in riparian areas. They are non-native species that spread rapidly and are difficult to control.

An influx of shallow-rooted invasive and disturbance-caused plants can negatively impact streambank stability, resulting in potential for accelerated bank erosion and loss of overhanging cover for Westslope Cutthroat Trout, increased sedimentation and water quality concerns, and loss of productive land due to erosion. Many invasive species such as ox-eye daisy (*Chrysanthemum leucanthemum*) and tall buttercup (*Ranunculus acris*) are avoided by livestock as they are highly unpalatable and have poor forage value. Tall buttercup also contains high concentrations of an irritant, protoanemonin that causes

inflammation of the throat and digestive tract in livestock and can be fatal if large quantities are ingested (Tannas 2004). Widespread incursion of invasive and non-native disturbance-caused plants may also alter the dynamics of natural food webs due to displacement of preferred native plant species that have evolved with the local fauna.

- **The prevalence of invasive plants is a concern.** Seven invasive species were recorded in the project area, including **six *noxious weeds*** [blueweed (*Echium vulgare*), Canada thistle, common mullein (*Verbascum thapsus*), oxeye daisy, perennial sow-thistle (*Sonchus arvensis*), tall buttercup] and **one *prohibited noxious weed*** [orange hawkweed (*Hieracium aurantiacum*)]. A single small patch of orange hawkweed was found in the LST1 site along Lost Creek. Prohibited noxious weeds are of particular management concern as they are not yet widespread in the province; priority weed control efforts should be directed at eradicating these weeds before they spread and become much more difficult to manage.
- **The most widespread and abundant invasive species in the project area are ox-eye daisy** (found in six sites and comprising 3.4% of the project area), **tall buttercup** (found in 12 sites and comprising 0.7% of the project area), and **Canada thistle** (found in 12 sites and comprising 0.6% of the project area). Ox-eye daisy is especially prevalent in the Castle River watershed along Lost Creek, North Lost Creek and Lynx Creek (Photo e, page 24). It was also recorded at trace levels in 2005 along Blairmore Creek (BLC1) and the Carbondale River tributary (CRT1). Tall buttercup has highest cover in the Johnson Creek sub-basin (including along JOY1 and JOH3) (Photo f, page 24), while Canada thistle is present in trace amounts in most sites except for higher cover along Willow Creek (WIL15).
- **Collectively, invasive plants comprise 4% of the project area.** Invasive plants have more than 1% cover in 5 sites and greater than 15% cover in 1 site (LST1) due to high cover from ox-eye daisy. Only 5 of the 20 sites were found to be free of invasive species at the time of the RHI inventory (WAI9, WAZ1, HID1, HID2 and OLD37).
- Invasive plants are widely distributed throughout the project area with 13 sites (i.e. 65%) having unhealthy scores for invasive species density distribution. This indicates distribution or infestation (a function of weed density and spread throughout a site) is high overall.
- **Non-native disturbance-caused plants are widespread in the project area.** Six of the 20 sites have greater than 25% of the riparian area covered in disturbance-caused herbaceous species (Figure 10). These species cover approximately 41% of the project area.
- Of the 26 disturbance-caused plants present, 11 are native species like wild strawberry (*Fragaria virginiana*) and silverweed (*Potentilla anserina*) that naturally colonize areas of exposed soil. However, the most prevalent disturbance-caused plants are introduced, non-native species including Kentucky bluegrass, timothy, quack grass, alsike clover, smooth brome and common dandelion that have encroached due to cumulative impacts from human land use disturbances in the watershed (Photos g and h, page 24).
- Despite the abundance of disturbance-caused plants, native grasses and forbs continue to be maintained within the project area.

K. Stebanuk, RHIP01LST017

Photo e: Ox-eye daisy is especially abundant along Lost Creek where it is encroaching from an old (inactive) road that parallels the north side of the creek.

K. Hull. RHASIPS0045

Photo f: Tall buttercup occurs in 60% of the RHI sites. It is especially abundant along Johnson Creek (JOH3) and the unnamed tributary to Johnson Creek (JOY1) in the Willow Creek Watershed.

K. Stebanuk, RHIP03JOH005

Photo g: Non-native, disturbance-caused species like Kentucky bluegrass, timothy, clovers and dandelion are encroaching into riparian sites from disturbed roadsides and trails in the project area

C. Wood. RHIP01JOY008

Photo h: Pipeline rights-of-way are another source of non-native disturbance-caused herbaceous species, such as this pipeline crossing near the downstream end of the unnamed Johnson Creek tributary (JOY1). Disturbance-caused plants lack deep binding roots, contributing to outward channel erosion here.

HERBACEOUS (NON-WOODY) VEGETATION HEALTH PARAMETER PHOTOGRAPHS

Total Vegetation Cover and Woody Canopy Cover

A high level of vegetation cover in the riparian area, in particular cover from native trees and shrubs, provides soil stabilization and minimizes potential for erosion or runoff of sediment into trout bearing streams. Undisturbed native riparian habitats in the foothills and montane regions of Alberta typically all have potential to support tree and shrub community types given adequate annual precipitation levels combined with frequent flood events following snow melt. A diversity of native woody plants is especially important for providing low, medium, and tall "habitat layers", benefitting shelter and cover availability for fish, wildlife and livestock. A diversity of trees and shrubs also improves bank and soil stability by providing improved diversity of rooting depths across the site.

- With the exception of 2 sites, all other RHI sites in the project area have greater than 95% vegetation cover in the riparian zone (Photo i, page 26).
- A wide variety of native trees and shrubs in combination cover 78% of the project area. Refer to page 20 and Appendix C for a listing of dominant tree and shrub species in the project area.

Woody (Tree and Shrub) Riparian Health Parameters:

- *Establishment and Regeneration*

A good indicator of ecological stability of a riparian reach is the presence of woody plants in all age classes, especially young age classes. To maintain age class structure, at least 15% of the total cover of preferred[6] trees and shrubs should be comprised of seedlings and saplings. Preferred woody plants include deeply rooted native species and / or preferred browse species for livestock or wildlife such as red-osier dogwood and willows. There are no concerns with the regeneration and establishment of young-age classes of preferred trees and shrubs in the project area (Figure 10) (Photo j, page 26).

- *Browse Pressure / Woody Plant Removal*

In 75% of sites, preferred trees and shrub species are receiving minimal browse pressure from livestock and wildlife. Woody plants can sustain low levels of use but greater browse pressure can deplete root reserves and inhibit establishment and regeneration. Five sites (three of which are in the upper Willow Creek watershed) show signs of moderate to heavy browse pressure. Livestock use is likely a contributing factor to browse utilization in the Willow Creek watershed since access is not limiting and other indicators of livestock use are apparent. The indicators of heavy browse pressure are umbrella-shaped mature shrubs and flat-topped or hedged seedling and saplings (Photo k, page 26).

Live woody vegetation removal unrelated to browse (e.g. human cutting, clearing or beaver use) is minimal, with most sites showing limited or no signs of this type of removal (Figure 10). The only exception is the LYX2 site. Road construction, OHV trails and random camping activities along the upper reach of Lynx Creek (LYX2) have contributed to removal of more than 25% of the woody vegetation on this site.

[6] See Appendix F, for further explanation and a list of excluded species.

D. White, RHIP02HID010

Photo i: The majority of the project area has healthy levels of riparian vegetation cover from a diversity of native plant species, in particular white spruce and willow species.

C. Wood, RHIP37OLD004

Photo j: There are healthy levels of native tree and shrub regeneration in most sites. New willow growth is especially common along newly deposited alluvial point bars.

K. Hull , RHASUTS0014

Photo k: Five RHI sites have moderate to heavy levels of browse utilization of preferred woody forage species such as willows. This browse pressure is likely from a combination of livestock and wildlife use. Heavily browsed shrubs have a hedged or 'flat-topped' appearance.

D. White, RHIP01NLS003

Photo l: The 2003 Lost Creek fire resulted in extensive fire damage to riparian sites along Lost Creek, North Lost Creek and Lynx Creek in the Castle River watershed. New re-growth of willows is helping to offset loss of root-mass protection along portions of the fire impacted reaches.

WOODY (TREE AND SHRUB) VEGETATION HEALTH PARAMETER PHOTOGRAPHS

- ***Woody Canopy Dead and Decadence***

With the exception of sites in the Castle River watershed, existing tree and shrub communities show normal amounts of dead and decadent branches in the upper canopy. This indicates there is sufficient moisture within the system, and that disease is not a problem in maintaining these communities.

The 2003 Lost Creek fire severely impacted the North Lost Creek and Lost Creek sites, contributing to more than 45% dead / dying trees in the woody canopy in the NLS1 site (Photo l, page 26) and more than 25% dead / dying trees in the woody canopy of the LST1 site. The Lynx Creek sites were less severely impacted, with both sites having 5% to 25% of the canopy cover comprised of fire killed trees. Standing, rooted dead / dying fire-damaged trees still contribute to overall vegetation cover although they are easily susceptible to wind and flood damage. Burnt areas are expected to heal over time through natural processes of tree and shrub regeneration, but in the interim they are susceptible to accelerated rates of bank erosion and instability due to loss of streambank root mass protection.

4.4 Soil and Hydrology Health Parameter Results

The average soil / hydrology health rating for the Westslope Cutthroat Trout RHI sites is 87% (*Healthy)*. Most sites have minimal amounts of human-caused bare ground, few streambank structural alterations and unincised channel profiles that allow for natural flooding to occur unimpeded (Figure 11). Natural and human-caused land use disturbances have contributed to slightly to moderately reduced levels of streambank root mass protection in 50% of the sites (Figure 11). Human-caused soil compaction and alterations in the floodplain beyond the bank are a concern in 10 sites, 4 of which have severe amounts of alterations (>15%), while 6 others have minor amounts of alterations (>5%).

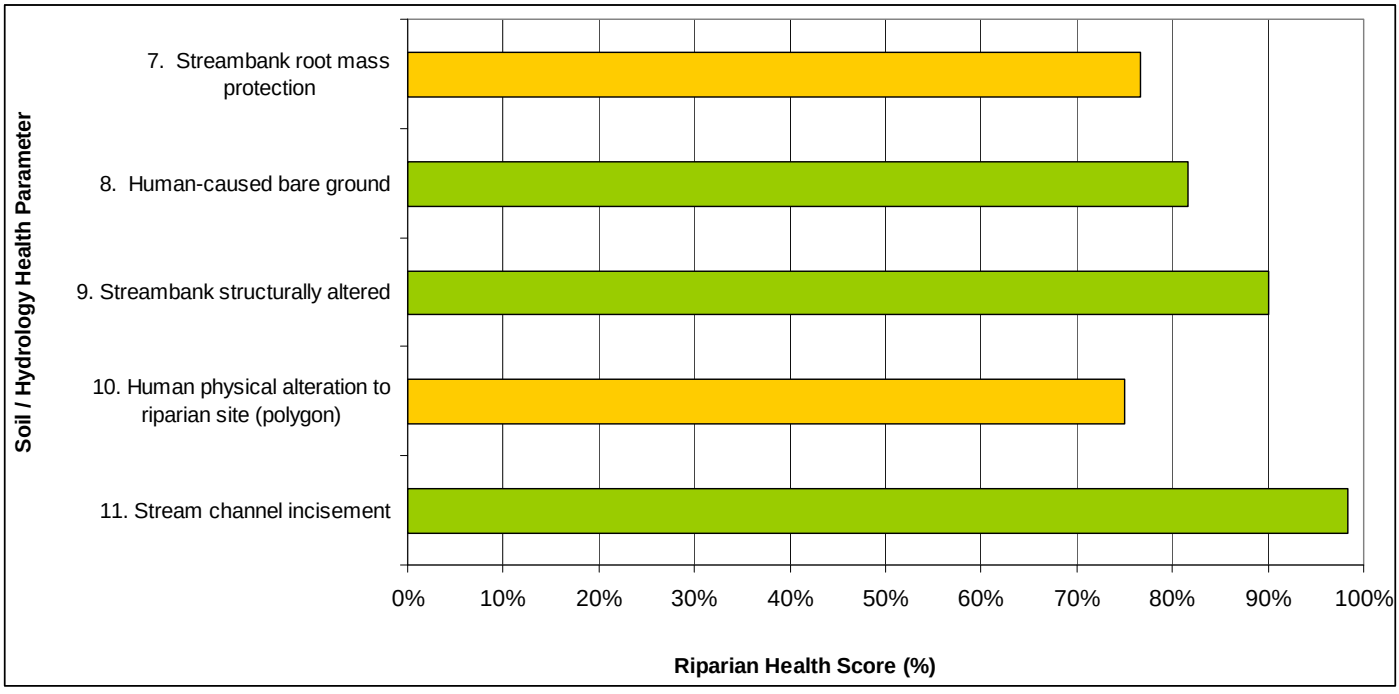


Figure 11. Soil / Hydrology Health Parameter Results.

Streambank Stability and Root Mass Protection

The role of streambank vegetation is to maintain the integrity and structure of the bank by dissipating energy, resisting erosion and trapping sediment to build and restore banks. Healthy, well vegetated riparian areas slow the rate of erosion and balance erosion in one spot with bank increases through deposition elsewhere. If unstable banks are occasional, limited to a few outside meander bends, and the banks revegetate within a year, erosion rates are likely normal. Accelerated bank erosion and removal of streambank vegetation can lead to rapid loss of riparian function, including degradation of habitat for Westslope Cutthroat Trout due to sediment inputs, loss of overhead cover, depleted water quality and degraded spawning and rearing habitat.

- 10 sites (50%) have healthy levels of streambank root mass protection (i.e. >85% of the reach has deep, binding root mass along the bank).
- 6 sites (30%) have slightly reduced levels of streambank root mass protection due to human / natural causes (i.e. 65% to 85% of the reach has deep, binding root mass along the bank).
- 4 sites (20%) have moderate to highly reduced levels of streambank root mass protection due to human / natural causes (i.e. 35% to 65% of the reach has deep, binding root mass along the bank). Two of these sites (LST1 and NLS1) were severely impacted by the Lost Creek 2003 fire event, resulting in natural loss of woody cover along the streambank (Photo o, page 30). Invasion of ox-eye daisy (a shallow rooted creeping weed) in these and other sites in the Castle River watershed is also contributing to reduced root-mass protection (Photo m, page 30). Human removal of woody cover and bank alterations from road construction and recreational uses contribute to reduced root mass protection along the upper reach of Lynx Creek (LYX2) (Photo p, page 30). Human-caused bank alterations (i.e. livestock and recreational uses) combined with the prevalence of non-native disturbance caused plants (Photo n, page 30), contribute to reduced root mass protection along the upper reach of Willow Creek (WIL15). This site is also naturally more susceptible to elevated flood intensities due to it's headwater position, stream gradient and linear channel morphology.

Human-caused Bare Ground

Bare ground is unprotected soil that is capable of being eroded by rain drops, overland flow and wind. Bare ground in riparian areas is often present due to natural processes (e.g. sediment deposition from recent flood events). Bare ground can also result from activities such as vehicle traffic, livestock hoof shear and trailing, recreational trails, timber harvest, and landscaping. Areas of natural or human-caused bare ground are susceptible to the encroachment of invasive and disturbance-caused species. Elevated levels of exposed soil due to human-causes can also contribute to abnormally high sediment inputs into trout bearing streams with negative consequences to availability of suitable spawning habitat and degraded water quality concerns.

- Approximately 5% (2 ha) of the total project area has bare ground, 75% of which is attributed to human rather than natural causes. Recreational land uses (including roads and trails) account for the majority of human-caused bare ground (i.e. approximately 75% of the human-caused bare ground is from recreational activities). Livestock use is a secondary contributor to bare

ground (i.e. approximately 25% of the human-caused bare ground is due to livestock trails or heavy use areas).

- 8 sites have elevated levels of human-caused bare ground, 3 of which (JON1, LYX2 and WIL15) have high levels (i.e. 5% to 15%), mainly due to recreational activities such as OHV trails and random campsites. Of particular concern are rutting, 'mud-bogging', accelerated erosion and bare soil impacts from intense OHV use at the upstream end of the JON1 site (Photo s, page 31) along Johnson Creek, a major tributary to Waiparous Creek. Fencing and signage were recently installed to restrict OHV use at this location, however, evidence of unauthorized use was observed in 2010.

Human-caused Alterations to the Streambank and Floodplain

A key function of riparian areas is to have abundant plants which filter and trap sediment. This builds a soil layer of moist, fine-textured material. Associated with this, roots and underground fauna create soil structure and macropores that allow water infiltration and storage. These types of soils are very susceptible to vehicle traffic, hoof action and compaction. When a streambank is physically altered, erosion can increase, mobilizing channel and bank materials. As a consequence, water quality can deteriorate and instability can increase within the reach as well as downstream, with negative consequences to Westslope Cutthroat Trout habitat and downstream water users.

- Overall most of the sites (75%) have minimal (<5%) human-caused streambank alterations. Four sites have 5% to 15% of altered bank length and two others have >15% of their bank length altered by human activities.

- In total, approximately 0.8 km of bank length in the entire project area (i.e. approximately 6% of the total streambank length examined) has evidence of human-caused stream crossings or other bank alterations. *Although minor in spatial extent, streambank alterations such as heavily used stream crossings can have a significant impact on water quality depending on time of use and the erodibility of the substrate at the crossing location.*

- The dominant causes of bank alterations are recreational trails and livestock hoofshear/ trampling (Photos q and r, page 31). These land uses account for 80% of the bank alteration types and each impacts a similar proportion of the total bank length (i.e. 0.3 km). Three sites have bank alterations due to rip-rap bank armouring associated mainly with road / trail construction (JOH3, JOY1 and LYX2). A small percentage of bank length has been altered due to vegetation removal in two sites (OLD37 and LYX2) associated with random camping activities.

- 10 of the 20 sites have less than 5% of the entire riparian area (excluding streambanks) physically altered by human causes (these sites all rate as *healthy* for this parameter). 4 sites have severe levels of human-caused floodplain alterations (i.e. >15%), while the remaining 6 sites have minor levels of floodplain alterations (i.e. 5% to 15%).

- Overall, about 13% (5.5 ha) of the project area, away from the streambank, has human-caused alterations. Soil compaction is the dominant kind of floodplain alteration, with recreational uses contributing to 66% of the compacted area (Photos s and t, page 31) and livestock trampling contributing to 33% of the compacted area. Road and / or pipeline construction has impacted a small portion of the JOY1, JOH3 and LYX2 sites.

K. Stebanuk, RHIP01LST007

Photo m: Ox-eye daisy is prolific along portions of Lynx Creek. This shallow-rooted, invasive species does not provide sufficient root-mass protection to stabilize streambanks and prevent accelerated rates of erosion.

C. wood. RHIP15WIL008

Photo n: Streambank reaches with high cover from non-native disturbance-caused species such as Kentucky bluegrass are subject to accelerated rates of erosion and bank slumping due to absence of deeply rooted plants.

K. Stebanuk, RHIP02LYX003

Photo o: The 2003 Lost Creek fire has contributed to reduced root mass protection along streambank reaches with fire killed trees.

K. Stebanuk. RHIP02LYX016

Photo p: Portions of the upper reach of Lynx Creek have been altered due to rip-rap bank armouring adjacent to the gravel road. Rip-rap removes important shelter and cover habitat and it can contribute to accelerated rates of erosion downstream or channel widening where floodwater erodes behind the rip-rap as in this photograph.

SOIL AND HYDROLOGY HEALTH PARAMETER PHOTOS

C. Wood, RHIP15WIL009.

Photo q: Most of the inventoried stream reaches in the project area have only isolated streambank alterations such as from stream crossings.

C. Wood. RHIP01JON005

Photo r: Intensively used OHV stream crossings, although small in extent, can have potentially severe negative impacts to water quality especially where crossing locations impact highly erodible fine-textured soils.

C. Wood, RHIP01JON007

Photo s: Recreational activities are the primary cause of soil compaction and bare ground in the project area. Of particular concern are heavy OHV impacts to a portion of the Johnson Creek floodplain in the Waiparous Creek watershed.

K. Stebanuk. RHIP02LYX017

Photo t: Random camping impacts are apparent in several sites and contribute to soil compaction, woody vegetation removal, spread of weeds, bare ground exposure and erosion concerns.

SOIL AND HYDROLOGY HEALTH PARAMETER PHOTOS

Channel Incisement

Periodic flood events are important to disperse moisture throughout the riparian area for the maintenance of riparian vegetation. Flooding also spreads the energy of moving water over the riparian area, allowing sediment to be deposited and creating new areas for seedling tree and shrub establishment. Channel incisement, or downcutting, can limit the ability of a river to access its floodplain during high water events. Streams are incised when downcutting has significantly lowered the channel so that the average two-year flood event cannot escape the existing channel.

