Cows and Fish Report

2012 Riparian Health Inventory Project (Year 2): Westslope Cutthroat Trout Priority Streams

A Summary of the Riparian Health Status and Habitat Improvement Needs for 17 Priority Westslope Cutthroat Trout Sites in the South Eastern Slopes of Alberta

Alberta Riparian Habitat Management Society (Cows and Fish)
Report No. 042

Cows and Fish

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

Working with producers and communities on riparian awareness

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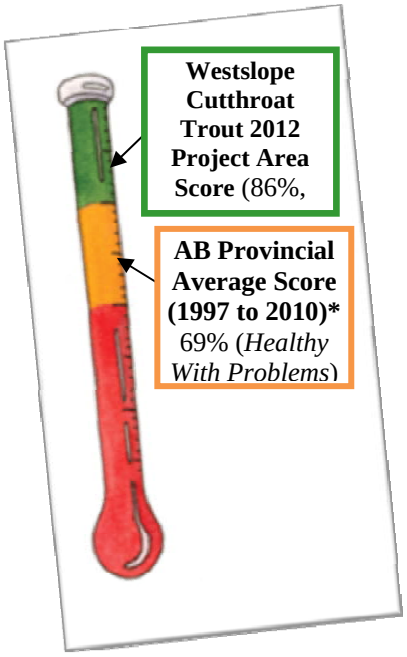
Disclaimer

- *Riparian health inventories of small stream systems do not address 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

In 2012, the Alberta Riparian Habitat Management Society (Cows and Fish) conducted 17 riparian health inventories (RHIs) in priority native Westslope Cutthroat Trout stream reaches in the Elbow River, Sheep River, Highwood River, Todd Creek, Crowsnest River and Castle River watersheds of south-western Alberta. A total of 10.5 km of bank length and 20.6 hectares of riparian habitat was assessed primarily in multi-use forest reserves and Public Land Use Zones. This project follows on from riparian health inventories conducted in 2011 on 15 priority Westslope Cutthroat Trout streams in the Eastern Slopes within the Bow and Oldman River basins. Project partners include Alberta Environment and Sustainable Resource Development (AESRD), Fisheries and Oceans Canada, the Alberta Conservation Association (ACA) and Trout Unlimited Canada. Riparian health data collected as part of this project will be used to help further Westslope Cutthroat Trout habitat stewardship and recovery efforts in Alberta. Westslope Cutthroat Trout, a *Threatened* native fish species under Canada's *Species At Risk Act* and Alberta's *Wildlife Act*, have been reduced to less than 10% of their historic range in the province.



The average riparian health rating for the 17 stream sites assessed in 2012 is 86% (*healthy*); only 5 of the sites received health ratings in the *healthy, but with problems* category (i.e. below the *healthy* threshold of 80%). By area, of the 20.6 ha of riparian habitat evaluated, 74% (15.2 ha) rated *healthy*. The 2012 riparian sites averaged 1.2 ha in size, with many having access constraints due to naturally steep sided valley walls. Vegetation health concerns include invasive and disturbance-caused non-native species cover / distribution in addition to moderate to heavy browse levels in five sites. Five invasive noxious weed species were observed in the project area, including Canada thistle (*Cirsium arvense*), common mullein (*Verbascum thapsus*), oxeye daisy (*Chrysanthemum leucanthemum*), perennial sow-thistle (*Sonchus arvensis*) and tall buttercup (*Ranunculus acris*). Invasive species have widespread distribution in 9 of the 17 sites. Most of the soil / hydrology health parameters rated *healthy* on average except for elevated levels of soil compaction in the floodplain in 8 of the 17 sites mainly due to either livestock or recreational land uses or a combination thereof. Further study is needed to assess and monitor water quality and sedimentation of spawning reaches within priority Westslope Cutthroat Trout streams in the project area.

Next steps and management recommendations for riparian health improvements are provided in Section 6 of this report. Cohesive and collaborative efforts to plan and manage land uses in the project area will be important for improving riparian health and maintaining existing healthy sites in an ecologically functioning condition. Ongoing dialogue and engagement with multiple user groups is a necessary part of this planning process. Multi-stakeholder workshops and field days led by Cows and Fish in 2012 and 2013 provide a good platform from which to continue to encourage collaborative land stewardship efforts.

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

1 BACKGROUND

1.1 Project Overview

In 2011 and 2012, the Alberta Riparian Habitat Management Society (Cows and Fish) conducted riparian health inventories (RHIs) along streams and rivers with native pure strains of 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 Environment and Sustainable Resource Development (AESRD), 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 through financial support provided by the Government of Canada (Environment Canada's Habitat Stewardship Program). This project was also made possible through ongoing grants and in-kind support provided by AESRD, Alberta Agriculture and Rural Development, 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. RHIs conducted in 2012 were done as the second phase of a proposed multi-year project aimed at assessing priority habitat for native pure Westslope Cutthroat Trout strains 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 17 Westslope Cutthroat Trout priority sites assessed during the 2012 field season by Cows and Fish in the Bow and Oldman River watersheds. Individual site scores and details are provided in individual RHI summary reports submitted to AESRD, grazing allotment holders and private landowner project participants.

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 AESRD, 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 10% of the species' historical range. Most of the remaining habitat lies within federal or provincial Crown land.