- All sites in the project area rate healthy for this parameter. This means that high water events can periodically access the highest terraces of the floodplain indicating that these stream reaches are not incised.

4.5 Additional Westslope Cutthroat Trout Habitat Data

Channel Substrate Data

In keeping with described habitat preferences for Westslope Cutthroat Trout, the 2011 RHI stream channel reaches are mainly comprised of a mix of coarse gravel (26%), small cobbles (24%), fine gravel (19%) and large cobbles (9%) (Table 9, Figure 12). Small and medium boulders are also commonly occurring along the assessed reaches. *Detailed stream channel substrate data are given in Appendix D.*

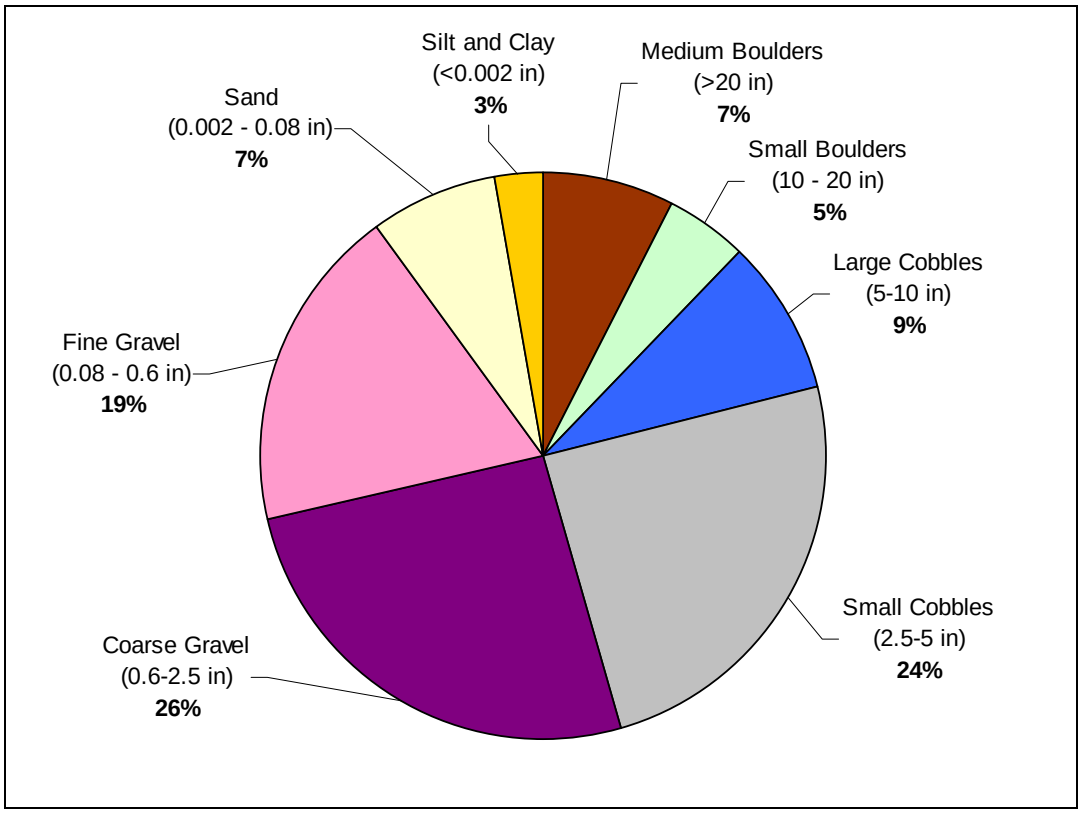
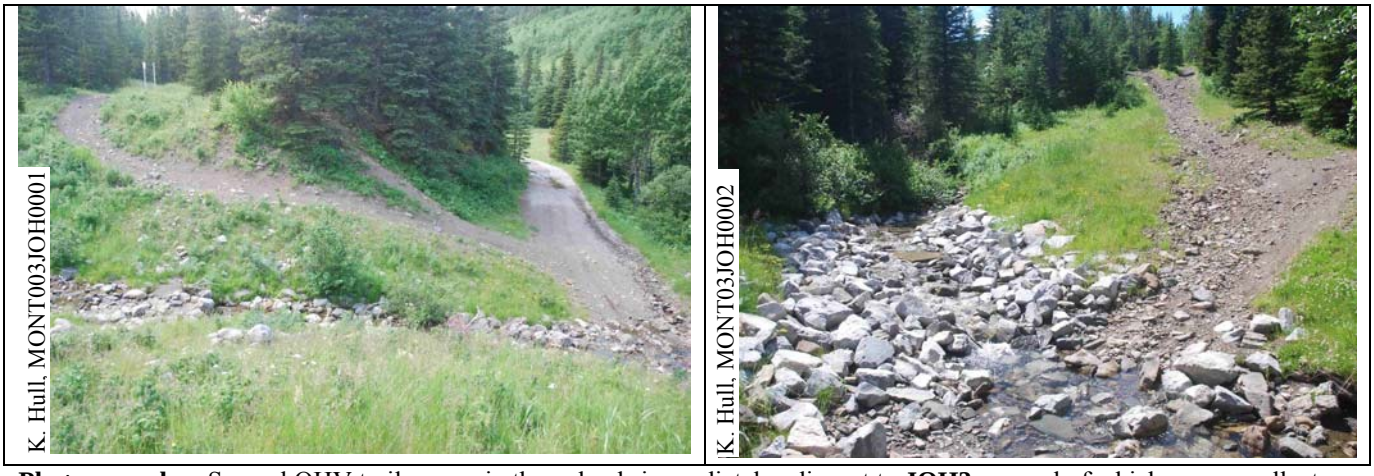


Figure 12. Average Channel Substrate Composition in the 2011 RHI Project Area.

Table 9. Average Channel Substrate Composition for the 2011 RHI Stream Reaches.

RHI Site ID	Medium Boulders (>20 in)	Small Boulders (10 - 20 in)	Large Cobbles (5-10 in)	Small Cobbles (2.5-5 in)	Coarse Gravel (0.6-2.5 in)	Fine Gravel (0.08 - 0.6 in)	Sand (0.002 - 0.08 in)	Silt and Clay (<0.002 in)
COL1	0%	0%	0%	44%	20%	14%	11%	11%
COL2	1%	5%	16%	34%	26%	16%	2%	0%
DEE1	4%	0%	3%	19%	36%	29%	8%	0%
HID1	14%	15%	15%	17%	26%	10%	2%	0%
HID2	29%	14%	10%	23%	18%	2%	0%	3%
JOH3	9%	4%	11%	28%	22%	15%	6%	5%
JOY1	0%	0%	6%	23%	33%	27%	8%	2%
LST1	2%	3%	12%	27%	22%	16%	10%	8%
LYX1	21%	9%	19%	16%	20%	13%	1%	1%
LYX2	11%	0%	1%	29%	27%	17%	8%	6%
NLS1	5%	6%	13%	20%	22%	28%	3%	4%
OLD37	2%	4%	19%	39%	20%	10%	4%	1%
SHA1	0%	0%	4%	18%	34%	30%	13%	1%
WIL15	0%	0%	3%	13%	35%	30%	18%	1%
ZEP1	14%	12%	9%	26%	17%	15%	6%	2%

On average, most of the 2011 RHI reaches have channel bottoms comprised of less than 5% silt and clay (Table 9). Exceptions include COL1 (the downstream reach of Corral Creek), LYX2 (the upper reach of Lynx Creek), LST1 (Lost Creek) and JOH3 (Johnson Creek in the Willow Creek watershed). Human-caused alterations to the bank and the floodplain combined with reduced root mass protection may be contributing factors to elevated levels of channel siltation for the COL1 and LYX2 sites. Erosion of OHV trails upslope from JOH3 may be contributing to sedimentation of this stream.



Photos u and v: Several OHV trails occur in the uplands immediately adjacent to **JOH3**, several of which cross small, steep tributaries that feed directly into Johnson Creek.

Fire disturbance, reduced root mass protection and upstream OHV stream crossings may be contributors to elevated sediment levels in the LST1 site.

Potential Barriers to Fish Movement

Ten possible barriers to fish movement were observed in the 2011 RHI sites (Table 10). This includes 1 to 3 possible barriers along each of the following streams: the unnamed tributary to Johnson Creek (JOY1), Johnson Creek (JOH3), Deep Creek (DEE1), Hidden Creek (HID2) and Zephyr Creek (ZEP1) (Table 10). Except for a hanging culvert at the road crossing at the downstream end of JOY1, these are all naturally formed barriers created by log jams, bedrock steps or natural waterfalls. All of these barriers are likely passable by fish during high flow periods with the exception of the natural water fall at the downstream end of HID2.

Table 10. Potential Barriers to Trout Movement in the 2011 RHI Project Area.

RHI Site ID	Waypoint	UTM Easting	UTM Northing	Zone	Fish barrier Height (m) / (ft)	Fish barrier type
JOY1	JOY1L	685332	5566986	11U	N/A	Hanging culvert at road crossing
JOY1	JOY1B	685286	5566976	11U	0.5 m / 1.5 ft	Log jam/falls
JOY1	JOY1G	684972	5566761	11U	0.6 m / 2 ft	Log jam/falls
JOH3	JOH3C	684908	5565964	11U	N/A	Log jam
DEE1	DEE1A	678100	5589492	11U	0.9 m / 3 ft	Bedrock step
DEE1	DEE1I	678530	5589214	11U	0.9 m / 3 ft	Log fall
HID2	HID2L	677446	5539153	11U	4.5 m / 15 ft	Log jam over rock water fall
ZEP1	ZEP1L	672332	5584245	11U	0.5 m / 1.5 ft	Rock step
ZEP1	ZEP1A	672327	5584227	11U	0.5 m / 1.5 ft	Rock step
ZEP1	ZEP1B	672308	5584202	11U	1 m / 3.5 ft	Log jam, rock step

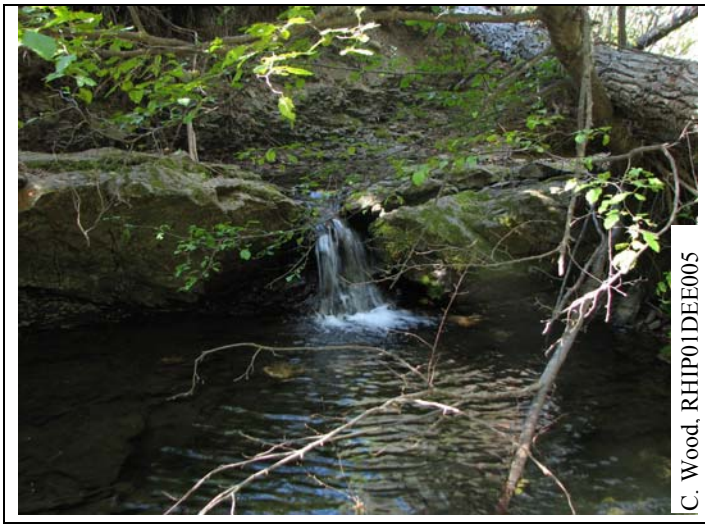


Photo w: Natural rock fall along Deep Creek (possible barrier to fish movement during low flow periods).

Photo x: Hanging culvert (barrier to fish passage) at the downstream end of JOY1.

5 LANDOWNER AND MULT-STAKEHOLDER CONSULTATION

A multi-stakeholder workshop, coordinated by Cows and Fish, was held on February 29, 2012 at the M.D. of Ranchland Administrative Building at Chain Lakes Provincial Park. The workshop was aimed at bringing together various land user groups and land managers in the Westslope Cutthroat Trout project area. The purpose of the workshop was to build awareness about the habitat requirements and threats facing Westslope Cutthroat Trout and to begin a collaborative process to identify solutions and encourage beneficial land management practices that will benefit Westslope Cutthroat Trout recovery. Workshop partners included SRD, DFO, TUC and the MD of Ranchland. The workshop was facilitated by David Green (Manager of the Southwest Alberta Sustainable Community Initiative).

Including the workshop presenters, 60 participants attended the workshop, including:

- 11 livestock producers;
- 3 energy sector representatives;
- 1 forestry industry representative;
- 5 private environmental consulting firm representatives from 4 firms;
- 1 recreational user group representative;
- 13 environmental non-governmental organization (ENGO) representatives from 8 ENGOs;
- 2 Water Stewardship Group directors;
- 2 community members (general public);
- 1Watershed Planning and Advisory Council;
- 2 Municipality Agricultural Fieldmen;
- 1 Parks Canada and 2 DFO representatives (federal natural resource managers);
- 4 SRD, Lands Division – Rangeland Management representatives;
- 4 SRD, Forestry Division representatives;
- 2 SRD, Fish and Wildlife Division representatives;
- 3 AEW representatives;
- 1 Alberta Agriculture and Rural Development representatives; and
- 2 Alberta Tourism, Parks and Recreation representatives.

Key messages and next steps from this workshop will be summarized in a separate cover report. The majority of workshop participants indicated an interest for further dialogue and collaboration. Cows and Fish hopes to secure funding to build on this initiative and facilitate similar workshop sessions with our project partners in the near future.

6 THE NEXT STEPS

This project has established an important baseline to compare to in the future to help track riparian health in select priority Westslope Cutthroat Trout streams. In addition to being a robust monitoring tool, riparian health inventories are also an important mechanism to generate awareness and prompt beneficial land use changes. Pending renewed funding through ACA and Environment Canada, this project will be expanded over the next few years, including completion of additional RHIs in priority Westslope Cutthroat Trout habitat and follow-up stakeholder consultation workshops and interaction.

Results from this project were provided to SRD to assist with land use management and planning decisions and strategies in the Westslope Cutthroat Trout project area. Individual one-on-one meetings were conducted with SRD Rangeland Agrologists and grazing allotment holders in the project area to discuss site specific results. Every participating grazing allotment holder received a report on the riparian health for their allotment indicating the health and function of their riparian areas. Within these reports are some basic management principles specific to their riparian areas. These and other management suggestions are provided below to help guide land user and community groups and land / natural resource managers with riparian health improvement initiatives in the project area.

Management Suggestions:

- **Monitor, control and prevent the spread of invasive plant species**.
  Invasive species are a concern in the project area. Ongoing efforts are required to monitor and control *prohibited noxious* weeds such as orange hawkweed and *noxious weeds* such as ox-eye daisy, tall buttercup and Canada thistle. Industrial and recreational user groups should be informed about invasive species concerns and encouraged to assist with weed control, monitoring and prevention efforts. Occurrences of prohibited noxious weeds should be reported to SRD Public Lands and / or the local Municipal / County Agricultural Fieldman.

  A pilot, web-based reporting and mapping tool is now available in Alberta to assist with the early detection of emerging weed threats in Alberta (i.e. *prohibited noxious* weeds). This tool, the **Early Detection and Distribution Mapping System (EDDMapS)** is available on-line at: http://www.eddmaps.org/Alberta/. SRD field staff, County and Municipal Agricultural field staff, grazing allotment holders, recreational user groups and industry environmental monitoring staff should be familiar with this tool and encouraged to submit weed data on an on-going basis. Appendix E provides step-by-step instructions for reporting an invasive plant to EDDMapS Alberta (including instructions for recording weed location, density distribution, habitat data and photography requirements). Currently only 15 prohibited noxious weed species are being tracked using the EDDMapS tool (refer to http://www.eddmaps.org/Alberta/ for a species list).

General Weed Prevention Strategies:

- Ensure that feed for horses brought into Public Lands in the eastern slopes is certified 'weed-free'.
- Ensure that vehicles and equipment are appropriately cleaned before entering weed-free areas to prevent the spread of weeds from infested areas.
- Avoid new human-caused ground disturbance in riparian areas adjacent to Westslope Cutthroat Trout priority streams (including creation of new trails, roads or random camping areas).

 **Ox-eye daisy**	Livestock generally avoid grazing ox-eye daisy and are not useful as a control agent. Grazing management strategies that maintain the health and vigour of native plants will help prevent the spread of ox-eye daisy. Repeated mowing helps prevent seed production, but it also can stimulate re-sprouting of stems. Hand-pulling or digging before flowering may be effective, provided as much as of the root system as possible is dug-up at the same time. Chemical herbicides may also be effective for ox-eye daisy control. Consult with your local Agricultural Fieldman or Rangeland Agrologist for assistance. For best success, an integrated, watershed-based approach and ongoing control efforts will be required over several years.
 **Tall buttercup**	Good pasture management will help prevent the spread of tall buttercup. Close mowing prior to flowering and / or hand pulling can be effective on small infestations. Be sure to wear gloves and long sleeves as the plant's juices can cause blistering and redness. Consult with your local Agricultural Fieldman or Rangeland Agrologist for other control options.
 **Canada thistle**	Most of the biomass of Canada thistle plants is below ground; therefore killing the roots is the only effective control method. An integrated management plan that uses a variety control options (pulling, mowing, chemical) is the only real chance of reducing infestations.

For more information on invasive species in Alberta and management strategies, refer to the Alberta Invasive Plant Council website (http://www.invasiveplants.ab.ca/).

- **Reduce encroachment of non-native disturbance-caused species.**
  One of the best techniques to limit the encroachment of non-native disturbance-caused species is to limit soil disturbance. Areas that have been subject to repeated disturbance often require complete rest from disturbance (a temporary or permanent closure of the area) in order to recover. Many non-native disturbance-caused species are not tolerant of heavy shading. Therefore, encouraging thick tree and shrub regrowth will limit their expansion or establishment. Full recovery of native species is unlikely in existing modified areas (i.e. areas with more than 70% cover from non-native such as Kentucky bluegrass). In these areas, maintaining existing native species components and limiting new disturbance is a priority.

- **Protect and maintain existing native riparian plant communities.**
  Most riparian area functions are dependent on the maintenance of diverse, vigorous stands of native plant communities, in particular tree and shrub community types. An integral part of maintaining and improving riparian health in the project area is to ensure that existing native riparian plant communities are protected and sustained in a healthy condition.

- **Minimize human-caused alterations and ground disturbance in and adjacent to riparian areas.**
  Human activities should be carefully managed in and adjacent to riparian areas to prevent alterations to the riparian area including soil compaction, bare ground, soil erosion or damage to streambanks. Willow / sedge communities with fine-textured, saturated soils are particularly susceptible to these types of impacts and should be excluded from use. Seasonal timing restrictions may also be appropriate to avoid impacts during the early, wet spring season when trail braiding, run-off, soil compaction and damage to new growth is likely to be most severe.

- **Maintain sustainable stocking rates and monitor livestock grazing impacts in the riparian area.**
  SRD, Public Lands is responsible for managing livestock grazing in Public Lands within the project area in collaboration with grazing allotment holders. Sustainable stocking rates should continue to be informed based on ongoing monitoring of upland range and riparian health, livestock and wildlife utilization levels and livestock distribution patterns. Stocking rates and grazing distribution strategies should be continually adapted to minimize impacts to primary use areas and sensitive riparian habitats. Impacts of recreational and industrial land uses on the landscape (e.g. logging) should also be factored into range management decisions.

- **Avoid spring grazing in the riparian area and provide sufficient growing-season rest.**
  Riparian areas are vulnerable to compaction in the spring, when streambanks are saturated. It is therefore important to continue to avoid grazing during this early season period. It is also important to ensure that native rangelands are provided with sufficient rest during the growing

season to allow plants to replenish stored carbohydrate reserves and maintain their productivity and vigour.

- **Adequately distribute livestock grazing pressure away from riparian areas.**
  Easily accessible riparian areas with herbaceous understory vegetation are often subject to heavy use from livestock. In these situations it is important to employ various strategies to improve livestock distribution, for example:
  - place salt/mineral/oilers up to 400 m from water sources and from each other;
  - provide off-stream water sources to reduce cattle use of sensitive riparian habitat;
  - cross-fence or use drift fencing in large grazing units; and / or
  - regularly herd livestock to desired areas.

  Off-stream watering facilities and salt / mineral / oilers should be placed in stable upland areas not subject to erosion or runoff. It is also important to avoid impacts to sensitive native plant habitats or areas with fragile, erodible or saturated soils. To be used most effectively, salt / mineral sites should be moved frequently in order to attract livestock to strategic grazing locations. Salting / mineral locations should be carefully monitored for weed, bare soil and erosion concerns.

- **Promote natural recovery of woody species in burned areas.**
  Riparian areas in recently burned watersheds should be carefully managed to promote natural recovery of woody species. Seedling and saplings willows and poplars are especially vulnerable to livestock browse impacts.

- **Manage and monitor recreational trails.**
  Careful use, maintenance and monitoring of designated recreational trails is required to ensure these trails are not negatively impacting Westslope Cutthroat Trout habitat due to erosion, soil compaction or direct damage to sensitive spawning streams. Existing access management plans should be closely reviewed, monitored on the ground, and more strictly enforced to prevent the use / creation of unauthorized trails and to allow for reclamation of trails in sensitive riparian habitats. OHV use should be restricted within riparian areas to a few select crossing points to limit structural disturbances to streambanks and soil exposure. Stream crossing areas should be designated according to their suitability to stream system dynamics and ability to minimize ecological impact.

  Trail closures or seasonal trail use restrictions should be considered for high risk areas such as steep slopes and sensitive riparian habitats / streambanks with fine textured organic soils. Areas that are dominated by willow – sedge communities are generally water saturated for the majority of the growing season. Rutting and trail braiding / widening can be severe when use occurs on wet soils. Off road vehicle use causes serious long-term damage on these sites. Identification and avoidance of these sites should be a priority for maintaining watershed function and protecting Westslope Cutthroat Trout habitat.

User access fees or user pay systems (e.g. taxes on OHV vehicle registrations) could be considered to help fund trail maintenance, monitoring and enforcement of access management plans. Year-round, permanent field staff (e.g. field rangers or Forest Officers) may be required in high use areas to better monitor recreational activities, respond to concerns and help promote meaningful education and awareness opportunities.

- **Manage and monitor random camping activities.**
  No new random camping activities should be permitted in priority Westslope Cutthroat Trout riparian habitat. Existing random campsites in sensitive sites should be relocated to more sustainable locations where appropriate.

  Where random camping activities are permitted, existing SRD PLUZ guidelines and "Respect the Land" guidelines should be more closely monitored and enforced. Existing guidelines state that random campsites should be at least 30 m (100 feet) from lakes, rivers and streams and that existing vegetation and live trees are to be left undisturbed (www.srd.alberta.ca). More stringent regulations, enforcement and education efforts are needed to prevent random camping on sensitive alluvial aquifers where there is higher potential for water contamination concerns due to a lack of sanitation facilities. More efforts are also needed to monitor and control weed, bare ground and erosion issues in high use random camp sites and to ensure protection of native riparian vegetation.

- **Develop design guidelines for trail maintenance and OHV bridge crossings.**
  Appropriate, safe and approved bridge crossings should be installed at stream crossings that are presently endangering aquatic life and causing sediment loading, riparian degradation and bank instability along priority Westslope Cutthroat Trout streams. SRD and DFO are encouraged to pro-actively work with industry and recreational user groups to develop suitable design guidelines and hands-on workshops for trail maintenance and OHV bridge crossing structures as well as education on appropriate use on Public Land. Collaboration with industry and recreational user groups is required to identify unsustainable, eroding trails and high risk crossing locations where erosion controls and / or bridge installation is recommended.

- **Strategically allow damaged portions of the riparian area time to heal.**
  Temporary fencing may be used to prevent further degradation of riparian areas where there are bare ground, soil compaction or soil erosion concerns. Natural recovery is usually possible in areas adjacent to intact native plant communities. All recovery efforts should aim to engage land users and land managers for greatest effect.

- **Improve public education and awareness about Westslope Cutthroat Trout and potential impacts from recreational activities.**

  Public education and awareness campaigns aimed at recreational user groups are needed to develop a greater public concern for Westslope Cutthroat Trout and their habitat needs. This type of education campaign can be tied into efforts to protect water quality in headwater areas.

  Tools to promote awareness could include:
  - public educational signage;
  - strategic water quality monitoring days before and after long-weekends in the peak of the summer season;
  - public demonstration fish population surveys;
  - riparian health awareness field days and workshops;
  - televised awareness stories and education messaging via local news media.

- **Better inform forestry and industrial user groups as to the location of threatened Westslope Cutthroat Trout habitat in Alberta to prevent new disturbances in sensitive watersheds.**

  SRD, Fish and Wildlife and DFO are encouraged to work with forestry and industry groups to better inform cumulative effects management and land use planning in watersheds with remaining Westslope Cutthroat Trout populations. This may entail sharing maps and fish population data to identify priority habitats and ensure no new development activities in sensitive Westslope Cutthroat Trout watersheds.

Monitoring Suggestions

- **Map and monitor all existing stream crossing locations on priority Westslope Cutthroat Trout streams.**

  Mapping and monitoring of existing stream crossings is recommended to better identify high risk crossing locations where bridge or trail improvements are needed to lessen potential for sedimentation or direct damage to Westslope Cutthroat Trout habitat.

- **Monitor water quality along priority Westslope Cutthroat Trout streams to better understand the cumulative impacts of existing and proposed land use activities and developments.**

  To better assess and manage cumulative land uses in sensitive Westslope Cutthroat Trout watersheds, ongoing water quality monitoring is needed during critical periods. Baseline water quality monitoring should be done in undisturbed watersheds and compared with watersheds with higher levels of existing or planned developments or high-intensity land uses. Additionally, water quality monitoring could be strategically done during critical periods such as before, during and after busy long-weekends during the spawning season or before, during and after proposed logging or industrial development activities. Water quality monitoring results would provide valuable information to help improve and inform land use planning and

management (e.g. livestock grazing management; recreation and access management planning; bridge, road or trail improvements; forestry / industry best management practices etc.).

A key limitation with riparian health evaluations is that no data is acquired concerning water quality. Even where riparian areas are intact and healthy, heavily used stream crossings or runoff loads from adjacent uplands can degrade water quality. For example, Cows and Fish riparian health results suggest that riparian health in the Waiparous Creek watershed is healthy on average (Halawell *et al.* 2011). However, a 2006 water quality study commissioned by Alberta Environment found that sediment loading coefficients in the lower regions of Waiparous Creek were much greater than expected for a stream draining a forested environment in the Upper Foothills Natural Subregion (Andrews 2006). Sediment loads were considered abnormally high even in comparison to streams draining agricultural lands at lower elevations where sediment erosion is a common problem (Andrews 2006). Motorized recreational use was described as being one of the main contributors to high sediment loads in the Waiparous basin (Andews 2006).

- **Monitor riparian health of priority Westslope Cutthroat Trout streams, in particular those with existing or proposed impacts from human land-use activities.**

  More extensive riparian health monitoring is needed in all watersheds with remaining pure Westslope Cutthroat Trout populations to identify riparian health concerns throughout its current range. Only a small subset of priority streams was sampled as part of this project.

  To assess riparian health trend, Cows and Fish generally recommends that extensive riparian health inventories be repeated at least every five years by qualified professionals. Ongoing, yearly community-based monitoring of riparian health is also encouraged at 'hotspot' sites of concern. The field workbook Riparian Health Assessment for Streams and Small Rivers (Fitch *et al.* 2001) is available from Cows and Fish. This workbook explains how to conduct a rapid survey to quickly check the health status of your riparian area. Cows and Fish provides outdoor field workshops to community or land user groups interested in learning how to apply this tool.

  Photography monitoring is another way that community or user groups can participate in tracking changes in riparian health. Benchmark photographs were taken as part of our study at the upstream and downstream end points of each riparian health inventory site, and at other locations of interest within riparian health sites. These benchmark photographs can be repeated yearly by community volunteers to track changes in riparian health especially at sites where impacts have occurred. Other locations of concern not encompassed by our study can also be photographed for monitoring purposes, as warranted by SRD and DFO field staff and / or land user groups.

7 CLOSING

The Cows and Fish emphasis is to help individuals, resource managers, municipalities and local communities address riparian management issues on a watershed basis by increasing awareness and obtaining baseline riparian health information. This riparian health assessment enables local communities and managers to identify and effectively develop plans to address specific land use issues. Working locally to develop common goals and objectives for entire watersheds is rewarding – it helps keep people invested in natural landscapes.

To inquire about additional references for riparian health monitoring and management and for further information on any aspect of this report, please contact:

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GLOSSARY

Bankfull channel width – width of a stream channel at the point where high water will begin to escape the channel during floods. This point may be determined by: the elevation at the top of depositional features like sand, silt or gravel bars; changes in bank material from coarse substrate within an active channel to deposited material of a smaller size; or exposed roots below an intact, vegetated soil layer indicating erosion.

Canopy cover – the ground area covered by vegetative growth. Different plant species can provide varying degrees of cover depending on their overall size and abundance. Total canopy cover can be greater than the area being studied due to overlap in plant structural layers.

Community type – An aggregation of all plant communities distinguished by floristic and structural similarities in both overstory and undergrowth layers. For the purposes of this document, a community type represents seral vegetation, and is never considered to be climax.

Disturbance-caused undesirable herbaceous species – native or introduced non-woody plant species that are well adapted to disturbance or an environment of continual stress. This term *does not* include invasive plant species.

Floodplain – the land base alongside a stream that has the potential to be flooded during high water events.

Habitat type – the land area that supports, or has the potential to support, the same primary climax vegetation. It is based on the potential of the site to produce a specific plant community (plant association).

Human-caused bare ground – areas devoid of vegetation as a result of human activity. This can include vehicle roads, recreational trails and livestock trampling.

Invasive plant species – plant species that are designated by the *Weed Control Act* of Alberta as *restricted* or *noxious* weeds, as well as some additional species identified by Cows and Fish and / or Public Lands (Alberta Sustainable Resource Development) to be invasive within riparian areas.

Lotic – this term means *flowing water* (i.e., streams and rivers).

Lentic – this term means *standing* or *still water* (i.e., lakes, ponds and sloughs).

Pointbar – areas along the stream edge where sediment has been naturally deposited by moving water. These typically occur on the inside portion of a channel bend. Also known as a *sandbar*.

Polygon – term used to describe a riparian inventory site. On lotic systems, a polygon has an upstream and downstream end along a reach of a stream and an associated riparian width. The lateral extent (width) of the riparian area is subjectively determined in the field based on vegetation and terrain clues indicating the flood prone area.

Reach – section of a stream or river with similar physical and vegetative features and similar management influences.

Stream channel incisement – the degree of downward erosion within the channel bed.

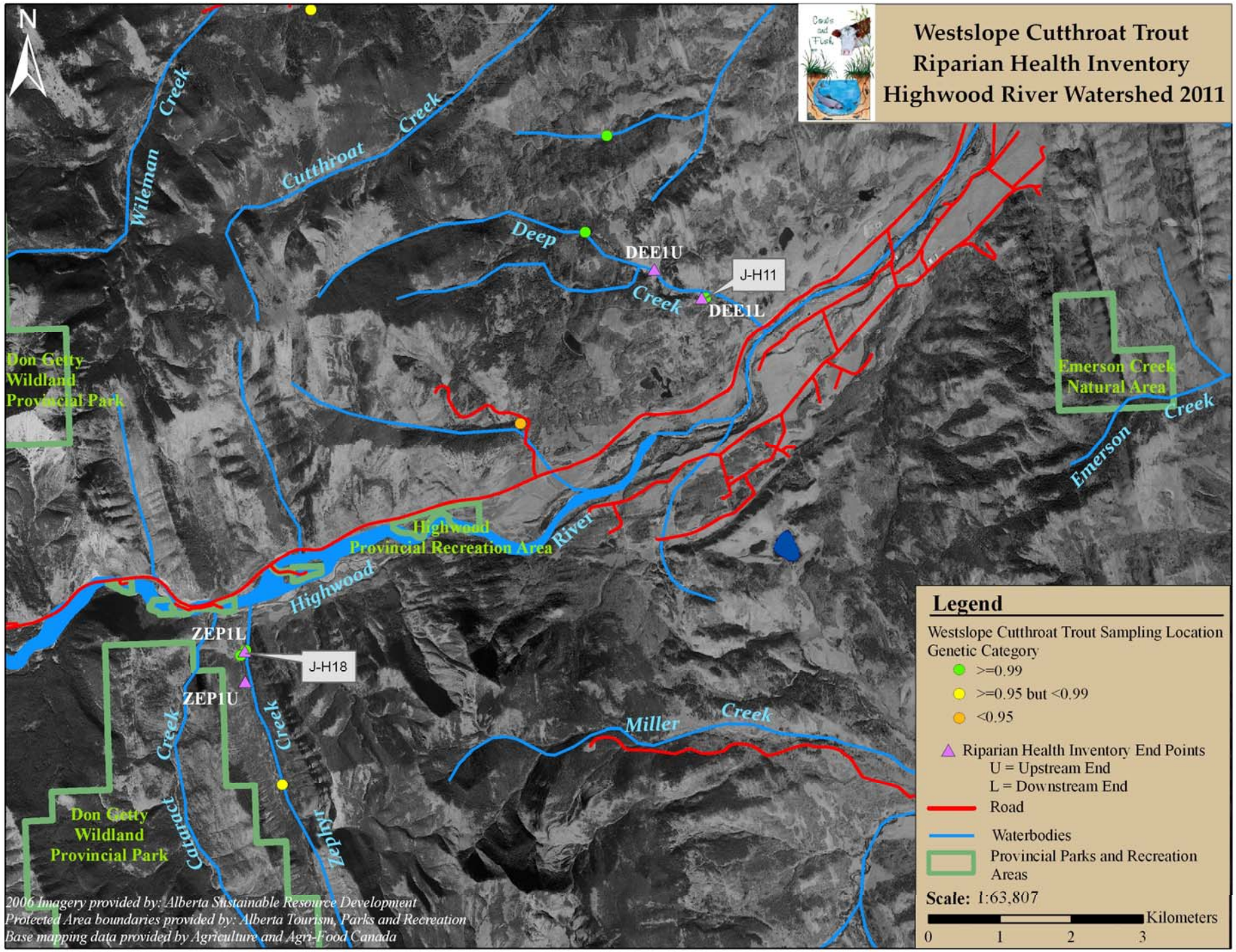
Structural alteration – physical changes to the shape or contour of the streambank caused by human influences. Some examples are livestock crossings, culverts and 'riprap'

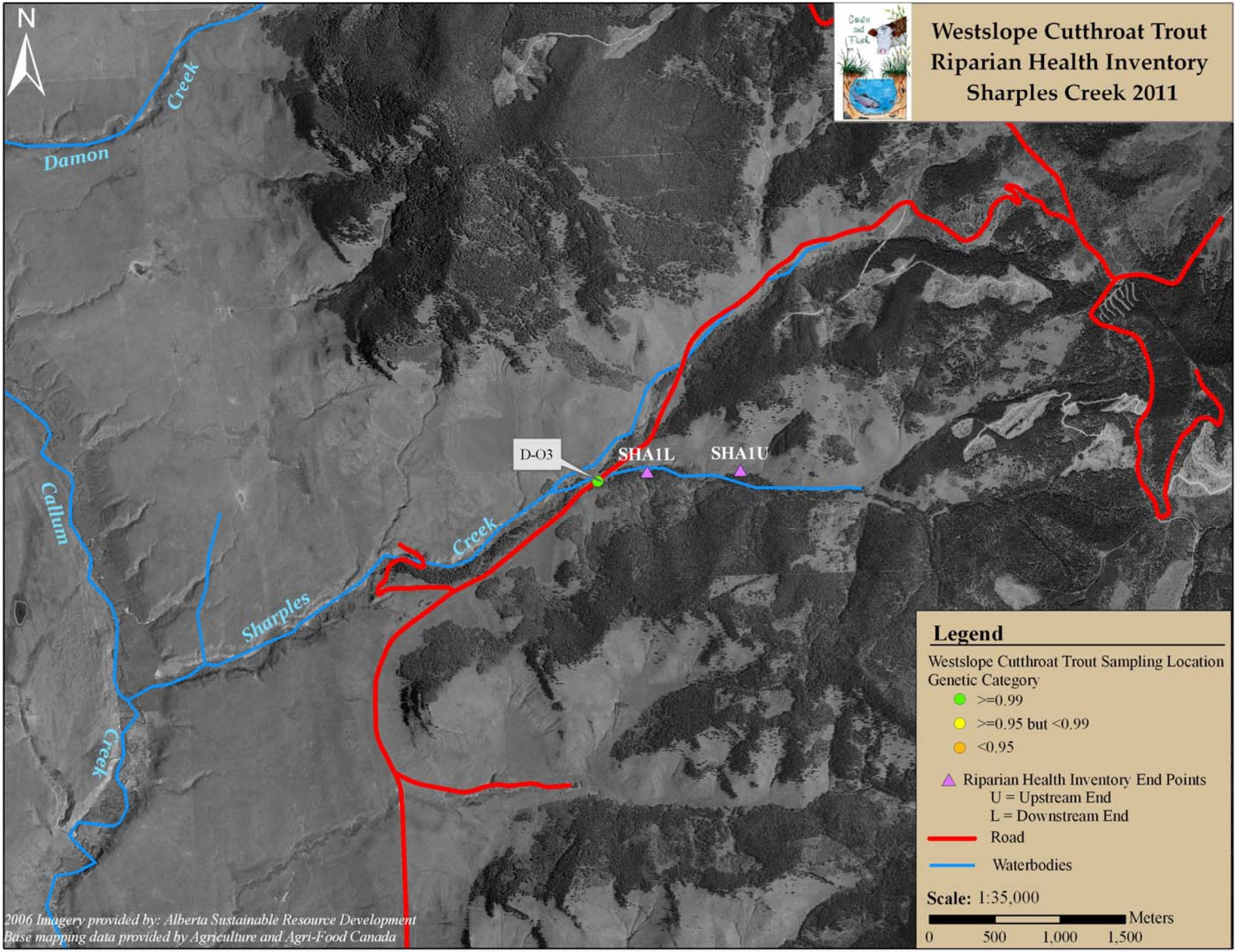
Tree and shrub regeneration – the presence of seedlings and saplings, or the 'new growth'.

Woody plant species – simply refers to trees and shrubs. These plants serve different riparian functions than grasses and broad-leaf plants.