Current Status

Native stocks of Westslope Cutthroat Trout are presently listed as *Threatened* in Alberta under the provincial *Wildlife Act* and have recently been up-listed to *Threatened* under the federal *Species At Risk Act* (as of March 2013). Joint provincial and federal recovery plans are expected to be available on-line within the near future.

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).

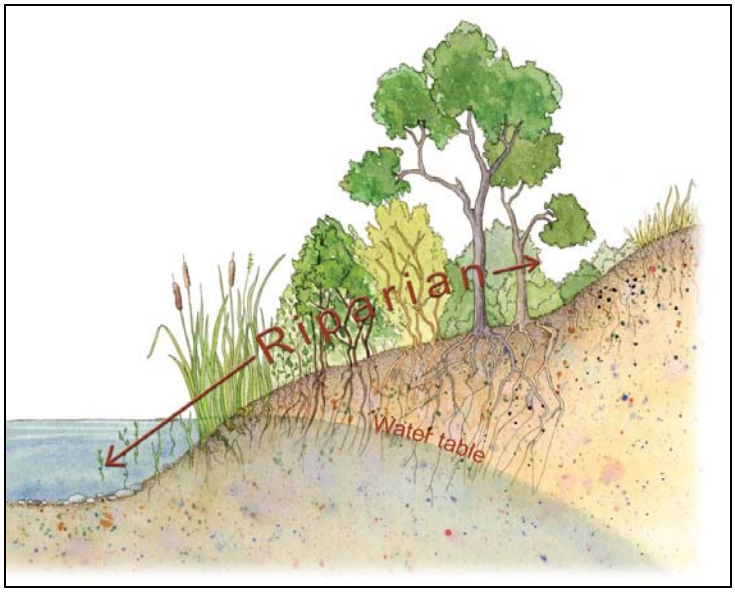


Figure 1 Diagrammatic Representation of a Riparian Area

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 AESRD, DFO, ACA and TUC. RHI sites were strategically selected on watercourses where recent fisheries assessments have confirmed the presence of genetically pure (95% purity or higher) Westslope Cutthroat Trout populations. To assist with site selection, AESRD 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 AESRD Fisheries Biologist and AESRD Public lands, Rangeland Agrologist.

In total 17 sites were assessed from July to September, 2012, on 10 watercourses primarily in Public Land Grazing Allotments in the Elbow River, Sheep River, Highwood River, Todd Creek, Crowsnest River and Castle River watersheds (Table 1, Figure 2). A total of 10.5 km of bank length and 20.6 ha of riparian habitat were assessed as part of this project in 2012 (Table 1).

Table 1 Westslope Cutthroat Trout 2012 Project Area RHI Sites

RHI Site ID	Watercourse	2012 RHI Assessment Date	Streambank Length Inventoried (m)	Approximate Riparian Area Inventoried (ha)	ACA/AESRD Record No.	WSCT Purity
Elbow River Watershed						
SIL1	Silvester Creek	August 21-23	400	1.0	AFW-SiC	≥0.99
SIL2			410	1.5		
SIL3			410	1.0		
Sheep River Watershed						
GOR1	Gorge Creek	August 9	740	0.5	J-S17a	>=0.95 but <0.99
Highwood River Watershed						
FLA1	Flat Creek	September 7	680	0.8	J-H7b	>=0.95 but <0.99
CTH1	Cutthroat Creek	September 7	620	1.0	AFW-CuC	≥0.99
PEK15	Pekisko Creek	September 12	710	0.7	AFW-PeC	>=0.95 but <0.99
PEK17			550	0.6		
Todd Creek Watershed						
TCT1	Unnamed Tributary to Todd Creek	August 7	30	<0.1	ACA-Crow-8	>=0.95 but <0.99
TCT2		August 8	510	0.8		
TCT3		August 7	230	0.4		
Crowsnest River Watershed						
ALL1	Allison Creek	July 30	1730	3.5	D-Cr2	>=0.95 but <0.99
ALL2			470	0.5	ACA-Crow-24	>=0.95 but <0.99
Castle River Watershed						
OHA1	O'Hagen Creek	August 31	830	3.4	D-C4	≥0.99
CRB1	Carbondale River	August 2	990	2.5	AFW-CaR	≥0.99
CRB2			690	2.1	ACA-59	>=0.95 but <0.99
SYN1	Syncline Brook	July 31	520	0.4	ACA-44	≥0.99