APPENDIX A

2011 RHI WATERSHED MAPS


Westslope Cutthroat Trout
Riparian Health Inventory
Highwood River Watershed 2011
N
Wileman Creek
Cutthroat Creek
Deep Creek
DEE1U
DEE1L
J-H11
Don Getty Wildland Provincial Park
Emerson Creek Natural Area
Emerson Creek
Highwood Provincial Recreation Area
Highwood River
ZEP1L
ZEP1U
J-H18
Miller Creek
Cataract Creek
Zephyr Creek
Don Getty Wildland Provincial Park
Legend
Westslope Cutthroat Trout Sampling Location
Genetic Category
>=0.99
>=0.95 but <0.99
<0.95
Riparian Health Inventory End Points
U = Upstream End
L = Downstream End
Road
Waterbodies
Provincial Parks and Recreation Areas
Scale: 1:63,807
Kilometers
0 1 2 3
2006 Imagery provided by: Alberta Sustainable Resource Development
Protected Area boundaries provided by: Alberta Tourism, Parks and Recreation
Base mapping data provided by Agriculture and Agri-Food Canada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Riparian Health Inventory
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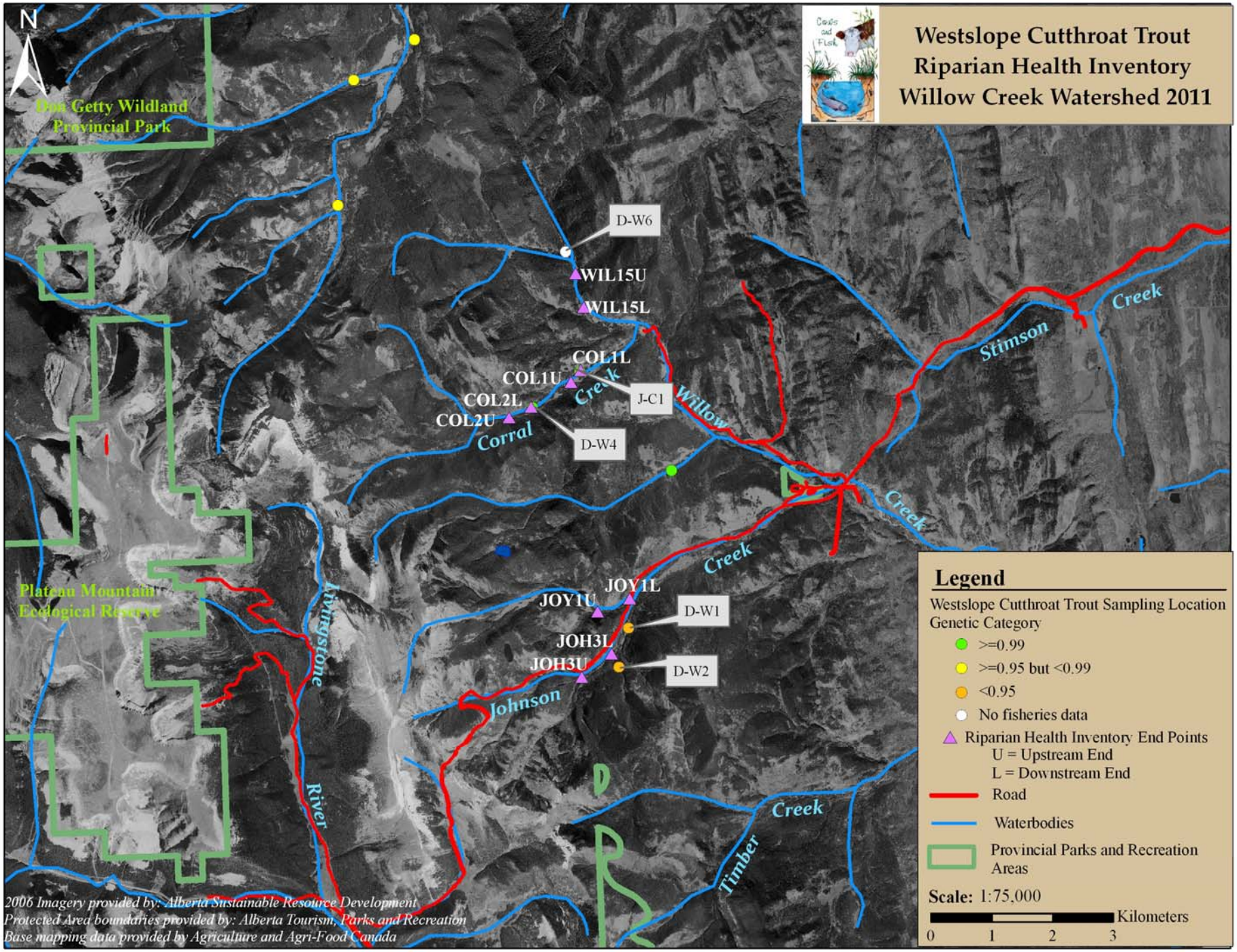
Damon
Creek
Callum
Creek
Sharples
Creek
Creek
D-O3
SHA1L
SHA1U
Legend
Westslope Cutthroat Trout Sampling Location
Genetic Category
>=0.99
>=0.95 but <0.99
<0.95
Riparian Health Inventory End Points
U = Upstream End
L = Downstream End
Road
Waterbodies
Scale: 1:35,000
Meters
0
500
1,000
1,500
2006 Imagery provided by: Alberta Sustainable Resource Development
Base mapping data provided by Agriculture and Agri-Food Canada


Westslope Cutthroat Trout
Riparian Health Inventory
Willow Creek Watershed 2011
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Don Getty Wildland
Provincial Park
Plateau Mountain
Ecological Reserve
D-W6
WIL15U
WIL15L
COL1L
COL1U
COL2L
COL2U
J-C1
D-W4
D-W1
D-W2
JOY1L
JOY1U
JOH3L
JOH3U
Willow
Creek
Stimson
Creek
Corral
Creek
Creek
Livingstone
River
Johnson
Creek
Timber
Creek
Legend
Westslope Cutthroat Trout Sampling Location
Genetic Category
>=0.99
>=0.95 but <0.99
<0.95
No fisheries data
Riparian Health Inventory End Points
U = Upstream End
L = Downstream End
Road
Waterbodies
Provincial Parks and Recreation Areas
Scale: 1:75,000
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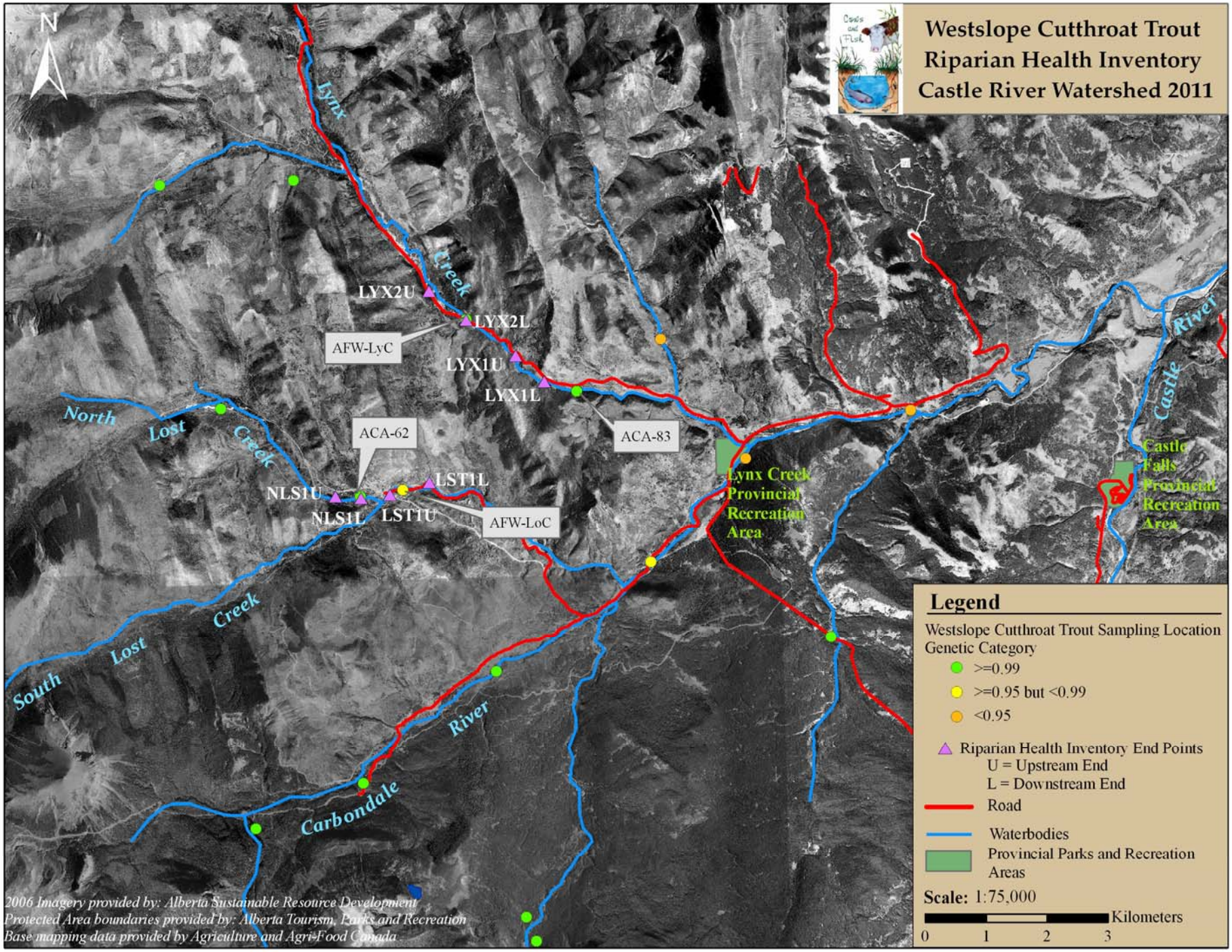
Westslope Cutthroat Trout
Riparian Health Inventory
Castle River Watershed 2011
N
Lynx Creek
LYX2U
LYX2L
AFW-LyC
LYX1U
LYX1L
ACA-83
ACA-62
North Lost Creek
NLS1U
NLS1L
LST1L
LST1U
AFW-LoC
Lynx Creek Provincial Recreation Area
Castle River
Castle Falls Provincial Recreation Area
South Lost Creek
River
Carbondale
2006 Imagery provided by: Alberta Sustainable Resource Development
Protected Area boundaries provided by: Alberta Tourism, Parks and Recreation
Base mapping data provided by Agriculture and Agri-Food Canada
Legend
Westslope Cutthroat Trout Sampling Location
Genetic Category
>=0.99
>=0.95 but <0.99
<0.95
Riparian Health Inventory End Points
U = Upstream End
L = Downstream End
Road
Waterbodies
Provincial Parks and Recreation Areas
Scale: 1:75,000
Kilometers
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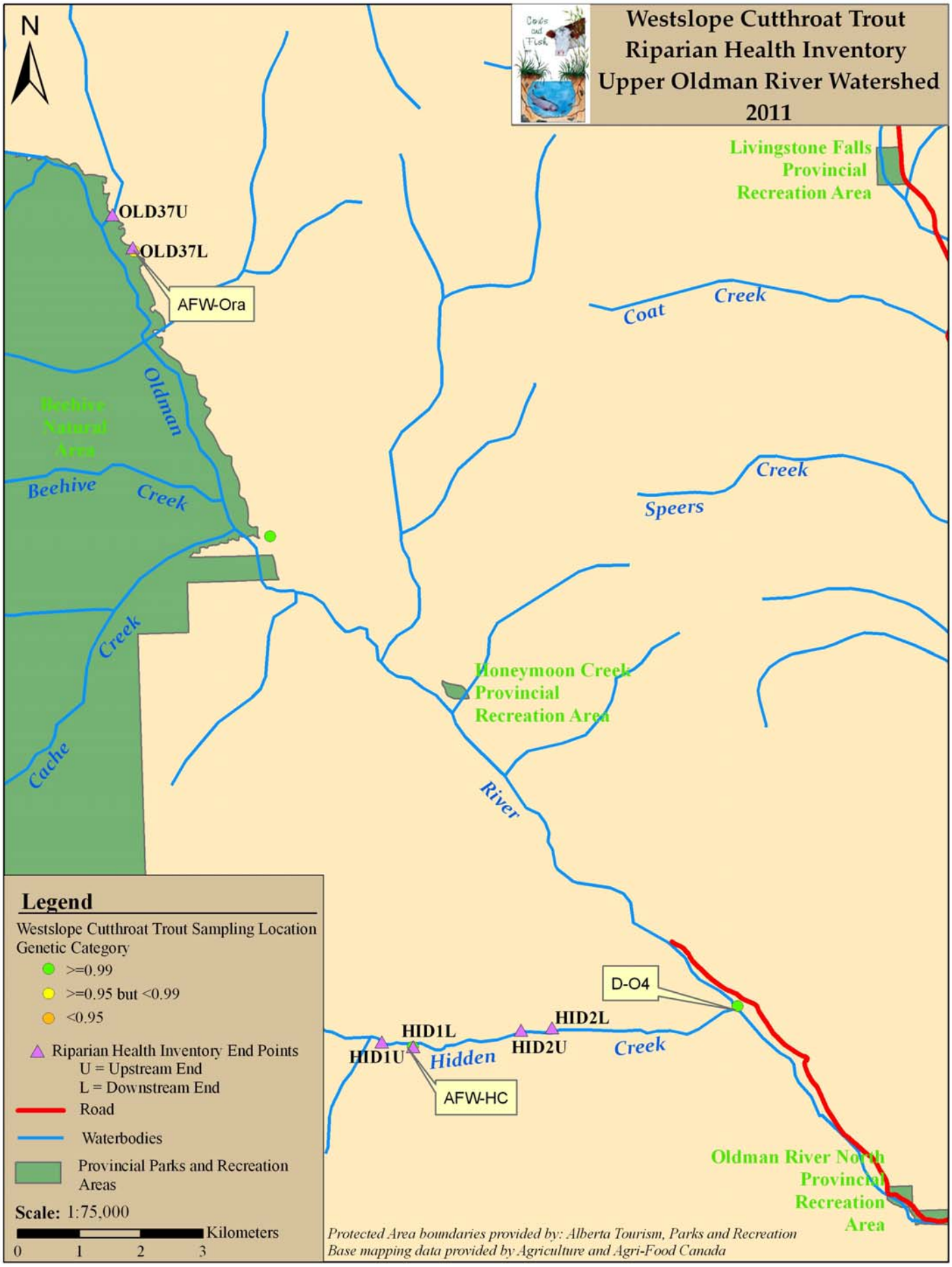

Westslope Cutthroat Trout
Riparian Health Inventory
Upper Oldman River Watershed
2011
N
Livingstone Falls
Provincial
Recreation Area
OLD37U
OLD37L
AFW-Ora
Coat
Creek
Oldman
Beehive
Natural
Area
Beehive
Creek
Speers
Creek
Creek
Honeymoon Creek
Provincial
Recreation Area
Cache
River
D-O4
HID2L
HID1L
HID1U
Hidden
HID2U
Creek
AFW-HC
Oldman River North
Provincial
Recreation
Area
Legend
Westslope Cutthroat Trout Sampling Location
Genetic Category
>=0.99
>=0.95 but <0.99
<0.95
Riparian Health Inventory End Points
U = Upstream End
L = Downstream End
Road
Waterbodies
Provincial Parks and Recreation Areas
Scale: 1:75,000
Kilometers
0
1
2
3
Protected Area boundaries provided by: Alberta Tourism, Parks and Recreation
Base mapping data provided by Agriculture and Agri-Food Canada

APPENDIX B

RHI UPSTREAM AND DOWNSTREAM UTM LOCATIONS

RHI Site ID	UPSTREAM UTM COORDINATE (Zone: 11U)		DOWNSTREAM UTM COORDINATE (Zone: 11U)	
	Easting	**Northing**	**Easting**	**Northing**
BLC1	683413	5509027	683497	5509044
COL1	684366	5570554	684706	5570858
COL2	683349	5569969	683710	5570145
CRT1	689076	5478581	689068	5478622
DEE1	678063	5589580	678729	5589189
HID1	674686	5538926	675199	5538848
HID2	676940	5539112	677446	5539153
JOH3	684546	5565691	685034	5565077
JON1	631900	5694451	632363	5694767
JOY1	684802	5566771	685332	5566986
LST1	681934	5480351	682580	548055
LYX1	684002	5482641	684468	5482221
LYX2	682576	5483712	683186	5483228
NLS1	681037	5480317	681457	5480291
OLD37	670323	5552295	670657	5551760
SHA1	711639	5529589	710925	5529579
WAI9	650635	5683838	650625	5683508
WAZ1	633031	5696082	633294	5696572
WIL15	684440	5572342	684576	5571786
ZEP1	672336	5583810	672332	5584245

APPENDIX C

WESTSLOPE CUTTHROAT TROUT PROJECT AREA, RIPARIAN PLANT SPECIES INVENTORY

Plant Species Name[1]	Plant Status[2]	Area by Species (ha)	% Canopy Cover[3]	Constancy[4]	Percent of Project Area
TREES					
aspen (*Populus tremuloides*)	native	0.2	0.6%	70%	<1%
balsam poplar (*Populus balsamifera*)	native	3.7	9.2%	90%	9%
black spruce (*Picea mariana*)	native	0.1	3.0%	5%	<1%
Engelmann spruce (*Picea engelmannii*)	native	0.1	40.0%	5%	<1%
fir (*Abies* spp.)	native	<0.1	3.0%	5%	<1%
lodgepole pine (*Pinus contorta*)	native	0.9	2.7%	65%	2%
subalpine fir (*Abies lasiocarpa*)	native	0.3	2.0%	35%	1%
white spruce (*Picea glauca*)	native	22.3	53.2%	100%	53%
SHRUBS					
alpine bearberry (*Arctostaphylos rubra*)	native	<0.1	0.5%	5%	<1%
balsam willow (*Salix pyrifolia*)	native	0.1	0.5%	30%	<1%
basket willow (*Salix petiolaris*)	native	0.5	3.5%	20%	1%
beaked hazelnut (*Corylus cornuta*)	native	<0.1	0.5%	5%	<1%
beaked willow (*Salix bebbiana*)	native	1.9	4.8%	90%	4%
bog birch (*Betula glandulosa*)	native	1.4	8.9%	35%	3%
bracted honeysuckle (*Lonicera involucrata*)	native	0.7	2.0%	75%	2%
bristly black currant (*Ribes lacustre*)	native	0.1	0.5%	35%	<1%
buckbrush/snowberry (*Symphoricarpos occidentalis*)	native	0.1	1.3%	20%	<1%
bunchberry (*Cornus canadensis*)	native	0.2	1.2%	40%	1%
Canada buffaloberry (*Shepherdia canadensis*)	native	0.8	2.3%	85%	2%
common bearberry (*Arctostaphylos uva-ursi*)	native	0.2	1.1%	45%	1%
common wild rose (*Rosa woodsii*)	native	0.3	1.3%	55%	1%
creeping juniper (*Juniperus horizontalis*)	native	0.2	1.4%	30%	<1%
creeping mahonia (*Berberis repens*)	native	0.1	0.5%	20%	<1%
currant (*Ribes* spp.)	native	<0.1	0.5%	10%	<1%
dewberry (*Rubus pubescens*)	native	<0.1	0.5%	10%	<1%
Drummond's willow (*Salix drummondiana*)	native	3.1	8.9%	70%	7%
dusky willow (*Salix melanopsis*)	native	<0.1	0.5%	15%	<1%
dwarf birch (*Betula pumila*)	native	<0.1	0.5%	5%	<1%
dwarf raspberry (*Rubus arcticus*)	native	<0.1	0.5%	10%	<1%
false mountain willow (*Salix pseudomonticola*)	native	0.1	0.6%	30%	<1%
firm leaf willow (*Salix pseudomyrsinites*)	native	0.4	3.1%	40%	1%
flat-leaved willow (*Salix planifolia*)	native	1.3	6.1%	55%	3%
green alder (*Alnus crispa*)	native	0.1	50.0%	5%	<1%
ground juniper (*Juniperus communis*)	native	0.4	1.0%	80%	1%
hoary willow (*Salix candida*)	native	0.4	3.0%	10%	1%
hybrid dwarf raspberry (*Rubus x paracaulis*)	native	<0.1	0.5%	5%	<1%
low-bush cranberry (*Viburnum edule*)	native	<0.1	3.0%	5%	<1%
northern gooseberry (*Ribes oxyacanthoides*)	native	0.2	0.6%	70%	<1%
prickly rose (*Rosa acicularis*)	native	0.9	5.6%	45%	2%
purple clematis (*Clematis occidentalis*)	native	0.1	0.5%	40%	<1%
pussy willow (*Salix discolor*)	native	<0.1	0.5%	5%	<1%
red-osier dogwood (*Cornus stolonifera*)	native	0.1	1.2%	20%	<1%
river alder (*Alnus tenuifolia*)	native	2.8	10.0%	55%	7%

Plant Species Name[1]	Plant Status[2]	Area by Species (ha)	% Canopy Cover[3]	Constancy[4]	Percent of Project Area
SHRUBS CONT'D.					
round-leaved hawthorn (*Crataegus rotundifolia*)	native	<0.1	0.5%	5%	<1%
Saskatoon (*Amelanchier alnifolia*)	native	0.1	0.6%	40%	<1%
Scouler's willow (*Salix scouleriana*)	native	<0.1	0.5%	5%	<1%
shrubby cinquefoil (*Potentilla fruticosa*)	native	0.6	1.9%	70%	1%
silverberry (*Elaeagnus commutata*)	native	<0.1	1.0%	20%	<1%
smooth willow (*Salix glauca*)	native	0.1	4.7%	15%	<1%
snowberry (*Symphoricarpos albus*)	native	0.1	1.6%	40%	<1%
thimbleberry (*Rubus parviflorus*)	native	0.3	2.1%	20%	1%
twinflower (*Linnaea borealis*)	native	0.3	1.1%	50%	1%
twining honeysuckle (*Lonicera dioica*)	native	<0.1	0.5%	15%	<1%
white meadowsweet (*Spiraea betulifolia*)	native	0.1	3.0%	10%	<1%
wild red raspberry (*Rubus idaeus*)	native	0.2	0.8%	55%	<1%
willow (*Salix* spp.)	native	0.1	2.9%	10%	<1%
yellow clematis (*Clematis tangutica*)	**invasive, introduced**	<0.1	0.5%	5%	<1%
yellow mountain avens (*Dryas drummondii*)	native	0.1	0.5%	10%	<1%
yellow willow (*Salix lutea*)	native	<0.1	0.5%	10%	<1%
GRASSES AND GRASS-LIKES					
alpine bluegrass (*Poa alpina*)	native	0.1	0.5%	45%	<1%
alpine fescue (*Festuca brachyphylla*)	native	<0.1	0.5%	5%	<1%
awned sedge (*Carex atherodes*)	native	<0.1	0.5%	5%	<1%
bluebunch fescue (*Festuca idahoensis*)	native	0.1	1.6%	10%	<1%
bluejoint (*Calamagrostis canadensis*)	native	1.9	6.4%	60%	4%
bristle-leaved sedge (*Carex eburnea*)	native	<0.1	0.5%	5%	<1%
broad-glumed wheat grass (*Agropyron violaceum*)	native	<0.1	0.5%	5%	<1%
brownish sedge (*Carex brunnescens*)	native	<0.1	0.5%	5%	<1%
Canada bluegrass (*Poa compressa*)	disturbance, introduced	<0.1	0.5%	10%	<1%
Canada wild rye (*Elymus canadensis*)	native	0.2	6.5%	10%	<1%
Canby bluegrass (*Poa canbyi*)	native	<0.1	0.5%	10%	<1%
Columbia needle grass (*Stipa columbiana*)	native	<0.1	0.5%	5%	<1%
common tall manna grass (*Glyceria grandis*)	native	0.1	1.3%	15%	<1%
creeping spike-rush (*Eleocharis palustris*)	native	<0.1	0.5%	5%	<1%
few-flowered rush (*Juncus confusus*)	native	<0.1	0.5%	5%	<1%
field wood-rush (*Luzula multiflora*)	native	<0.1	0.5%	5%	<1%
fowl bluegrass (*Poa palustris*)	native	0.4	1.6%	50%	1%
fowl manna grass (*Glyceria striata*)	native	<0.1	0.5%	20%	<1%
fringed brome (*Bromus ciliatus*)	native	0.1	0.5%	30%	<1%
golden sedge (*Carex aurea*)	native	<0.1	0.5%	5%	<1%
graceful sedge (*Carex praegracilis*)	native	<0.1	0.5%	5%	<1%
hair-like sedge (*Carex capillaris*)	native	<0.1	0.5%	15%	<1%
hairy wild rye (*Elymus innovatus*)	native	1.4	5.2%	65%	3%
Hood's sedge (*Carex hoodii*)	native	<0.1	0.5%	10%	<1%
June grass (*Koeleria macrantha*)	native	<0.1	0.5%	20%	<1%
Kentucky bluegrass (*Poa pratensis*)	disturbance, introduced	5.4	16.3%	80%	13%
knotted rush (*Juncus nodosus*)	native	0.1	0.5%	10%	<1%
northern awnless brome (*Bromus inermis* ssp. *pumpellianus*)	native	0.1	2.6%	15%	<1%