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

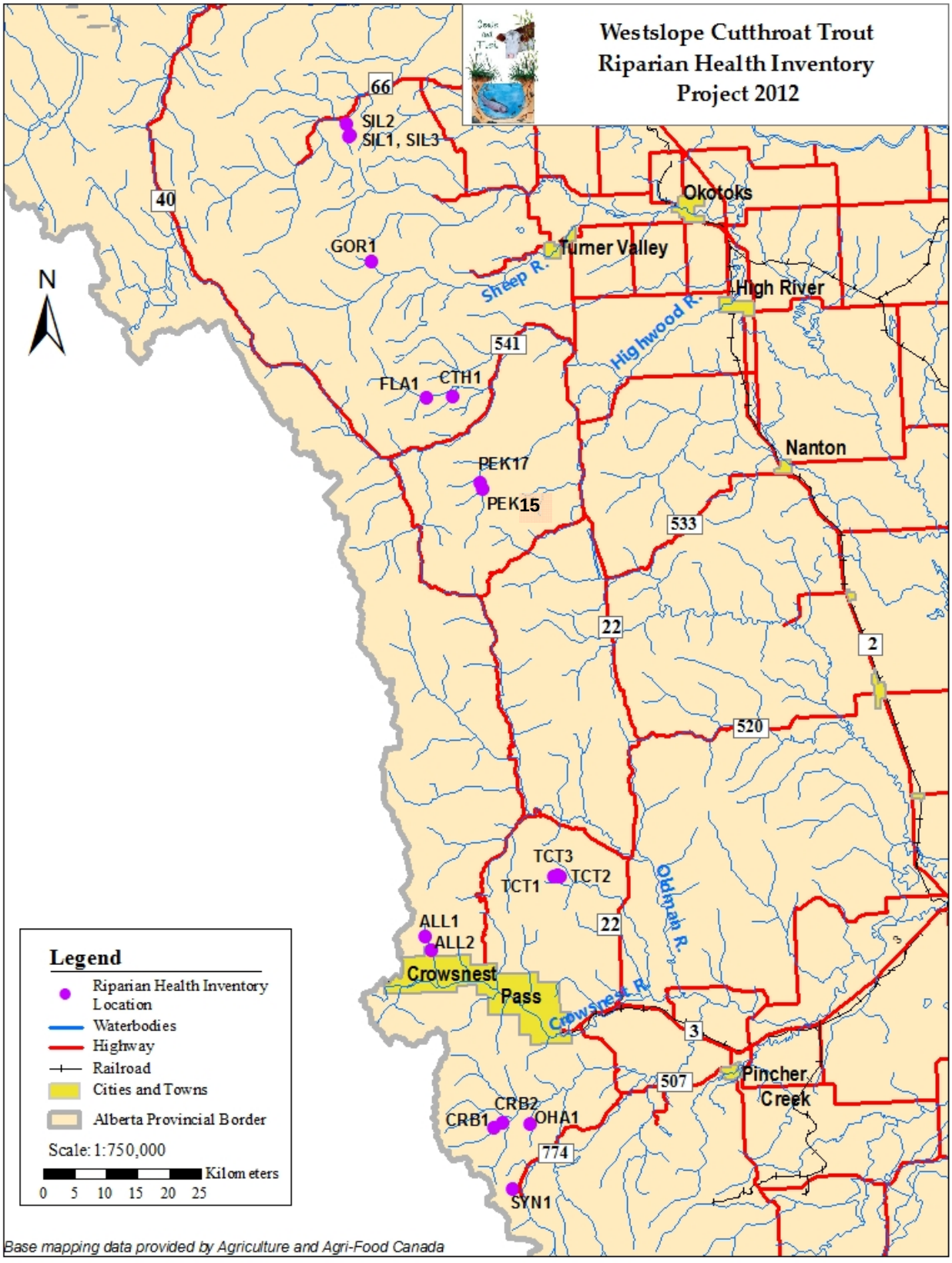


Figure 2 Westslope Cutthroat Trout 2012 Riparian Health Inventory Locations

2.2 Land Use and Land Management

Most of the 2012 RHI sites are located in headwater stream/river reaches in multi-use Alberta Forest Reserve lands, managed by AESRD (Table 2). Forest Reserve lands encompass the McLean Creek and Castle Special Management Area Public Land Use Zones (PLUZ)[1] and grazing allotments within Sheep River Provincial Park, the M.D. of Foothills and the M.D. of Ranchlands (Table 2). Two sites (one along Pekisko Creek and one along a tributary to Todd Creek) are located within private landholdings (Table 2). The entire project area occurs within the Montane Natural Subregion of Alberta's Rocky Mountain Natural Region.

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. Access management maps and guidelines for recreational use activities for the McLean Creek and Castle Special Management Area PLUZ are available on-line.[2]

The Project Area encompasses nine Gazing Allotments (including PNTs and GRLs) managed by AESRD, Public Lands, Rangeland Management Division (Table 2). 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

[1] Formerly referred to as "Forest Land Use Zones", "Public Land Use Zones are "*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*" (http://srd.alberta.ca/RecreationPublicUse/RecreationOnPublicLand/PublicLandUseZones/Default.asp).

[2] http://srd.alberta.ca/RecreationPublicUse/RecreationOnPublicLand/PublicLandUseZones/

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.

Table 2 Administrative Land Management Units within the Project Area

RHI Site ID	Watercourse	Land Management Unit	Municipality / Park / PLUZ	Natural Region (NR) and Subregion (SR
Elbow River Watershed				
SIL1	Silvester Creek	Kananaskis Country (PNT 930439)	McLean Creek PLUZ	Rocky Mountain NR, Montane SR
SIL2				
SIL3				
Sheep River Watershed				
GOR1	Gorge Creek	PNT 940129	Sheep River Provincial Park	Rocky Mountain NR, Montane SR
Highwood River Watershed				
FLA1	Flat Creek	Sullivan Flat Grazing Allotment (PNT 930179)	MD of Foothills	Rocky Mountain NR, Montane SR
CTH1	Cutthroat Creek	GRL880178		
PEK15	Pekisko Creek	Private Landholding		
PEK17		GRL 030004		
Todd Creek Watershed				
TCT1	Unnamed Tributary to Todd Creek	PNT 930163	MD of Ranchlands	Rocky Mountain NR, Montane SR
TCT2		Private Landholding		
TCT3		GRL 32699		
Crowsnest River Watershed				
ALL1	Allison Creek	PNT 930200	MD of Ranchlands	Rocky Mountain NR, Montane SR
ALL2				
Castle River Watershed				
OHA1	O'Hagen Creek	Pincher Creek Stock Association (PNT 940206)	Castle Special Management Area PLUZ	Rocky Mountain NR, Montane SR
CRB1	Carbondale River			
CRB2				
SYN1	Syncline Brook			

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

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 3). 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*.

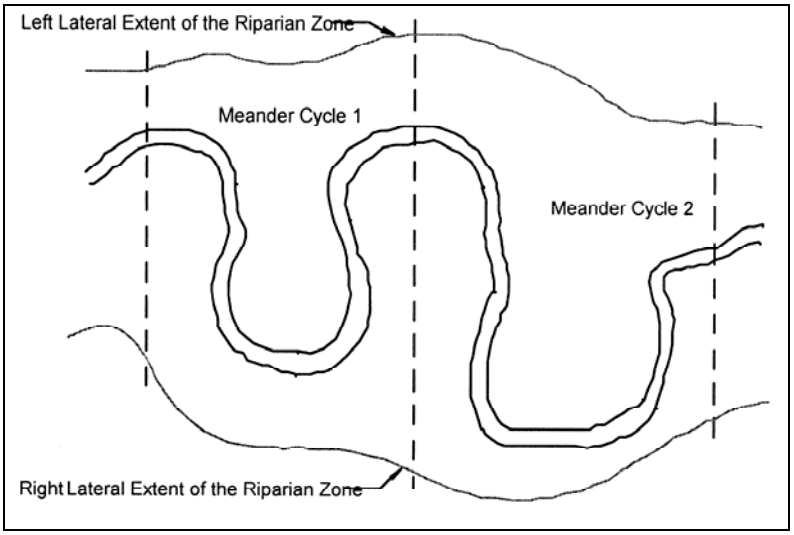


Figure 3 Stream Meander Cycle Diagram[3]

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

[3] 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 4).

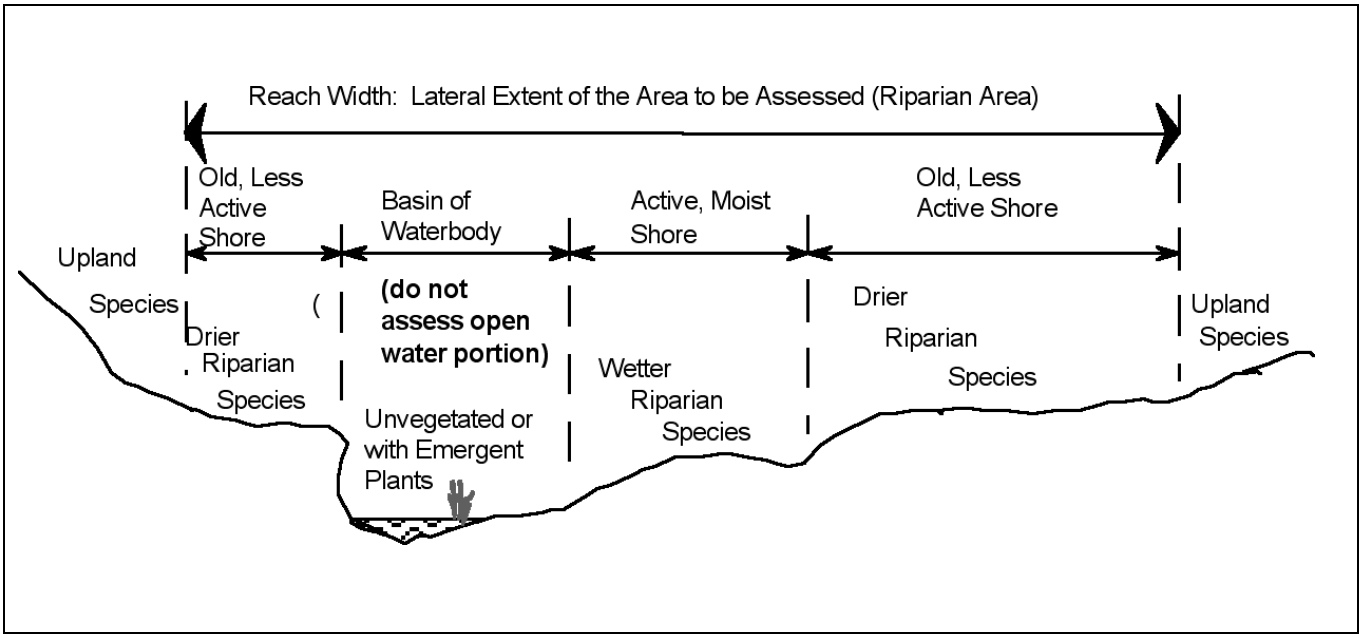


Figure 4 Cross Section Profile of Riparian Area Extent Adjacent to a Stream Channel

The outer edge of the riparian zone generally exists where[4]:

- 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 5).