Plant Species Name[1]	Plant Status[2]	Area by Species (ha)	% Canopy Cover[3]	Constancy[4]	Percent of Project Area
GRASSES AND GRASS-LIKES CONT'D.					
northern reed grass (*Calamagrostis inexpansa*)	native	<0.1	0.5%	5%	<1%
northern wheat grass (*Agropyron dasystachyum*)	native	<0.1	0.5%	5%	<1%
Norway sedge (*Carex norvegica*)	native	<0.1	0.5%	15%	<1%
orchard grass (*Dactylis glomerata*)	introduced	<0.1	0.5%	10%	<1%
pine reed grass (*Calamagrostis rubescens*)	native	<0.1	0.6%	15%	<1%
purple oat grass (*Schizachne purpurascens*)	native	<0.1	0.5%	5%	<1%
quack grass (*Agropyron repens*)	disturbance, introduced	2.5	12.2%	30%	6%
Raymond's sedge (*Carex raymondii*)	native	<0.1	0.5%	15%	<1%
red fescue (*Festuca rubra*)	native or introduced	<0.1	0.5%	10%	<1%
redtop (*Agrostis stolonifera*)	introduced	0.1	0.5%	15%	<1%
reed canary grass (*Phalaris arundinacea*)	native	<0.1	0.5%	5%	<1%
Richardson needle grass (*Stipa richardsonii*)	native	<0.1	0.5%	5%	<1%
Rocky Mountain fescue (*Festuca saximontana*)	native	0.4	2.6%	30%	1%
rough hair grass (*Agrostis scabra*)	native	<0.1	0.5%	10%	<1%
rush (*Juncus* spp.)	native	<0.1	0.5%	5%	<1%
rush-like sedge (*Carex scirpoidea*)	native	0.1	2.9%	10%	<1%
Sandberg bluegrass (*Poa sandbergii*)	native	<0.1	0.5%	5%	<1%
Sartwell's sedge (*Carex sartwellii*)	native	0.1	2.9%	10%	<1%
sedge (*Carex* spp.)	native	<0.1	0.5%	5%	<1%
sheathed sedge (*Carex vaginata*)	native	<0.1	0.5%	5%	<1%
short sedge (*Carex curta*)	native	<0.1	0.5%	5%	<1%
slender rush (*Juncus tenuis*)	native	<0.1	0.5%	5%	<1%
slender wheat grass (*Agropyron trachycaulum*)	native	0.1	0.5%	20%	<1%
slender wheat grass (var. of AGROTRA) (*Agropyron unilaterale*)	native	<0.1	0.8%	20%	<1%
small bottle sedge (*Carex utriculata*)	native	0.2	1.9%	30%	<1%
small-flowered wood-rush (*Luzula parviflora*)	native	0.1	0.5%	40%	<1%
small-winged sedge (*Carex microptera*)	native	0.2	0.5%	70%	<1%
smooth brome (*Bromus inermis*)	disturbance, introduced	1.2	4.4%	50%	3%
smooth wild rye (*Elymus glaucus*)	native	0.2	1.2%	30%	<1%
spike trisetum (*Trisetum spicatum*)	native	<0.1	0.5%	5%	<1%
sweet grass (*Hierochloe odorata*)	native	<0.1	0.5%	20%	<1%
timothy (*Phleum pratense*)	disturbance, introduced	4.4	11.8%	90%	11%
tufted hair grass (*Deschampsia cespitosa*)	native	1.1	4.6%	65%	3%
two-seeded sedge (*Carex disperma*)	native	<0.1	0.5%	5%	<1%
water sedge (*Carex aquatilis*)	native	0.5	3.8%	25%	1%
western wheat grass (*Agropyron smithii*)	native	<0.1	0.5%	5%	<1%
white-grained mountain rice grass (*Oryzopsis asperifolia*)	native	<0.1	0.5%	5%	<1%
wild rye (*Elymus* spp.)	unknown	<0.1	0.5%	5%	<1%
wire rush (*Juncus balticus*)	native	0.5	2.9%	50%	1%
yellow trisetum (*Trisetum flavescens*)	introduced	<0.1	0.5%	5%	<1%

Plant Species Name[1]	Plant Status[2]	Area by Species (ha)	% Canopy Cover[3]	Constancy[4]	Percent of Project Area
FORBS					
alpine bistort (*Polygonum viviparum*)	native	0.1	0.5%	35%	<1%
alpine everlasting (*Antennaria alpina*)	disturbance, native	<0.1	0.5%	5%	<1%
alpine hedysarum (*Hedysarum alpinum*)	native	0.1	0.5%	50%	<1%
alpine milk vetch (*Astragalus alpinus*)	native	<0.1	0.5%	5%	<1%
alsike clover (*Trifolium hybridum*)	disturbance, introduced	1.4	4.4%	65%	3%
American brooklime (*Veronica americana*)	native	<0.1	0.5%	20%	<1%
American winter cress (*Barbarea orthoceras*)	native	<0.1	0.5%	5%	<1%
annual whitlow-grass (*Draba nemorosa*)	native	<0.1	0.5%	5%	<1%
arrow-leaved coltsfoot (*Petasites sagittatus*)	native	0.1	0.5%	20%	<1%
aster (*Aster* spp.)	unknown	<0.1	0.5%	5%	<1%
balsam groundsel (*Senecio pauperculus*)	native	0.2	1.1%	35%	1%
bastard toadflax (*Comandra umbellata*)	native	<0.1	0.5%	5%	<1%
bishop's-cap (*Mitella nuda*)	native	<0.1	0.5%	5%	<1%
black medick (*Medicago lupulina*)	introduced	0.1	0.5%	25%	<1%
black-tipped groundsel (*Senecio lugens*)	native	<0.1	0.5%	5%	<1%
bluebur (*Lappula squarrosa*)	disturbance, introduced	<0.1	0.5%	5%	<1%
blueweed / viper's-bugloss (*Echium vulgare*)	**invasive, introduced**	<0.1	0.5%	5%	<1%
blunt-leaved sandwort (*Moehringia lateriflora*)	native	<0.1	0.5%	5%	<1%
broad-leaved arnica (*Arnica latifolia*)	native	<0.1	0.5%	5%	<1%
broad-leaved everlasting (*Antennaria neglecta*)	disturbance, native	<0.1	0.5%	10%	<1%
broad-leaved fireweed (*Epilobium latifolium*)	native	0.1	0.6%	35%	<1%
bronzebells (*Stenanthium occidentale*)	native	<0.1	0.5%	15%	<1%
brook ragwort (*Senecio triangularis*)	native	0.2	1.0%	35%	<1%
bull thistle (*Cirsium vulgare*)	introduced	<0.1	0.5%	10%	<1%
Canada anemone (*Anemone canadensis*)	native	<0.1	0.5%	15%	<1%
Canada goldenrod (*Solidago canadensis*)	native	0.1	0.7%	25%	<1%
Canada thistle (*Cirsium arvense*)	**invasive, introduced**	0.3	0.7%	60%	1%
clasping-leaved twisted-stalk (*Streptopus amplexifolius*)	native	0.2	1.0%	45%	<1%
columbine (*Aquilegia* spp.)	native	<0.1	0.5%	20%	<1%
common blue-eyed grass (*Sisyrinchium montanum*)	native	<0.1	0.5%	10%	<1%
common butterwort (*Pinguicula vulgaris*)	native	<0.1	0.5%	10%	<1%
common dandelion (*Taraxacum officinale*)	disturbance, introduced	0.7	1.8%	100%	2%
common fireweed (*Epilobium angustifolium*)	native	1.3	3.1%	100%	3%
common goat's-beard (*Tragopogon dubius*)	introduced	0.1	0.5%	15%	<1%
common horsetail (*Equisetum arvense*)	native, poisonous	2.1	5.0%	95%	5%
common mouse-ear chickweed (*Cerastium vulgatum*)	disturbance, introduced	<0.1	0.5%	15%	<1%
common mullein (*Verbascum thapsus*)	**invasive, introduced**	0.1	0.5%	20%	<1%
common nettle (*Urtica dioica*)	native	<0.1	0.5%	20%	<1%
common pink wintergreen (*Pyrola asarifolia*)	native	0.1	0.5%	20%	<1%
common plantain (*Plantago major*)	disturbance, introduced	0.2	1.1%	30%	<1%
common red paintbrush (*Castilleja miniata*)	native	0.1	0.5%	40%	<1%
common scouring-rush (*Equisetum hyemale*)	native	0.1	0.5%	50%	<1%

Plant Species Name[1]	Plant Status[2]	Area by Species (ha)	% Canopy Cover[3]	Constancy[4]	Percent of Project Area
FORBS CONT'D.					
common yarrow (*Achillea millefolium*)	native	0.3	0.6%	95%	1%
cow parsnip (*Heracleum lanatum*)	native	0.7	2.0%	70%	2%
cream-colored vetchling (*Lathyrus ochroleucus*)	native	0.1	0.5%	60%	<1%
curled dock (*Rumex crispus*)	introduced	<0.1	0.5%	5%	<1%
cut-leaved anemone (*Anemone multifida*)	native	0.1	0.5%	25%	<1%
cut-leaved ragwort (*Senecio eremophilus*)	native	0.1	0.5%	30%	<1%
dwarf scouring-rush (*Equisetum scirpoides*)	native	<0.1	0.5%	10%	<1%
early blue violet (*Viola adunca*)	native	<0.1	0.5%	5%	<1%
early yellow locoweed (*Oxytropis sericea*)	native, poisonous	<0.1	0.5%	5%	<1%
elephant's-head (*Pedicularis groenlandica*)	native	0.1	0.5%	30%	<1%
entire-leaved groundsel (*Senecio integerrimus*)	native	<0.1	0.5%	5%	<1%
fairybells (*Disporum trachycarpum*)	native	<0.1	0.5%	10%	<1%
felwort (*Gentianella amarella*)	native	<0.1	0.5%	5%	<1%
few-flowered ragwort (*Senecio pauciflorus*)	native	<0.1	0.5%	15%	<1%
field mouse-ear chickweed (*Cerastium arvense*)	disturbance, native	<0.1	0.5%	20%	<1%
forb (Unidentified forbs pp.)	unknown	<0.1	0.5%	5%	<1%
gaillardia (*Gaillardia aristata*)	native	<0.1	0.5%	5%	<1%
geranium (*Geranium* spp.)	native	<0.1	0.5%	5%	<1%
graceful cinquefoil (*Potentilla gracilis*)	native	0.1	0.5%	65%	<1%
green alpine sandwort (*Minuartia austromontana*)	native	<0.1	0.5%	5%	<1%
green false hellebore (*Veratrum eschscholtzii*)	native	<0.1	0.5%	5%	<1%
green sorrel (*Rumex acetosa*)	introduced	<0.1	0.5%	5%	<1%
hairy rock cress (*Arabis hirsuta*)	native	<0.1	0.5%	5%	<1%
harebell (*Campanula rotundifolia*)	native	0.2	0.7%	65%	1%
heal-all (*Prunella vulgaris*)	native	<0.1	0.5%	15%	<1%
heart-leaved Alexanders (*Zizia aptera*)	native	<0.1	0.5%	25%	<1%
heart-leaved arnica (*Arnica cordifolia*)	native	<0.1	0.5%	25%	<1%
hedysarum (*Hedysarum* spp.)	native	<0.1	0.5%	5%	<1%
lance-leaved paintbrush (*Castilleja occidentalis*)	native	<0.1	0.5%	15%	<1%
large-leaved yellow avens (*Geum macrophyllum*)	native	<0.1	0.5%	5%	<1%
late yellow locoweed (*Oxytropis monticola*)	native, poisonous	0.1	0.5%	25%	<1%
leafy arnica (*Arnica chamissonis*)	native	<0.1	0.5%	5%	<1%
leafy-bracted aster (*Aster subspicatus*)	native	<0.1	0.5%	10%	<1%
long-fruited anemone (*Anemone cylindrica*)	native	<0.1	0.5%	10%	<1%
long-leaved chickweed (*Stellaria longifolia*)	native	<0.1	0.5%	10%	<1%
long-stalked chickweed (*Stellaria longipes*)	native	<0.1	0.5%	10%	<1%
lyre-leaved rock cress (*Arabis lyrata*)	native	<0.1	0.5%	5%	<1%
Macoun's buttercup (*Ranunculus macounii*)	native	<0.1	0.5%	5%	<1%
mariposa lily (*Calochortus apiculatus*)	native	<0.1	0.5%	5%	<1%
marsh hedge-nettle (*Stachys palustris*)	native	<0.1	0.5%	5%	<1%
marsh skullcap (*Scutellaria galericulata*)	native	<0.1	0.5%	5%	<1%
marsh yellow cress (*Rorippa palustris*)	native	<0.1	0.5%	10%	<1%
meadow horsetail (*Equisetum pratense*)	native	<0.1	0.5%	5%	<1%

Plant Species Name[1]	Plant Status[2]	Area by Species (ha)	% Canopy Cover[3]	Constancy[4]	Percent of Project Area
FORBS CONT'D.					
Menzies' catchfly (*Silene menziesii*)	native	0.1	0.5%	20%	<1%
milk vetch (*Astragalus* spp.)	native	<0.1	0.5%	5%	<1%
mountain goldenrod (*Solidago spathulata*)	native	0.1	0.5%	20%	<1%
mountain valerian (*Valeriana sitchensis*)	native	<0.1	0.5%	5%	<1%
narrow-leaved collomia (*Collomia linearis*)	native	<0.1	0.5%	5%	<1%
narrow-leaved dock (*Rumex triangulivalvis*)	native	<0.1	0.5%	10%	<1%
narrow-leaved hawkweed (*Hieracium umbellatum*)	native	<0.1	0.5%	5%	<1%
night-flowering catchfly (*Silene noctiflora*)	disturbance, introduced	<0.1	0.5%	5%	<1%
nodding onion (*Allium cernuum*)	native	0.1	0.5%	35%	<1%
northern bedstraw (*Galium boreale*)	native	0.2	0.5%	95%	<1%
northern grass-of-parnassus (*Parnassia palustris*)	native	0.1	0.5%	45%	<1%
northern green bog orchid (*Habenaria hyperborea*)	native	0.1	0.5%	35%	<1%
northern twayblade (*Listera borealis*)	native	<0.1	0.5%	5%	<1%
northern willowherb (*Epilobium ciliatum*)	native	0.1	0.6%	45%	<1%
one-flowered wintergreen (*Moneses uniflora*)	native	0.1	0.5%	25%	<1%
one-sided wintergreen (*Orthilia secunda*)	native	0.1	0.5%	20%	<1%
orange hawkweed (*Hieracium aurantiacum*)	**invasive, introduced**	<0.1	0.5%	5%	<1%
ox-eye daisy (*Chrysanthemum leucanthemum*)	**invasive, introduced**	1.4	8.1%	30%	3%
pale coralroot (*Corallorhiza trifida*)	native	<0.1	0.5%	5%	<1%
palmate-leaved coltsfoot (*Petasites palmatus*)	native	<0.1	0.5%	5%	<1%
pearly everlasting (*Anaphalis margaritacea*)	native	<0.1	0.5%	20%	<1%
perennial sow-thistle (*Sonchus arvensis*)	**invasive, introduced**	0.1	0.5%	15%	<1%
Philadelphia fleabane (*Erigeron philadelphicus*)	native	0.1	0.5%	20%	<1%
prairie onion (*Allium textile)*	native	<0.1	0.5%	5%	<1%
purple avens (*Geum rivale*)	native	<0.1	0.5%	20%	<1%
purple-stemmed aster (*Aster puniceus*)	native	0.3	1.0%	55%	1%
red and white baneberry (*Actaea rubra*)	native, poisonous	0.3	1.3%	40%	1%
red clover (*Trifolium pratense*)	disturbance, introduced	0.1	0.5%	30%	<1%
Robbins' milk vetch (*Astragalus robbinsii*)	native	<0.1	0.5%	5%	<1%
rosy everlasting (*Antennaria rosea*)	disturbance, native	<0.1	0.5%	10%	<1%
rough cinquefoil (*Potentilla norvegica*)	disturbance, native	<0.1	0.5%	5%	<1%
saline shooting star (*Dodecatheon pulchellum*)	native	<0.1	0.5%	15%	<1%
senecio (*Senecio* spp.)	unknown	<0.1	0.5%	5%	<1%
shining arnica (*Arnica fulgens*)	native	<0.1	0.5%	5%	<1%
showy aster (*Aster conspicuus*)	native	0.3	1.8%	20%	1%
showy everlasting (*Antennaria pulcherrima*)	disturbance, native	<0.1	0.5%	20%	<1%
showy locoweed (*Oxytropis splendens*)	native, poisonous	0.1	0.5%	25%	<1%
silky perennial lupine (*Lupinus sericeus*)	native	<0.1	0.5%	20%	<1%
silverweed (*Potentilla anserina*)	disturbance, native	<0.1	0.5%	5%	<1%
Sitka romanzoffia (*Romanzoffia sitchensis*)	native	<0.1	0.5%	5%	<1%
slender arrow-grass (*Triglochin palustris*)	native, poisonous	<0.1	0.5%	5%	<1%