[4] Fitch *et al.* 2001

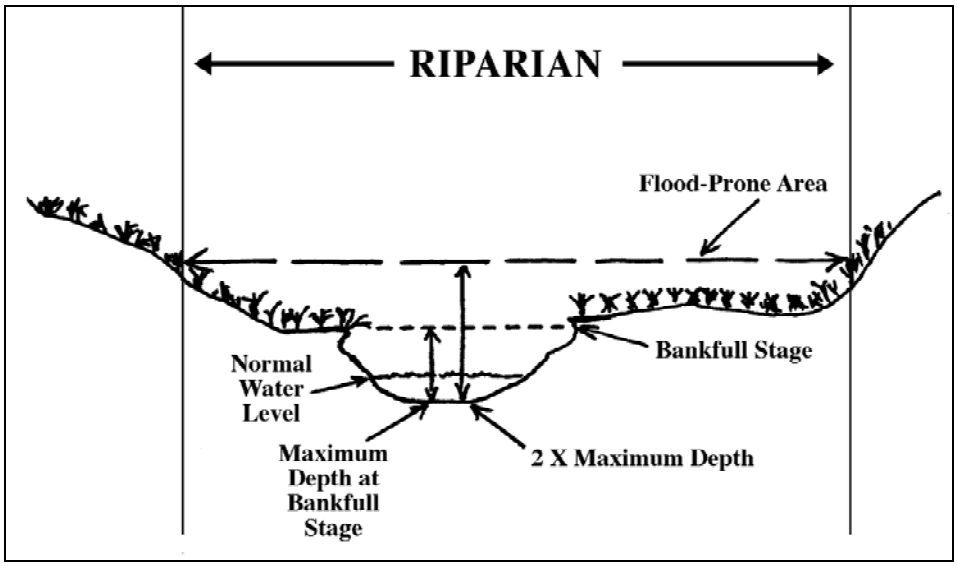


Figure 5 Flood-Prone Area Diagram for Small Stream Systems[5]

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 3). This information is entered into a provincial riparian health FileMaker Pro database developed by the Ecological Solutions Group LCC for Cows and Fish.

Table 3 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;
General	- General comments about riparian vegetation health, including discussion of human use impacts.

[5] 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 4). **A more detailed description of each of these parameters and how they are scored is described in Appendix D.** Riparian health scores (ratings) are expressed as a percentage and a health category (*healthy*, *healthy, but with problems*, or *unhealthy*) (Table 5).

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 4 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*
	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
	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 5 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

The *Range Plant Community Guide for the Montane Subregion* (Willoughby *et al.* 2008) was used to classify riparian plant communities in the project area. Plant community types that did not fit with any of the types in the Willoughby *et al.* Guide were described as "Unclassified". The Willoughby *et al.* 2008 Guide is based on field sampling of over 1800 sites in the Montane Subregion in Alberta.

3.7 Additional Westslope Cutthroat Trout Habitat Data

As was done in 2011, supplementary additional 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.

Two additional measurements were collected in 2012 that were not part of the 2011 sampling protocol. This included course estimates as to the degree to which small cobble and gravel substrate were embedded or cemented by the long-term accumulation of fine sediment. These parameters were assessed in at least four riffle habitats along the RHI reach with small gravel and cobble substrate less than 10 cm wide on average. UTM waypoints were recorded at each sampling location along the stream reach. To assess the degree of "embeddedness", surveyors walked perpendicular to the stream channel at suitable riffles and collected 5 random samples of gravel or cobble (less than 10 cm in width) at regular intervals across the channel. For each gravel / cobble sample collected, estimates were made as to the percentage of the rock surface buried in fine sediment. At each of the "embeddedness" sampling locations, a poke test was also done to assess the degree of "cementedness". Poke tests were done at 5 evenly spaced locations walking perpendicular to the channel using a long, 2.5 cm minimum diameter stick. Observers used the following categories to describe each poke test:

a) **Loose:** substrate readily moves when you walk on it; stick readily pokes into substrate spaces.
b) **Intermediate: somewhat cemented:** substrate does not easily move when you walk on it or poke it but it will move somewhat and is not extremely hard nor stationary.
c) **Cemented:** substrate does not move when you walk on it and a stick will not readily go into the substrate except when force is applied.

4 RESULTS AND DISCUSSION

4.1 Overview of Riparian Health Results

The average riparian health rating for the 17 stream sites assessed in 2012 is 86% (*healthy*). The majority of sites (12 sites) (i.e. 71%) rate *healthy*; the remainder are in the *healthy with problems* category (Figure 6). By area, of the 20.6 ha of riparian habitat evaluated, 74% (15.2 ha) rated *healthy* (Figure 7). The assessed sites range from 0.02 ha along a tributary to Todd Creek to 3.5 ha in size along Allison Creek, averaging 1.2 ha in size. Since the project area is in the foothills of the Rocky Mountains, most of these riparian sites are naturally constrained in size by steep sided valley walls.

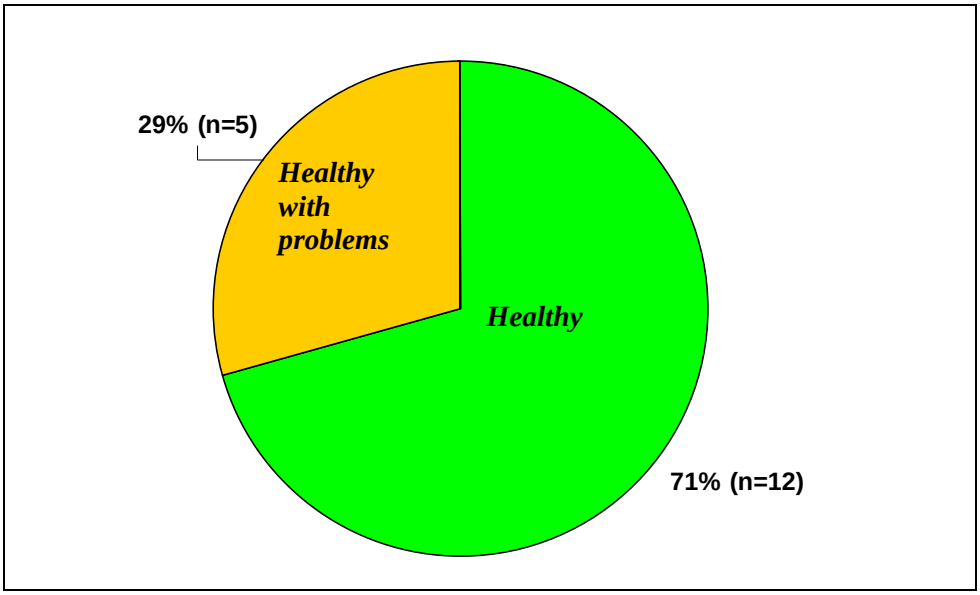


Figure 6 2012 Project Area Riparian Health Results

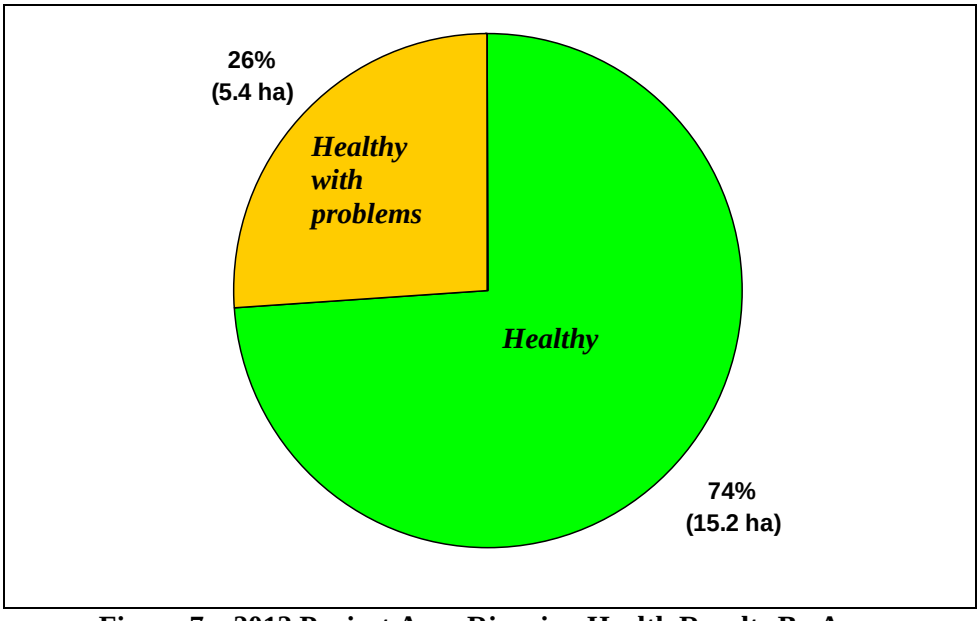


Figure 7 2012 Project Area Riparian Health Results By Area

4.2 Riparian Plant Communities in the Project Area

Tree Communities

The dominant mixedwood tree community type, occupying almost 40% of the project area, resembles the "white spruce – trembling aspen / dwarf scouring-rush" (*Picea glauca-Populus tremuloides/Equisetum scirpoides*) community type described by Willoughby *et al.* 2008 (Table 6, **Photo a** – page 17). This is a late successional, climax or potential natural community that is characteristic of moist, nutrient rich, low slope sites in the Montane Subregion (Willoughby *et al.* 2008). Balsam poplar is considered an early successional species, with white spruce becoming the dominant cover as the community matures over time. This community type is considered "non-use" for livestock due to heavy shading and limited understory herbaceous forage production (Willoughby *et al.* 2008).