Plant Species Name[1]	Plant Status[2]	Area by Species (ha)	% Canopy Cover[3]	Constancy[4]	Percent of Project Area
FORBS CONT'D.					
slender blue beardtongue (*Penstemon procerus*)	native	<0.1	0.5%	5%	<1%
small wood anemone (*Anemone parviflora*)	native	<0.1	0.5%	15%	<1%
small-leaved everlasting (*Antennaria parvifolia*)	disturbance, native	0.1	0.5%	20%	<1%
smooth aster (*Aster laevis*)	native	0.4	1.2%	75%	1%
sparrow's-egg lady's-slipper (*Cypripedium passerinum*)	native	<0.1	0.5%	5%	<1%
spreading dogbane (*Apocynum androsaemifolium*)	disturbance, native, poisonous	<0.1	0.5%	5%	<1%
spreading sweet cicely (*Osmorhiza depauperata*)	native	0.1	0.8%	55%	<1%
star-flowered Solomon's-seal (*Smilacina stellata*)	native	0.1	0.5%	60%	<1%
sticky false asphodel (*Tofieldia glutinosa*)	native	<0.1	0.5%	5%	<1%
sticky purple geranium (*Geranium viscosissimum*)	native	0.1	1.0%	30%	<1%
stinkweed (*Thlaspi arvense*)	disturbance, introduced	<0.1	0.5%	5%	<1%
sweet-flowered androsace (*Androsace chamaejasme*)	native	<0.1	0.5%	5%	<1%
sweet-scented bedstraw (*Galium triflorum*)	native	<0.1	0.5%	15%	<1%
tall buttercup (*Ranunculus acris*)	**invasive, introduced**	0.3	0.8%	60%	1%
tall larkspur (*Delphinium glaucum*)	native, poisonous	0.1	0.5%	40%	<1%
tall lungwort (*Mertensia paniculata*)	native	0.2	1.1%	45%	<1%
tall white bog orchid (*Habenaria dilatata*)	native	<0.1	0.5%	5%	<1%
thin-leaved ragwort (*Senecio pseudaureus*)	native	<0.1	0.5%	5%	<1%
thistle (*Cirsium* spp.)	unknown	<0.1	0.5%	5%	<1%
three-flowered avens (*Geum triflorum*)	native	<0.1	0.5%	10%	<1%
variegated horsetail (*Equisetum variegatum*)	native	<0.1	0.5%	15%	<1%
veiny meadow rue (*Thalictrum venulosum*)	native	0.4	1.2%	75%	1%
vine-leaved coltsfoot (*Petasites vitifolius*)	native	0.1	2.2%	15%	<1%
violet (*Viola* spp.)	native	<0.1	0.5%	10%	<1%
viscid locoweed (*Oxytropis viscida*)	native	<0.1	3.0%	5%	<1%
western bluebur (*Lappula occidentalis*)	introduced	<0.1	0.5%	5%	<1%
western Canada violet (*Viola canadensis*)	native	0.1	0.5%	35%	<1%
western dock (*Rumex occidentalis*)	native	<0.1	0.5%	10%	<1%
western lousewort (*Pedicularis bracteosa*)	native	<0.1	0.5%	15%	<1%
western willow aster (*Aster hesperius*)	native	<0.1	0.5%	5%	<1%
white angelica (*Angelica arguta*)	native	0.4	1.2%	75%	1%
white camas (*Zigadenus elegans*)	native, poisonous	<0.1	0.5%	5%	<1%
white clover (*Trifolium repens*)	disturbance, introduced	0.2	0.8%	30%	<1%
wild bergamot (*Monarda fistulosa*)	native	<0.1	0.5%	15%	<1%
wild licorice (*Glycyrrhiza lepidota*)	native	<0.1	0.5%	10%	<1%
wild mint (*Mentha arvensis*)	native	<0.1	0.5%	5%	<1%
wild sarsaparilla (*Aralia nudicaulis*)	native	<0.1	0.5%	10%	<1%
wild strawberry (*Fragaria virginiana*)	disturbance, native	0.4	1.0%	95%	1%
wild vetch (*Vicia americana*)	native	0.3	0.7%	95%	1%
wild white geranium (*Geranium richardsonii*)	native	0.1	0.5%	45%	<1%
wintergreen (*Pyrola* spp.)	native	<0.1	0.5%	5%	<1%

Plant Species Name[1]	Plant Status[2]	Area by Species (ha)	% Canopy Cover[3]	Constancy[4]	Percent of Project Area
FORBS CONT'D.					
woodland strawberry (*Fragaria vesca*)	disturbance, native	<0.1	0.5%	5%	<1%
wormseed mustard (*Erysimum cheiranthoides*)	disturbance, introduced	<0.1	0.5%	20%	<1%
yellow angelica (*Angelica dawsonii*)	native	0.2	1.3%	15%	<1%
yellow avens (*Geum aleppicum*)	native	0.1	0.5%	45%	<1%
yellow beardtongue (*Penstemon confertus*)	native	0.1	0.5%	20%	<1%
yellow columbine (*Aquilegia flavescens*)	native	<0.1	0.5%	5%	<1%
yellow false dandelion (*Agoseris glauca*)	native	0.1	0.5%	50%	<1%
yellow hedysarum (*Hedysarum sulphurescens*)	native	0.1	0.5%	35%	<1%
yellow monkeyflower (*Mimulus guttatus*)	native	<0.1	0.5%	5%	<1%
yellow rattle (*Rhinanthus minor*)	native	<0.1	0.5%	5%	<1%

[1] Our primary resource for plant species naming is Flora of Alberta by E.H. Moss (1994); for species not listed in Moss (1994), taxonomy follows the Integrated Taxonomic Information System (http://www.itis.gov/).

[2] Plant status is designated by Cows and Fish in association with Alberta Sustainable Resource Development (Public Lands), Alberta Agriculture, Food and Rural Development and the Alberta *Weed Control Act*. '*unknown*' = plant not identified to species; plant status unknown.

[3] Based on visual estimates of the amount of ground the canopy of the plant covers. The percent cover values presented are the mid-values for the following ranges: 0.5=less than 1%; 3.0=1%-5%; 10.0=5%-15%; 20.0=15%-25%; 30.0=25%-35%; 40.0=35%-45%; 50.0=45%-55%; 60.0=55%-65%; 70.0=65%-75%; 80.0=75%-85%; 90.0=85%-95%; 97.5=greater than 95%; — = not observed.

[4] Constancy is the number of times the species occurs divided by the total number of polygons.

APPENDIX D

WESTSLOPE CUTTHROAT TROUT 2011 RHI CHANNEL WIDTH AND CHANNEL SUBSTRATE DATA

RHI Site ID	Waypoint	Easting	Northing	Ave. non-vegetated channel width (m)	>20 in. (med. Boulders +)	10-20 in (sm. boulders)	5-10 in (lg. cobbles)	2.5-5 in (sm. cobbles)	0.6-2.5 in (course gravel)	0.08 - 0.6 in (fine gravel)	0.062- 2mm (sand)	<0.062 mm (silt and clay)	Length of Reach (m)
COL1	COL1U	684366	5570554	3.3	0	0	0	40%	10%	10%	20%	20%	0
	COL1A	684390	5570653	3.7	0	0	0	30%	20%	10%	20%	20%	101
	COL1B	684479	5570697	4.7	0	0	0	50%	20%	20%	3%	3%	99
	COL1C	684564	5570755	5.5	0	0	<1%	50%	20%	10%	10%	10%	100
	COL1D	684667	5570750	4.4	0	0	0	30%	30%	20%	10%	10%	103
	COL1LNEW	684706	5570858	7.2	0	0	0	60%	20%	10%	3%	<1%	115
COL2	COL2U	683349	5569969	4.3	<1%	<1%	3%	70%	20%	10%	3%	<1%	110
	COL2A	683616	5570110	3	<1%	3%	10%	20%	40%	30%	3%	<1%	100
	COL2B	683537	5570052	4.2	0	<1%	20%	40%	30%	10%	<1%	<1%	100
	COL2C	683454	5569997	3.1	3%	20%	30%	30%	20%	3%	<1%	<1%	100
	COL2L	683710	5570145	3.6	<1%	3%	20%	20%	30%	30%	3%	<1%	100
DEE1	DEE1U	678063	5589580	3.8	0	<1%	3%	10%	50%	40%	3%	<1%	100
	DEE1B	678109	5589491	2.9	40%	0	<1%	3%	10%	20%	30%	<1%	100
	DEE1C	678123	5589393	3.7	0	0	0	30%	50%	20%	3%	<1%	100
	DEE1D	678142	5589292	5	0	0	0	40%	30%	30%	3%	<1%	100
	DEE1E	678202	5589199	4.3	0	0	0	3%	50%	40%	10%	<1%	100
	DEE1F	678304	5589195	4.2	0	0	<1%	20%	50%	30%	3%	<1%	100
	DEE1G	678418	5589185	5.2	0	<1%	10%	40%	30%	20%	3%	<1%	100
	DEE1H	678535	5589221	4.7	0	0	0	3%	20%	60%	20%	<1%	100
	DEE1J	678633	5589185	2.5	0	<1%	3%	10%	50%	30%	10%	<1%	100
	DEE1L	678729	5589189	4.8	0	3%	10%	40%	40%	20%	3%	<1%	100
HID1	HID1U	674686	5538926	7.6	<1%	10%	20%	30%	30%	10%	3%	<1%	100
	HID1A	674746	5538843	7.4	3%	20%	10%	20%	40%	10%	3%	<1%	100
	HID1B	674836	5538893	6.1	0	0	<1%	20%	60%	20%	3%	<1%	100
	HID1C	674903	5538976	4.7	10%	20%	20%	20%	20%	10%	3%	<1%	100
	HID1D	674999	5538934	6.3	30%	20%	30%	20%	3%	3%	<1%	<1%	100
	HID1E	675062	5538853	5.2	50%	20%	20%	3%	3%	3%	<1%	<1%	100
	HID1L	675199	5538848	6.2	10%	20%	10%	10%	30%	20%	3%	<1%	100
HID2	HID2U	676940	5539112	7.9	30%	10%	20%	10%	30%	<1%	<1%	3%	0
	HID2A	677040	5539133	6.6	50%	10%	10%	10%	20%	<1%	<1%	<1%	100
	HID2B	677153	5539229	6	40%	30%	10%	10%	10%	3%	<1%	<1%	100
	HID2C	677249	5539195	5.7	40%	20%	3%	10%	10%	10%	<1%	10%	100
	HID2D	677303	5539109	12.7	10%	20%	20%	20%	30%	<1%	<1%	3%	100
	HID2E	677421	5539102	16.6	10%	10%	10%	50%	20%	<1%	<1%	3%	100
	HID2L	677446	5539153	9.4	30%	<1%	<1%	60%	10%	<1%	<1%	<1%	53
JOH3	JOH3U	684546	5565691	3	10%	10%	30%	30%	10%	10%	<1%	<1%	50
	JOH3B	684943	5566031	4.6	0	<1%	3%	40%	30%	20%	3%	3%	103
	JOH3D	684891	5565947	2.9	0	<1%	<1%	40%	20%	20%	10%	10%	99
	JOH3E	684806	5565897	3.3	<1%	0	<1%	20%	40%	30%	3%	3%	100
	JOH3F	684727	5565827	3.8	10%	3%	20%	30%	10%	10%	10%	10%	106
	JOH3G	684677	5565732	4.4	0	10%	10%	10%	40%	20%	10%	3%	101
	JOH3H	684578	5565709	3.7	50%	10%	20%	10%	10%	<1%	<1%	<1%	101
	JOH3L	685034	5566077	3.8	0	<1%	3%	50%	20%	10%	10%	10%	0
JOY1	JOY1U	684802	5566771	3.2	<1%	<1%	20%	30%	30%	20%	3%	<1%	100
	JOY1C	685238	5566936	4.1	0	<1%	<1%	20%	30%	50%	3%	<1%	100

RHI Site ID	Waypoint	Easting	Northing	Ave. non-vegetated channel width (m)	>20 in. (med. Boulders +)	10-20 in (sm. boulders)	5-10 in (lg. cobbles)	2.5-5 in (sm. cobbles)	0.6-2.5 in (course gravel)	0.08 - 0.6 in (fine gravel)	0.062- 2mm (sand)	<0.062 mm (silt and clay)	Length of Reach (m)
	JOY1D	685140	5566883	3.2	0	0	3%	20%	40%	30%	10%	<1%	100
	JOY1E	685061	5566124	2.3	<1%	<1%	20%	30%	30%	20%	3%	<1%	100
	JOY1F	684988	5566754	2.9	0	<1%	3%	20%	40%	20%	20%	<1%	100
	JOY1H	684858	5566760	2.9	<1%	<1%	<1%	20%	40%	20%	20%	<1%	100
	JOY1L	685332	5566986	3.5	0	<1%	<1%	30%	30%	40%	3%	10%	100
LST1	LST1U	681934	5480351	7	<1%	3%	10%	20%	30%	10%	10%	10%	0
	LST1A	682018	5480411	12	<1%	<1%	10%	30%	30%	20%	10%	3%	100
	LST1B	682110	5480432	10	10%	10%	20%	20%	20%	10%	3%	3%	100
	LST1C	682214	5480428	11	<1%	3%	20%	30%	20%	10%	10%	10%	103
	LST1D	682305	5480389	8	0	<1%	3%	20%	20%	30%	20%	10%	100
	LST1E	682382	5480447	11	<1%	<1%	3%	40%	20%	20%	10%	10%	96
	LST1G	682488	5480469	13	3%	3%	20%	20%	20%	20%	10%	10%	108
	LST1L	682580	5480555	16	<1%	<1%	10%	40%	20%	10%	10%	10%	120
LYX1	LYX1U	684001	5482641	12	20%	3%	10%	20%	30%	20%	<1%	<1%	0
	LYX1A	684046	5482538	8	40%	3%	10%	10%	20%	10%	3%	<1%	113
	LYX1B	684078	5482443	8	10%	20%	20%	10%	10%	20%	<1%	<1%	100
	LYX1C	684170	5482407	10.1	3%	20%	40%	20%	10%	10%	<1%	<1%	100
	LYX1D	684264	5482370	10.5	0	10%	20%	30%	20%	20%	<1%	3%	103
	LYX1E	684315	5482285	12	10%	10%	20%	20%	30%	10%	<1%	3%	100
	LYX1F	684367	5482199	12	10%	3%	30%	20%	30%	10%	<1%	<1%	100
	LYX1L	684468	5482221	11	80%	3%	<1%	3%	10%	3%	<1%	<1%	103
LYX2	LYX2U	682576	5483712	12	<1%	<1%	0	40%	30%	20%	10%	10%	187
	LYX2C	683009	5483392	8	70%	<1%	<1%	3%	3%	20%	10%	3%	85
	LYX2E	682906	5483367	8	0	<1%	0	30%	40%	20%	10%	10%	110
	LYX2F	682877	5483485	13.5	0	0	0	40%	30%	20%	10%	3%	125
	LYX2G	682829	5483597	11.7	0	0	0	30%	40%	20%	3%	3%	122
	LYX2L	683186	5483228	7	<1%	<1%	3%	40%	30%	10%	10%	10%	0
NLS1	NLS1U	681037	54803317	7.9	20%	10%	10%	20%	10%	30%	3%	3%	109
	NLS1A	681342	5480311	13.2	3%	10%	10%	20%	20%	30%	3%	3%	115
	NLS1B	681237	5480267	13.6	0	3%	3%	10%	40%	40%	3%	3%	109
	NLS1C	681144	5480300	3.8	0	3%	20%	20%	10%	30%	3%	10%	100
	NLS1L	681457	5480291	9.8	0	3%	20%	30%	30%	10%	3%	3%	0
OLD37	OLD37U	670323	5552295	8.2	<1%	<1%	20%	50%	20%	10%	3%	<1%	160
	OLD37A	670561	5551809	8.9	3%	20%	50%	20%	10%	3%	<1%	<1%	100
	OLD37B	670480	5551864	9.9	<1%	3%	10%	50%	30%	10%	3%	<1%	100
	OLD37C	670490	5551981	7.2	0	0	<1%	80%	20%	3%	<1%	<1%	100
	OLD37D	670471	5552082	9.4	0	0	0	20%	30%	30%	20%	3%	100
	OLD37E	670418	5552165	5.5	0	3%	30%	40%	20%	10%	3%	<1%	100
	OLD37L	670657	5551760	9.8	10%	3%	30%	30%	20%	10%	3%	<1%	100
SHA1	SHA1U	711639	5529589	2.9	<1%	<1%	30%	10%	20%	30%	10%	<1%	75
	SHA1D	711018	5529611	4.5	0	0	0	3%	10%	40%	50%	3%	100
	SHA1F	711117	5529622	2.7	<1%	<1%	<1%	20%	40%	40%	3%	<1%	100
	SHA1G	711212	5529591	2.3	0	0	<1%	20%	50%	20%	10%	<1%	100
	SHA1I	711292	5529531	1.6	0	<1%	<1%	40%	20%	30%	10%	<1%	100
	SHA1J	711389	5529539	2.9	0	0	0	<1%	30%	50%	20%	<1%	100

RHI Site ID	Waypoint	Easting	Northing	Ave. non-vegetated channel width (m)	>20 in. (med. Boulders +)	10-20 in (sm. boulders)	5-10 in (lg. cobbles)	2.5-5 in (sm. cobbles)	0.6-2.5 in (course gravel)	0.08 - 0.6 in (fine gravel)	0.062- 2mm (sand)	<0.062 mm (silt and clay)	Length of Reach (m)
	SHA1K	711486	5529532	1.6	0	0	<1%	20%	60%	20%	3%	<1%	100
	SHA1M	711570	5529563	3.2	<1%	<1%	3%	20%	40%	30%	10%	<1%	100
	SHA1L	710925	5529579	2.8	0	<1%	3%	30%	50%	20%	3%	<1%	100
WIL15	WIL15U	684440	5572342	6.6	0	0	3%	10%	10%	20%	60%	3%	100
	WIL15A	684504	5571856	3.6	0	0	<1%	20%	30%	30%	20%	<1%	100
	WIL15B	684464	5571948	5.7	0	<1%	10%	30%	40%	20%	3%	<1%	100
	WIL15C	684458	5572042	6.4	0	<1%	3%	10%	50%	40%	3%	<1%	100
	WIL15D	684416	5572132	5.4	0	<1%	3%	10%	70%	20%	3%	<1%	100
	WIL15E	684453	5572232	4	0	<1%	<1%	10%	30%	40%	20%	<1%	100
	WIL15L	684576	5571786	4.2	0	<1%	3%	3%	30%	50%	20%	<1%	100
ZEP1	ZEP1U	672336	5583810	3.3	<1%	30%	10%	50%	3%	10%	3%	<1%	82
	ZEP1C	672254	5584181	4.7	0	3%	<1%	30%	10%	20%	30%	10%	100
	ZEP1D	672275	5584082	3.9	0	10%	10%	40%	20%	20%	<1%	<1%	100
	ZEP1E	672311	5583987	3.4	20%	10%	20%	10%	20%	10%	<1%	<1%	100
	ZEP1F	672343	5583892	3.6	3%	10%	3%	20%	40%	30%	<1%	<1%	100
	ZEP1L	672332	5584245	3.7	60%	10%	10%	10%	10%	<1%	<1%	<1%	0

APPENDIX E

STEP-BY STEP INSTRUCTIONS: REPORTING AN INVASIVE PLANT TO EDDMAPS ALBERTA

(Source: **http://www.eddmaps.org/alberta/tools.cfm**)

STEP-BY STEP INSTRUCTIONS: REPORTING AN INVASIVE PLANT TO EDDMAPS ALBERTA

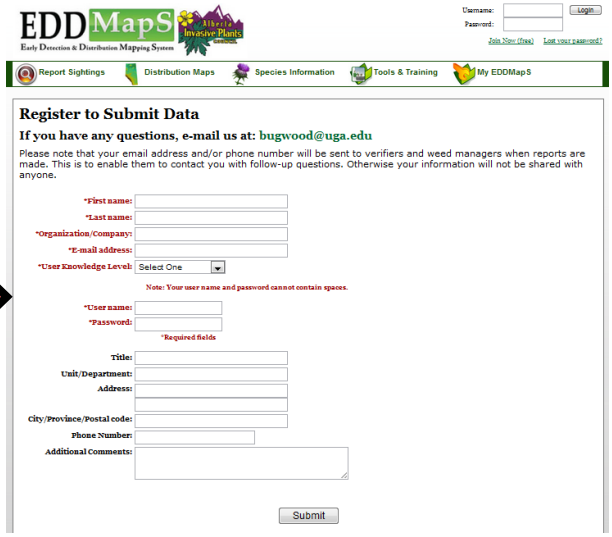
Additional information on EDDMapS Alberta's process is in our handbook at: http://www.eddmaps.org/alberta/tools.cfm

The basic information required is:

- Who collected the data,
- Description of invasive plant infestation,
- When & Where you collected the data,
- Digital image(s) of the invasive plant.

First Time Only: Register As An EDDMapS Alberta User.

1. Go to the EDDMapS Alberta website: http://www.eddmaps.org/alberta
2. Select "Report Sightings" from the menu bar.
3. Click the "Register Now" button.
4. Fill out the form with your personal profile (mandatory information is in red).
5. Click the "Submit" button. Your info can be easily updated any time from your personal EDDMapS Alberta page.
Once you have registered, you will simply sign in to report an infestation!



Who Collected The Data

1. Select Report Sightings from menu bar.
2. Log in at Please Log In. You're ready to begin the reporting procedure!

YOU WILL NOW SEE THE REPORTING FORM WITH A NUMBER OF FIELDS.

Note: If you place your cursor over a (?) at the end of each field on the form you will get a definition or more information about filling out that field. Take a few minutes the first time you reach this page to explore the information available at each (?). It answers the questions most often asked about filling out the form. Most of the fields have arrows for drop down menus with a list of possible choices for that field. Mandatory fields are marked in red.

Description Of Invasive Plant Infestation (See Screen Captures Next Page)

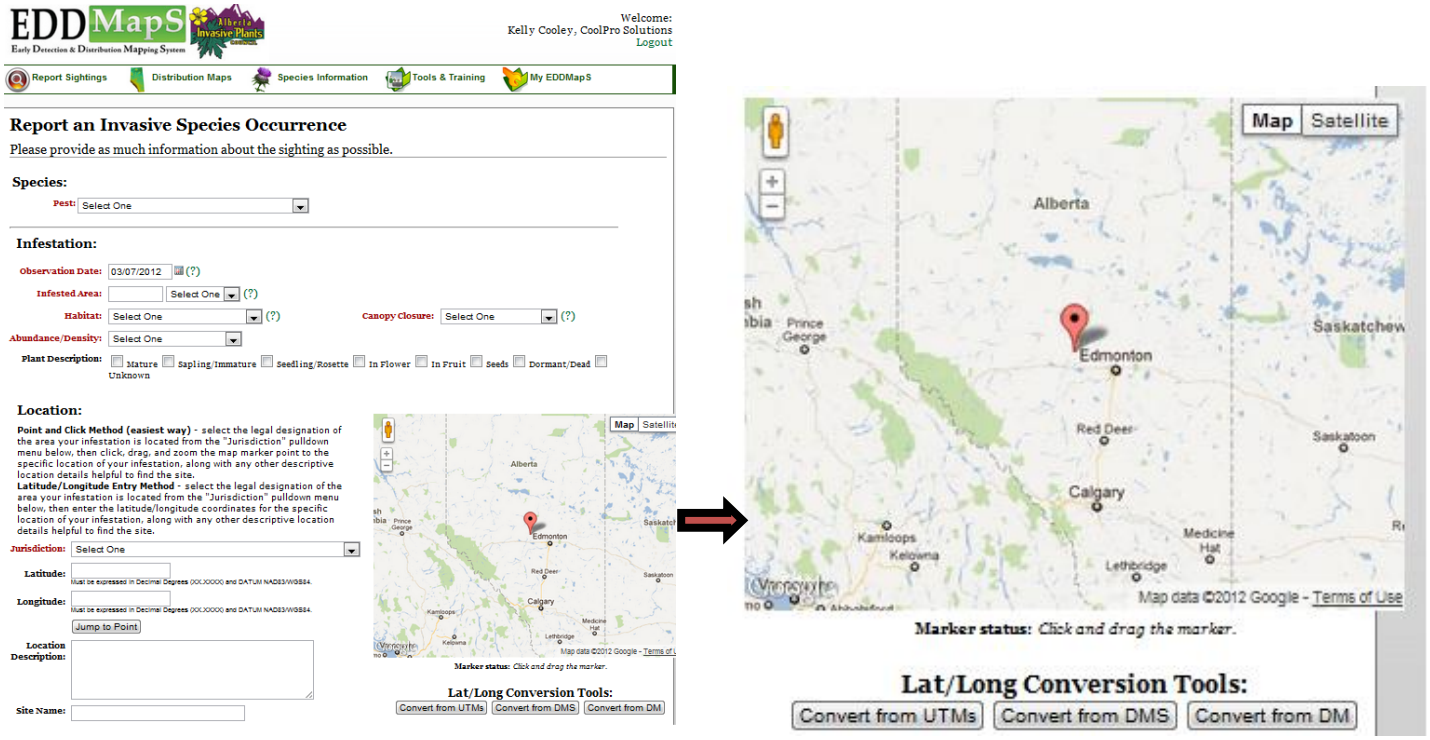
1. Pest: If you click on the arrow on the right you will find a drop-down menu with the list of invasive plants being tracked under the EDDMapS Alberta pilot program.
Note: Species are listed in alphabetical order by scientific name, but the common name is also listed.

2. Observation Date: Enter the date observed in the format mm/dd/yyyy.

3. Infested Area: This is basically an **estimation of the total area of land containing only the invasive weed species**. An infested area of land is described as the perimeter of the weed infestation as defined by the canopy cover of the plants, **excluding areas not infested**. Areas containing only occasional invasive plants per acre **do not** equal one acre infested.

It is highly recommended that only a single invasive plant species be entered for each infested area. Choose unit area from the drop down menu: acres, hectares, square feet, or square meters.

4. **Habitat**: From the drop down menu, choose the description that best describes the habitat where the infestation occurs. If you do not see the appropriate habitat listed, choose 'Other', and add clarification in the Location Description text box below.



5. Canopy Closure: Canopy closure is a way to estimate the amount or severity of an invasive plant infestation. Area tells you the extent of the population across the landscape. Canopy closure tells how that weed dominates the vegetation within that area. The greater the canopy cover, the more the invasive plants there are.

6. Abundance/Density: Choose from menu: Single Plant, Scattered Plants, Scattered Dense Patches, Dense Monoculture.

7. Plant Description: Check each description which applies at the time you gather the data. Choices are: in flower, in fruit, seedlings/rosettes, seeds, dormant/dead, bolting, and unknown.

Where You Collected The Data—Location (See Screen Captures Above)

Point and Click Method (Easiest Way)

1. Focus the Google Map Point by first selecting the legal designation of the area your infestation is located from the "**Jurisdiction**" pull-down menu (described below).

2. Click, Drag, and Zoom the Map Point to the specific location of your infestation, along with any other descriptive location details helpful to find the site. Choose normal map view or satellite image. Increase magnification of the point by clicking the plus (+) sign on the upper left hand corner of the map until you zero in on the infestation site.

You can adjust the location of the marker by pointing directly at it, left-clicking with your mouse, and dragging the marker to the appropriate spot on the map. You will see the correct latitude and longitude entered for you.

Alternative Method (Enter Legal Jurisdiction and Latitude/Longitude Details):

1. Jurisdiction: Choose where the infestation was found from the drop-down menu.

- ***Municipal Districts and Counties*** *(listed by their legal names)*
- ***Cities, Towns, and Villages*** *(designated as "CITY OF", "TOWN OF", or 'VILLAGE OF' the urban area you're looking for)*
- ***Special Areas*** *(listed as "SPECIAL AREAS No. 2, No. 3, and No. 4")*
- ***Specialized Municipalities*** *(Municipality of Crowsnest Pass, Municipality of Jasper, Mackenzie County, Strathcona County, and the Regional Municipality of Wood Buffalo are listed by their legal names)*
- ***Summer Villages*** *(listed as "S.V. of" the summer village you're looking for)*
- ***First Nations and Métis Settlements*** *(designated by their legal names)*
- ***Alberta Parks and Protected Areas*** *(designated by their legal names)*
- ***Improvement Districts*** *(including* ***National Parks***, ***Wilmore Wilderness Park, Kananaskis Country***, *and* ***CFB Cold Lake***, *are listed by their Alberta legal status as "ID's", ex. "ID NO. 9 BANFF" is Banff National Park)*

2. Latitude/Longitude: Enter the Latitude and Longitude coordinates. Remember to put the negative sign in front of the Longitude coordinate to place your entry in the Western hemisphere.
Note: *You can find coordinates using a GPS unit when you collect the data. Set GPS unit to NAD83 or WGS84 and decimal degrees.*

3. Location Description: Add any information that would aid in relocating the infestation or to clarify any other entry.

4. Site Name: If desired, a descriptive name can be entered for the site

Images of the Invasive Species

The next section of the online form requires you to upload images with your report. **Good images are vital to allowing an expert to validate your entry by making a positive identification of genus and species.**

Digital Imaging (See Examples Next Page)

A vital component of EDDMapS Alberta is providing images in digital format. Being able to use photographs to identify the species adds validity to the data collected and entered into EDDMapS Alberta. This section addresses general photography topics, including types of photographs, tips for taking quality images, and an introduction to digital photography.

Identification

Nearly all field guides and identification keys rely on illustrations, because seeing a picture or drawing of an organism greatly aids in the correct identification. These pictures may be of the whole organism or simply a specific characteristic or feature important for distinguishing that organism. For instance, a picture of an exotic plant infesting a natural area can help demonstrate the invasive potential of that plant. This type of picture can lend credibility to statements made by the photographer or user of the image.

Familiarize yourself with characteristics commonly needed for identification, such as Garlic Mustard's distinctive leaf characteristics. Take several pictures of the subject's diagnostic characteristics to ensure that identification is possible. Good photographs can also add validity to documentation of certain events, such as the first occurrence of a species in a county. Herbarium records have the highest validity, so consider collecting an herbarium specimen for the first reported occurrence of an invasive species in a region or county.

The following section briefly explains basic techniques and gives tips for taking useful photographs. To fully understand your camera's options, refer to the user manual.

Framing

Frame the subject for the intended purpose. Panoramic photographs give context to the subject, for example showing the extent of an infestation. Midrange shots illustrate the presence and effects of specific species and close-ups provide details for identification of a species of interest.

Focus

Attention is naturally drawn to the area of the photograph that is in focus. For landscape scale photographs, most of the scene should be in focus. For subjects closer in, the photographer should be sure the most important part of the photograph is in focus. For plants, focus on the entire plant or simply the area of interest. Many digital cameras do this automatically.

Light

The type, direction and intensity of the light can affect the color and texture of an image. **Hard light** on a sunny day or from a direct flash emphasizes shadows, highlights, and textures. **Soft light** in early morning, late evening or cloudy days minimizes shadows and highlights and brings out color and detail. The direction of a light source will also influence the photograph. **Front light** (the light source is in front of the subject) highlights colors while eliminating shadows and textures. **Back light** creates silhouettes or illuminates translucent subjects. **Side light** highlights both texture and color of a subject..

Background

Backgrounds which contrast to the main colors of the subject help make the subject stand out in the photograph, while backgrounds similar to the main colors of the subject make the subject blend in more. A busy background can be distracting and make viewing the subject difficult. Try changing the background by altering camera angles, or by placing something behind the subject. It can be as simple as a white or black sheet of paper behind a leaf to help it stand out more clearly.



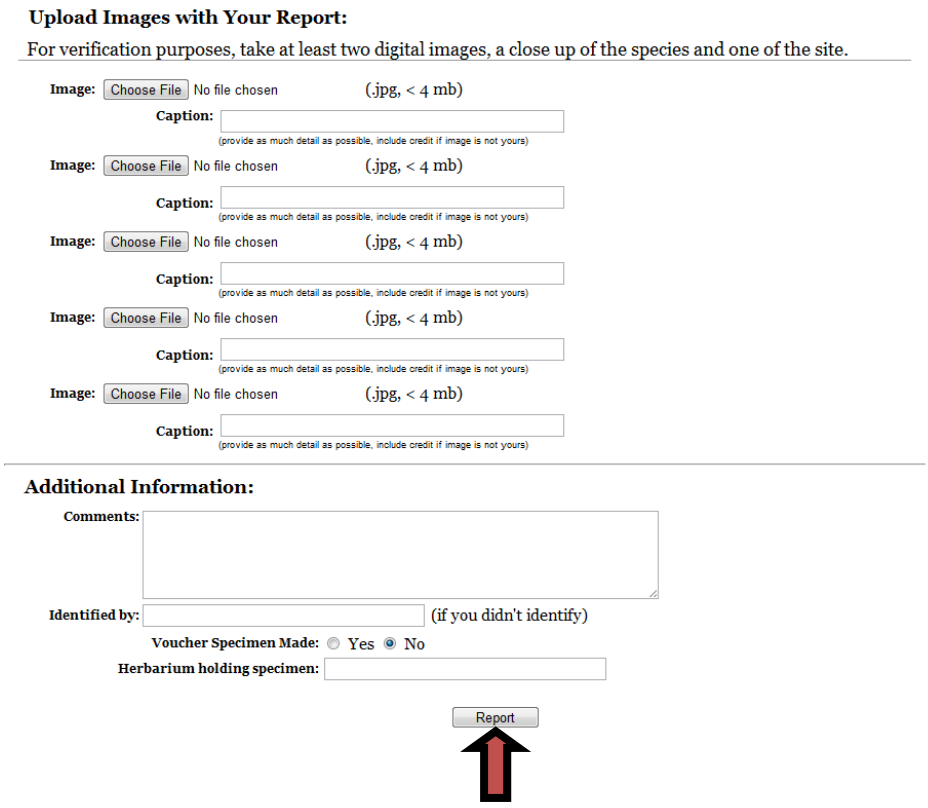

All Photos By
Kelly Cooley
CoolPro
Solutions
Environmental
Consulting

1. Image: Simply click Browse and navigate to the picture on your computer. Click Open and the image location will be entered for you. You can upload up to five images. Images are automatically resized for uploading.

2. Caption: Add captions to describe each image. Provide as much detail as possible. Include photographer's name if not you!

EDDMapS Alberta's web form allows up to 5 images to be uploaded with each record entered (see screen capture below).

Examples of possible plant subjects include:
- Site view showing extent of infestation, one invasive plant or many
- Flower shape, size, color and arrangement
- Leaf shape and arrangement (opposite, alternate or whorled attachment)
- Fruit shape, size, color and arrangement
- Bark, trunk or stem
- Roots, rhizomes or stolons



The Final Step Is To Click Report!

CONGRATULATIONS!!!! YOU HAVE SUCCESSFULLY COMPLETED AN ENTRY INTO EDDMAPS ALBERTA!

Be sure to return to your personal EDDMapS Alberta page (My EDDMapS).

This is where you keep track of 'Your Stats'; view, revisit, or edit the data you have entered; view or edit your profile, as well as set up & manage invasive species alerts.

THANK YOU FOR CONTRIBUTING TO EARLY DETECTION OF OUR TARGET LIST OF INVASIVE PLANT INFESTATIONS BY USING EDDMAPS ALBERTA!

APPENDIX F

DESCRIPTION OF RIPARIAN HEALTH PARAMETERS

1. Vegetative Cover of Floodplain and Streambanks. Vegetation cover helps to stabilize banks, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, and reduce the rate of evaporation. Stream channels that go dry during the growing season can create problems for polygon delineation. Some stream channels remain unvegetated after the water is gone. If the total vegetative cover of the channel is no more than 15%, it is considered a non-vegetated stream channel and is ***excluded*** from the polygon**.** Exceptions to this minimum of 15% canopy cover include channels with the vegetation removed by human-causes (such as grazing, logging, and construction). These are considered exposed soil surface (bare ground). Those channels that do contain more than 15% vegetative cover are included as part of the riparian vegetation.

The evaluator is to estimate the fraction of the polygon covered by plant growth. Vegetation cover is ocularly estimated using the canopy cover method (Daubenmire 1959).

Scoring:
6 = More than 95% of the polygon area is covered by plant growth.
4 = 85% to 95% of the polygon area is covered by plant growth.
2 = 75% to 85% of the polygon area is covered by plant growth.
0 = Less than 75% of the polygon area is covered by plant growth.

2. Invasive Plant Species (weeds). Invasive plants are alien species (e.g. "*prohibited noxious*" and "*noxious*" weeds listed on Alberta's *Weed Control Act*) whose introduction does or is likely to cause economic or environmental harm. Whether the disturbance that allowed their establishment is natural or human-caused, weed presence indicates a degrading ecosystem. While some of these species may contribute to some riparian functions, their negative impacts reduce overall site health. This item assesses the degree and extent to which the site is infested by invasive plants. The severity of the problem is a function of the density/distribution (pattern of occurrence), as well as canopy cover (abundance) of the weeds. In determining the health score, all invasive species are considered collectively, not individually.

A weed list should be used that is standard for the locality and that indicates which species are being considered (i.e., *Invasive Weed and Disturbance-caused Undesirable Plant List* [Cows and Fish 2002]). Some common invasive species are listed on the form, and space is allowed for recording others. Include both woody and herbaceous invasive species.

2a. Total Canopy Cover of Invasive Plant Species. The observer must evaluate the total percentage of the polygon area that is covered by the combined canopy of all plants of all species of invasive plants. Determine which rating applies in the scoring scale below.
Scoring:
3 = No invasive plant species (weeds) on the site.
2 = Invasive plants present with total canopy cover less than 1 percent of the polygon area.
1 = Invasive plants present with total canopy cover between 1 and 15 percent of the polygon area.
0 = Invasive plants present with total canopy cover more than 15 percent of the polygon area.

2b. Density/Distribution of Invasive Plant Species. The observer must pick a category of pattern and extent of invasive plant distribution from the chart below that best fits what is observed on the polygon, while realizing that the real situation may be only roughly approximated at best by any of these diagrams. Choose the category that most closely matches what you see.

Scoring:

3 = No invasive plant species (weeds) on the site.

2 = Invasive plants present with density/distribution in categories 1, 2, or 3.

1 = Invasive plants present with density/distribution in categories 4, 5, 6, or 7.

0 = Invasive plants present with density/distribution in categories 8, or higher.

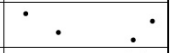
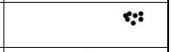
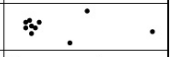
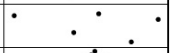
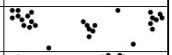
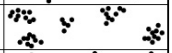
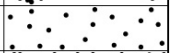
CLASS	DESCRIPTION OF ABUNDANCE	DISTRIBUTION PATTERN
0	No invasive plants on the polygon	
1	Rare occurrence	
2	A few sporadically occurring individual plants	
3	A single patch	
4	A single patch plus a few sporadically occurring plants	
5	Several sporadically occurring plants	
6	A single patch plus several sporadically occurring plants	
7	A few patches	
8	A few patches plus several sporadically occurring plants	
9	Several well spaced patches	
10	Continuous uniform occurrence of well spaced plants	
11	Continuous occurrence of plants with a few gaps in the distribution	
12	Continuous dense occurrence of plants	
13	Continuous occurrence of plants associated with a wetter or drier zone within the polygon.	

Figure 1. Density and distribution of invasive plants.

3. Disturbance-increaser Undesirable Herbaceous Species. A large cover of disturbance-increaser undesirable herbaceous species, native or exotic, indicates displacement from the potential natural community (PNC) and a reduction in riparian health. These species generally are less productive, have shallow roots, and poorly perform most riparian functions. They usually result from some disturbance which removes more desirable species. Invasive species considered in the previous item are not reconsidered here. As in the previous item, the evaluator should state the list of species considered. A partial list of undesirable herbaceous species appropriate for use in Alberta follows. A list should be used that is standard for the locality and that indicates which species are being considered (i.e., *Invasive Weed and Disturbance-caused Undesirable Plant List* [Cows and Fish 2002]). The evaluator should list additional species included.

Antennaria spp. (pussy-toes) *Hordeum jubatum* (foxtail barley) *Potentilla anserina* (silverweed)
Brassicaceae (mustards) *Plantago* spp. (plantains) *Taraxacum* spp. (dandelion)
Bromus inermis (smooth brome) *Poa pratensis* (Kentucky bluegrass) *Trifolium* spp. (clovers)
Fragaria spp. (strawberries) _____ _____

Scoring:

3 = Less than 5% of the site covered by disturbance-caused undesirable herbaceous species.

2 = 5% to 25% of the site covered by disturbance-caused undesirable herbaceous species.

1 = 25% to 45% of the site covered by disturbance-caused undesirable herbaceous species.

0 = More than 45% of the site covered by disturbance-caused undesirable herbaceous species.

4. Preferred Tree and Shrub Establishment and/or Regeneration. (Skip this item if the site lacks potential for trees or shrubs; for example, the site is a herbaceous wet meadow or marsh.) Not all riparian areas can support trees and/or shrubs. However, on those sites where such species do belong, they play important roles. The root systems of woody species are excellent bank stabilizers, while their spreading canopies provide protection to soil, water, wildlife, and livestock. Young age classes of woody species are important indicators of the continued presence of woody communities not only at a given point in time but into the future. Woody species potential can be determined by using a key to site type (Thompson and Hansen 2001, 2002, 2003 etc.). On severely disturbed sites, the evaluator should seek clues to potential by observing nearby sites with similar landscape position. (***Note:*** Vegetation potential is commonly underestimated on sites with a long history of disturbance.)

One tree species (*Elaeagnus angustifolia* [Russian olive]) and seven shrub genera or species (*Symphoricarpos* spp. [snowberry], *Rosa* spp. [rose], *Crataegus* spp. [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Caragana* spp [caragana], *Rhamnus cathartica* [European/common buckthorn], and *Tamarix* spp. [salt cedar] are excluded from the evaluation of establishment and regeneration. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-heavy grazing pressure; ***AND*** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* spp. [caragana], *Rhamnus cathartica* [European/common buckthorn], and *Tamarix* spp. [salt cedar] are considered especially aggressive, undesirable exotic plants.

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (i.e., *Salix* spp. [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern. ***FOR EXAMPLE***: A polygon may have *Symphoricarpos occidentalis* (common snowberry) with 30% canopy cover showing young plants for replacement of older ones, while also having a trace of *Salix exigua* (sandbar willow) present, but represented only by older mature individuals.