Table 6 Plant Community Types in the Project Area

Plant Community*	AESRD Range Plant Community Guide Plant Community Code	RHI Sites Where Found	Frequency of Occurrence in RHI Sites	Area Occupied	Area Occupied (%)
Tree Community Types					
white spruce – trembling aspen / dwarf scouring-rush	F12	ALL1, CTH1, OHA1	18%	7.6 ha (18.6 ac)	37.1%
balsam poplar – white spruce / prickly rose / forb	F14	FLA1, PEK15, PEK17	18%	2.1 ha (5.0 ac)	10%
white spruce / willow	Unclassified	CRB2	6%	2.0 ha (5.0 ac)	10%
white spruce / common horsetail	E12A	SIL2, TCT1	12%	1.5 ha (3.5 ac)	7.0%
white spruce – willow / water sedge / golden moss	D11	GOR1	6%	0.5 ha (1.3 ac)	2.5%
white spruce / thimbleberry	E16	SYN1	6%	0.4 ha (0.9 ac)	1.8%
trembling aspen	Unclassified	TCT3	6%	0.2 ha (0.5 ac)	1.0%
balsam poplar / willow	G20	TCT2	6%	0.1 ha (0.2 ac)	0.4%
Shrub Community Types					
basket willow / Kentucky bluegrass	D9A	CRB1	6%	2.4 ha (6.0 ac)	11.9%
basket willow / marsh reed grass	D19	SIL1, SIL3	12%	2.0 ha (4.9 ac)	9.7%
Bebb willow / marsh reed grass	D16	TCT2	6%	0.6 ha (1.5 ac)	3.0%
river alder / marsh reed grass	D22	ALL2	6%	0.5 ha (1.1 ac)	2.2%
River alder – Bebb willow / beaked sedge	Unclassified	TCT3	6%	0.1 ha (0.3 ac)	0.7%
Herbaceous Community Types					
Smooth brome – timothy / alfalfa	Unclassified	TCT2	6%	0.1 ha (0.2 ac)	0.4%

**Based on Willoughby et al. 2008. Listed in order of decreasing size by area.*

Another mixedwood community type that occurs in nutrient rich, low slope sites and is often associated with seepage areas is the "balsam poplar – white spruce / prickly rose / forb" (*Populus*

balsamifera – Picea glauca / Rosa acicularis / Forb) type (Table 6, **Photo b** – page 17). This community occupies about 10% of the project area within the Pekisko Creek and Flat Creek sub-basins. In the absence of disturbance, white spruce will become the dominant overstory cover leading to less herbaceous understory vegetation and an increase in moss cover. In early successional stages this community type provides moderate amounts of forage production for livestock but should be rated as secondary range (Willoughby *et al.* 2008).

Dominant coniferous tree communities that each comprise about 10% of the project area include a "white spruce / willow" (*Picea glauca – Salix* spp.) unclassified type and a "white spruce / common horsetail" (*Picea glauca – Equisetum arvense*) type (Table 6, **Photos c and d** - page 17). Aspen and balsam poplar deciduous tree community types only comprise a small percentage of the total project area (Table 6).

Shrub Communities

Five shrub community types collectively comprise almost 30% of the 2012 project area (Table 6). Dominant shrub types include a disturbed basket willow / Kentucky bluegrass (*Salix petiolaris / Poa pratensis*) type and an undisturbed climax basket willow / marsh reed grass (*Salix petiolaris /Calamagrostis canadensis*) type (**Photo e** – page 17). These are both considered, nutrient rich shrubby fen types typical of well to moderately-well drained soils. Grazing, fire and motorized vehicle use has led to encroachment of Kentucky bluegrass into the basket willow understory along the Carbondale River. The basket willow / Kentucky bluegrass type is prone to over utilization by livestock and should be carefully managed.

Herbaceous Communities

Most of the project area has tree and shrub canopy cover. Small patches of herbaceous cover within tree and shrub complexes were not separately mapped or classified. Only one unclassified herbaceous site was delineated as a unique community type along a tributary to Todd Creek. This community encompasses the smooth brome – timothy / alfalfa disturbed hayfield along the outer edge of the TCT2 riparian polygon (**Photo f** – page 17). Frequent mowing within this hayfield is limiting to tree and shrub establishment. Many hayfield forage species have encroached into the adjacent native riparian plant community along TCT2.

Plant Species Diversity in the Project Area:

Overall there is a high diversity of native 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.

- A total of 283 plant species were recorded in the project area (Appendix B), including 5 tree, 47 shrub, 66 grass / grass-likes and 165 forb species (Appendix B). Of these species 246 (87%) are confirmed native species, 31 (11%) are introduced (non-native) forbs or grasses and 6 are herbaceous species whose identity could not be confirmed in the field.

Photo a: This mixedwood forest community along Allison Creek (ALL1) has a mix of white spruce, balsam poplar, aspen, willows and alders. It closely resembles the F12 community type in the Montane Guide, although it has high willow cover in the understory. (*Photographer: K. Low, Catalogue No: RHIP01ALL005*)

Photo b: This mixedwood forest along Pekisko Creek (PEK17) has a mix of balsam poplar and white spruce in the canopy and a diverse understory of native shrubs (mainly prickly rose) and forbs. (*Photographer: S. Yuckin, Catalogue No: RHIP17PEK010*)

Photo c: A white spruce / willow unclassified community is the dominant community type along this reach of the Carbondale River in the CRB2 site. (*Photographer: K. Low, Catalogue No: RHIP02CRB004*)

Photo d: A white spruce / common horsetail community occurs along the lower reach of Silvester Creek (SIL2) near its confluence with the Elbow River. (*Photographer: K. Low,Catalogue No:RHIP02SIL012*)

Photo e: The lush beaver modified valley along this upper reach of Silvester Creek (SIL1) is comprised of a basket willow / marsh reed grass community. (*Photographer: A. Halawell, Catalogue No: RHIP01SIL011*)

Photo f: Only a narrow band of native riparian vegetation has been retained along this Todd Creek tributary (TCT2); the outer edge of the riparian zone is a disturbed hayland herbaceous community type. (*Photographer: K. Low, Catalogue No: RHIP02TCT003*)