We feel that the failure of the willow to regenerate (even though there is only a small amount) is very important in the health evaluation, but by including the snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of snowberry).

For shrubs in general, seedlings and saplings can be distinguished from mature plants as follows. For those species having a mature height generally over 6.0 ft (1.8 m), seedlings and saplings are those individuals less than 6.0 ft (1.8 m) tall. For species normally not exceeding 6.0 ft (1.8 m), seedlings and saplings are those individuals less than 1.5 ft (0.45 m) tall or which lack reproductive structures and the relative stature to suggest maturity. (***Note:*** Evaluators should take care not to confuse short stature resulting from heavy browsing with that due to youth.)

Scoring: *(If the site has no potential for trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA. If the evaluator is not fairly certain potential exists for preferred trees or shrubs, then enter NC and explain in the comment field below).*
6 = More than 15% of the total canopy cover of preferred trees/shrubs is seedlings and saplings.
4 = 5% to 15% of the total canopy cover of preferred trees/shrubs is seedlings and saplings.
2 = Less than 5% of the total canopy cover of preferred tree/shrubs is seedlings and saplings.
0 = Preferred tree/shrub seedlings or saplings absent.

5a. Utilization of Preferred Trees and Shrubs. (Skip this item if the site lacks trees or shrubs; for example, the site is a herbaceous wet meadow or cattail marsh.) Many riparian woody species are browsed by livestock and/or wildlife. Heavy browsing can prevent establishment or regeneration of these important species. Excessive browsing can eliminate them from the community and result in their replacement by undesirable invaders.

One tree species (*Elaeagnus angustifolia* [Russian olive]) and seven shrub genera or species (*Symphoricarpos* spp. [snowberry], *Rosa* spp. [rose], *Crataegus* spp. [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Caragana* spp [caragana], *Rhamnus cathartica* [European/common buckthorn], and *Tamarix* spp. [salt cedar] are excluded from the evaluation of utilization of woody species. These are plants that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-heavy grazing pressure; ***AND*** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* spp. [caragana], *Rhamnus cathartica* [European/common buckthorn], and *Tamarix* spp. [salt cedar] are considered especially aggressive, undesirable exotic plants.

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (i.e., *Salix* spp. [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a heavily utilized species of greater concern. ***FOR EXAMPLE***: A polygon may have *Symphoricarpos occidentalis* (common snowberry) with 30% canopy cover showing only light utilization, while also having a trace of *Salix exigua* (sandbar willow) present showing heavy utilization. We feel that, although there is only a small amount of willow present, the fact that it is being heavily utilized is very important to the health evaluation. By including the snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of snowberry).

When estimating degree of utilization, count browsed second year and older leaders on representative plants of woody species normally browsed by ungulates. Do not count current year's use. This may not accurately reflect actual use because more browsing can occur late in the season. Determine percentage by comparing the number of leaders browsed with the total number of leaders available (those within animal reach) on a representative sample (at least three plants) of each tree and shrub species present.

Also include human removals by such activities as shearing and mowing. Do not count use of dead plants unless it is clear this condition was the result of over-grazing. ***Note:*** If a plant is entirely mushroom/umbrella shaped by long-term heavy browse or rubbing use, or is chewed off completely at the stem base, count as heavy utilization. Be sure to include physical and mechanical damage or cutting by humans, as well as consumptive use by animals.

Scoring: *(If the site has no potential for trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA. If the evaluator is not fairly certain potential exists for preferred trees or shrubs, then enter NC and explain in the comment field below.)*
3 = None (0% to 5% of available second year and older leaders of preferred species are utilised).
2 = Light (5% to 25% of available second year and older leaders of preferred species are utilised).
1 = Moderate (25% to 50% of available second year and older leaders of preferred species are utilised).
0 = Heavy (More than 50% of available second year and older leaders of preferred species are utilised).

5b. Live Woody Vegetation Removal by Other Than Browsing. *(Skip this item if the polygon lacks trees and shrubs AND there are no stumps or cut woody plants to indicate that it ever had any.)*

Excessive cutting or removing parts of plants or whole plants by agents other than browsing animals (e.g., human clearing, cutting, beaver activity, etc.) can result in many of the same negative effects to the community that are caused by excessive browsing. However, other effects from this kind of removal are direct and immediate, including reduction of physical community structure and wildlife habitat values. Do not include natural phenomena such as natural fire, insect infestation, etc. in this evaluation.

For this item consider all woody vegetation together: trees and shrubs of all age classes, except for the invasive species (*Elaeagnus angustifolia* [Russian olive], Caragana species [caragana], *Rhamnus cathartica* [European/common buckthorne], and Tamarix species [salt cedar]). Record the amount of cutting or removing parts of plants or whole plants by agents other than browsing animals (e.g., human clearing, cutting, beaver activity, etc.). Do not include natural phenomena such as natural fire, insect infestation, etc. in this evaluation.

Removal of woody vegetation may occur at once (a logging operation), or it may be cumulative over time (annual firewood cutting or beaver activity). This question is not so much to assess long term incremental harvest, as it is to assess the extent that the stand is lacking vegetation that would otherwise be there today. Give credit for re-growth. Consider how much the removal of a tree many years ago may have now been mitigated with young replacements.

Scoring: (*If the site has no trees or shrubs AND no cut plants or stumps of any trees or shrubs [except for the species listed above to be excluded*], replace both Actual Score and Possible Score with NA.)
3 = None (0% to 5% of live woody vegetation expected on the site is lacking due to cutting).
2 = Light (5% to 25% of live woody vegetation expected on the site is lacking due to cutting).
1 = Moderate (25% to 50% of live woody vegetation expected on the site is lacking due to cutting).
0 = Heavy (More than 50% of live woody vegetation expected on the site is lacking due to cutting).

6. Standing Decadent and Dead Woody Material. (Skip this item if the site lacks trees or shrubs; for example, the site is a herbaceous wet meadow or cattail marsh.) The amount of decadent and dead woody material on a site can be an indicator of the overall health of a riparian area. Large amounts of decadent and dead woody material may indicate a reduced flow of water through the stream (dewatering) due to either human or natural causes. Dewatering of a site, if severe enough, may change the site vegetation potential from riparian species to upland species. In addition, decadent and dead woody material may indicate severe stress from over browsing. Finally, large amounts of decadent and dead woody material may indicate climatic impacts, disease and insect damage. For instance, severe winters may cause extreme die back of trees and shrubs, and cyclic insect infestations may kill individuals in a stand. In all these cases, a high percentage of dead and decadent woody material reflects degraded vegetative health, which can lead to reduced streambank integrity, channel incisement, and excessive lateral cutting, besides reducing production and other wildlife values.

The most common usage of the term ***decadent*** may be for over mature trees past their prime and which may be dying, but we use the term in a broader sense. We count decadent plants, both trees and shrubs, as those with 30% or more dead wood in the upper canopy. In this item, scores are based on the percentage of total woody canopy cover which is decadent or dead, not on how much of the total polygon canopy cover consists of dead and decadent woody material. Only decadent and dead standing material is included, not that which is lying on the ground.

Scoring: (If site lacks potential for woody species, replace both Actual and Potential Scores with NA.)
3 = Less than 5% of the total canopy cover of woody species is decadent or dead.
2 = 5% to 25% of the total canopy cover of woody species is decadent or dead.
1 = 25% to 45% of the total canopy cover of woody species is decadent or dead.
0 = More than 45% of the total canopy cover of woody species is decadent or dead.

7. Streambank/Riverbank Root Mass Protection. Streamside vegetation stabilizes the soil to the extent that it provides deep, binding roots. All tree and shrub species provide such roots. Herbaceous annuals lack this quality. Perennial herbs provide it in varying degree. Some rhizomatous species, such as sedges (*Carex* spp.), are excellent streambank stabilizers. Other rhizomatous species, such as Kentucky bluegrass (*Poa pratensis*), have shallow roots and are poor streambank stabilizers. The evaluator should seek to determine if the types of root systems present in the polygon are in fact contributing to the stability of the streambanks. For this item consider the streambank to

extend from the toe of the bank to approximately 18 inches beyond the top of the bank. The bank top is that point where the upper bank levels off to the relatively flat surface of a floodplain or terrace. Remember to include both banks (e.g., both sides of the stream). The amount of deep-binding roots needed is stream size dependent. Use the following table as a general guide to determine the width of band along the banks to assess for deep-binding roots.

Stream Size (Bankfull Channel Width)	Width of Band to Assess for Deep, Binding Roots
Small rivers approx. 10-15 m (33-55 ft)	10 m (35 ft)
Large streams approx. 5-10 m (16-33 ft)	5 m (17 ft)
Medium streams approx. 3-5 m (10-16 ft)	3 m (10 ft)
Small streams up to approx. 3 m (10 ft)	1 m (3 ft)

Scoring:
6 = More than 85% of the streambank has a deep, binding root mass.
4 = 65% to 85% of the streambank has a deep, binding root mass.
2 = 35% to 65% of the streambank has a deep, binding root mass.
0 = Less than 35% of the streambank has a deep, binding root mass.

8. Human-Caused Bare Ground. Bare ground is soil not covered by plants, litter or duff, downed wood, or rocks larger than 2.5 inches (6 cm). Bare ground caused by human activity indicates a deterioration of riparian health. Sediment deposits and other natural bare ground are excluded as normal or probably beyond immediate management control. Human land uses causing bare ground include livestock grazing, recreation, roads, and industrial activities. The evaluator should consider the causes of all bare ground observed and estimate the fraction that is human-caused.

Stream channels that go dry during the growing season can create problems for polygon delineation. Some stream channels remain unvegetated after the water is gone. If the total vegetative cover of the channel is no more than 15%, it is considered a non-vegetated stream channel and is ***excluded*** from the polygon**.** Exceptions to this minimum of 15% canopy cover include channels with the vegetation removed by human-causes (such as grazing, logging, and construction). These are considered exposed soil surface (bare ground). Those channels that do contain more than 15% vegetative cover are included as part of the riparian vegetation.

Scoring:
6 = Less than 1% of the site is human-caused bare ground.
4 = 1% to 5% of the site is human-caused bare ground.
2 = 5% to 15% of the site is human-caused bare ground.
0 = More than 15% of the site is human-caused bare ground.

9. Streambank/Riverbank Structurally Altered by Human Activity. Streambank structural integrity is vital to good channel configuration and bank shape. Impaired structure can mobilize channel and bank materials, cause loss of fishery and wildlife habitat, lower the water table, etc. Bank alteration can result from such causes as livestock trampling, pugging, hummocking, hoof shear, trails, human recreational use, and resource extraction activities, riprap, road crossings, etc. In rating this item, consider the bank area from the water's edge up to 0.5 meter (18 inches) beyond the top of the bank. The bank top is that point where the upper bank levels off to the relatively flat surface of a floodplain or terrace. Remember to include both banks (e.g., both sides of the stream).

Scoring:
6 = Less than 5% of the bank is structurally altered by human activity.
4 = 5% to 15% of the bank is structurally altered by human activity.
2 = 15% to 35% of the bank is structurally altered by human activity.
0 = More than 35% of the bank is structurally altered by human activity.

10. Human Physical Alteration to the Rest of the Polygon. Within the remainder of the polygon area, outside the streambank area that was addressed in the previous question, estimate the amount of area that has been physically altered by human causes.
The purpose of this question is to evaluate physical change to the soil, hydrology, etc. as it affects the ability of the natural sustem to function normally. Changes in soil structure will alter infiltration of water, increase soil compaction, and change the amount of sediment contributed to the water body. Every human activity in or around a natural site can alter that site. This question seeks to assess the accumulated effects of all human-caused change. Count such things as:

- Animal or human hummocking, pugging, rutting, and trampling;
- Changes to the soil surface that impede water infiltration (i.e., impervious covers, compacted paths, trails, etc.);
- Hydrologic changes (i.e., draining, ditching, berming, etc.); and
- Disturbance to the natural soil surface caused by farming (plowing/tilling) or any other human activity.

Scoring:
3 = Less than 5% of the polygon is altered by human causes.
2 = 5% to 15% of the polygon is altered by human causes.
1 = 15% to 25% of the polygon is altered by human causes.
0 = More than 25% of the polygon is altered by human causes.

11. Stream Channel Incisement (vertical stability). Incisement can lower the water table enough to change current vegetation and site potential. It can also increase stream energy, reduce water retention/storage, and increase erosion. A stream is incised when downcutting has lowered the channel bed so that two-year flood events cannot overflow the banks. Four typical downcutting indicators are: a) headcuts; b) exposed cultural features (pipelines, bridge footings, culverts, etc.); c) lack of sediment and exposed bedrock; and d) a low, vertical scarp at the bank toe on the inside of a channel bend.

Channel incisement can occur in any of several stages (Figure 4). A severe disturbance can initiate downcutting, transforming the system from a steady state of high water table, appropriate floodplain, and high productivity to one of degraded water table, narrow [or no] active floodplain, and low productivity. (These stages of incisement can be categorized in terms of Rosgen Level I channel types [Rosgen 1996].)

A top rating goes to those unincised channels from which the 1-2 year high flow can access its floodplain.
These can be meandering meadow streams (Rosgen E-type) and wide valley bottom streams (Rosgen C-type) which access floodplains much wider than the stream channel, or they may be mountain and foothill streams in V-shaped valleys which have limited floodplains because of topography. These latter types are usually armoured (well-rocked) systems with highly stable beds and streambanks that are not susceptible to downcutting. The lowest rating goes to entrenched channels (Rosgen F- or G-type) where even medium high flows which occur at 5-10 year intervals cannot overtop the high banks. Intermediate stages can be improving or degrading and may reflect slightly incised channels not yet so downcut that intermediate floods cannot access the floodplain, or they may be old incisements that are healing and rebuilding floodplain at a new, lower elevation.

Scoring:

9= Channel vertically stable and not incised; 1-2 year high flows access a floodplain appropriate to the stream type. Active downcutting is not evident. Any old incisement is characterized by a broad floodplain inside which perennial riparian plant communities are well established. This condition is illustrated in Figure 2 by the following three stages.

Stage A-1. A stable, unincised meandering meadow channel (Rosgen E-type). Flows greater than bankfull (1-2 year event) spread over a floodplain more than twice the bankfull channel width.

Stage A-2. A fairly stable, unincised wide valley bottom stream with broad curves and point bars (Rosgen C-type). Although these streams typically cut laterally on the outside of curves and deposit sediment on inside point bars, bankfull flows (1-2 year events) have access to a floodplain more than twice bankfull channel width.

Stage A-3. A stable, unincised mountain (Rosgen A-type) or foothill (Rosgen B-type) channel with limited sinuosity and slopes greater than 2%. Although bankfull flow stage is reached every 1-2 years, the adjacent floodplain is often narrower than twice the bankfull channel width. Consequently, overflow conditions are not so obvious as in Stages A-1 and A-2 systems.

6 = Either of two incisement phases: (a) an improving phase with a sinuous curve/point bar system (Rosgen C-type) or a narrow, meandering stream (E-type) establishing in an old incisement which now represents the new floodplain, although this may be much narrower than it will become;(b) an early degrading phase in which a narrow, meandering meadow stream (E-type) is degrading into a curve/point bar type (C-type) or a wide, shallow channel (Rosgen F-type). In either case, the 1-2 year high flow event can access only a narrow floodplain less than or only slightly wider than twice the bankfull channel width. Perennial riparian vegetation is well established along much of the reach. These conditions are represented in **Stage B** of Figure 2.

3 = Two phases of incisement fit this rating. (a) A deep incisement that is starting to heal. In this phase new floodplain development, though very limited, is key. This phase is characterized by a wide, shallow channel unable to access a floodplain (Rosgen F-type) evolving into a curve/point bar system (C-type) through sediment deposition and lateral cutting. Pioneer perennial plants are beginning to establish on the new depositional surfaces. (b) An intermediate phase with downcutting and headcuts probable. Flows less than a 5-10 year event can access a narrow floodplain less than twice bankfull channel width. These conditions are represented in **Stage C** of Figure 2.

0 = The channel is deeply incised to resemble a ditch or a gully. Downcutting is likely ongoing. Only extreme floods overtop the banks, and no floodplain development has begun. Both **Stages D-1** and **D-2** of Figure 2 fall into this rating.

Stage D-1. An incised stream with a wide, shallow (F-type) channel. Commonly found in fine substrates (sands, silts, and clays), channel banks are very erodable. Only limited vegetation, primarily pioneer species, is present along the side of the stream.

Stage D-2. A narrow, deep "gully" system (Rosgen G-type) downcut to the point that only extreme floods can overtop the banks. Distinguished from narrow mountain streams (A-type) by the presence of a flat floodplain through which the stream has downcut and by banks consisting of fine materials rather than larger rocks, cobbles, or boulders.

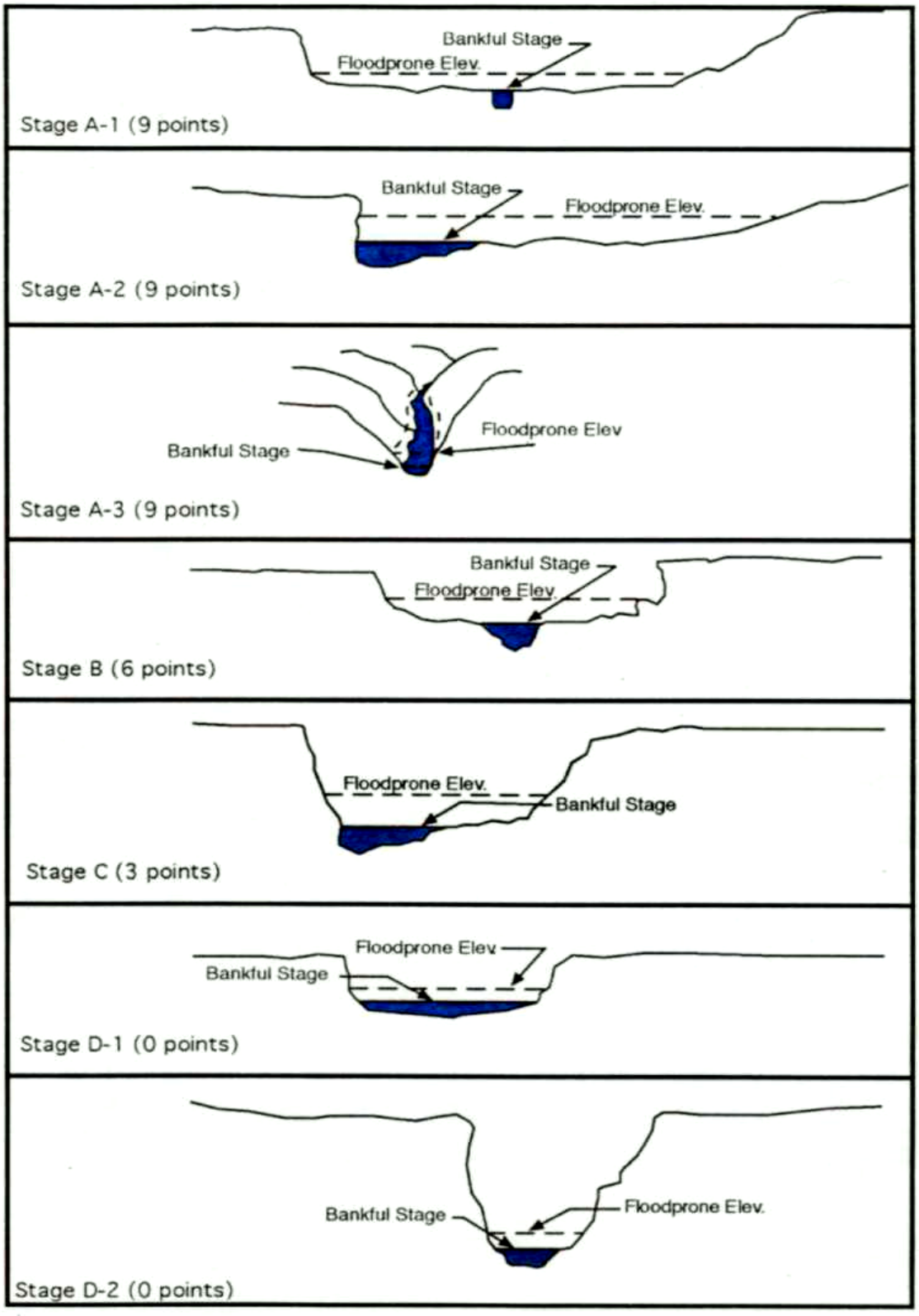


Figure 2. Guides for estimating stage of channel incisement.