EXAMPLES OF RIPARIAN PLANT COMMUNITY TYPES IN THE PROJECT AREA

- Dominant trees and shrubs include: white spruce, balsam poplar, Drummond's willow, river alder (*Alnus tenuifolia*), basket willow, beaked willow (*Salix bebbiana*), green alder (*Alnus crispa*), Canada buffaloberry (*Shepherdia canadensis*) and yellow willow (*Salix lutea*) (Appendix B).
- Dominant grass / grass-like species (that comprise at least 1% of the total project area) include 5 native species [marsh reed grass, small bottle sedge (*Carex utriculata*), water sedge (*Carex aquatilis*), rough hair grass (*Agrostis scabra*), wire rush (*Juncus balticus*)] and 4 introduced species [redtop (*Agrostis stolonifera*), timothy (*Phleum pratense*), Kentucky bluegrass and smooth brome (*Bromus inermis*)] (Appendix B).
- Dominant forbs (that comprise at least 1% of the total project area) include 7 native species [wild strawberry (*Fragaria virginiana*), common horsetail, smooth aster (*Aster laevis*), common fireweed (*Epilobium angustifolium*), white angelica (*Angelica arguta*), pearly everlasting (*Anaphalis margaritacea*) and veiny meadow rue (*Thalictrum venulosum*)] and 3 introduced species including white clover (*Trifolium repens*), common dandelion (*Taraxacum officinale*) and an invasive noxious weed, ox-eye daisy (*Chrysanthemum leucanthemum*).

4.3 Vegetation Health Parameter Results

The average vegetation health rating for the 2012 RHI sites is 82% (*Healthy)*. Similar to our findings in 2011, 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 8). Vegetation health concerns include invasive and disturbance-caused non native species in addition to moderate to heavy browse levels in five sites (Figure 8).

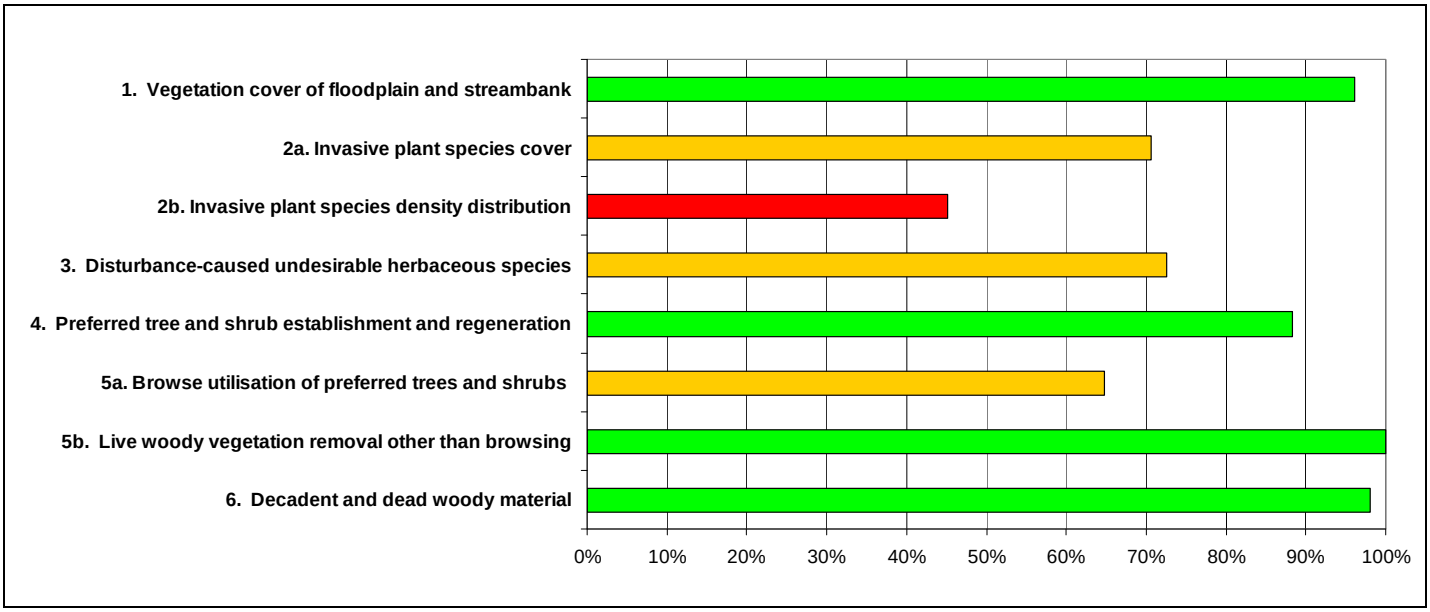


Figure 8 Vegetation Health Parameter Results

Herbaceous (Non-Woody) Riparian Health Parameters

Invasive species have widespread distribution in 9 of the 17 sites. 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. Disturbance caused plants have greater than 25% canopy cover in 4 of the 17 sites. Disturbance plants are typically non-native grasses and forbs that aggressively displace native plants once the soil surface has been disturbed.

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.** Five invasive noxious weed species were recorded in the project area, including Canada thistle, common mullein (*Verbascum thapsus*), oxeye daisy (Chrysanthemum leucanthemum), perennial sow-thistle (*Sonchus arvensis*) and tall buttercup (*Ranunculus acris*).
- **The most widespread and abundant invasive species in the project area is ox-eye daisy.** It occurs in 5 of the 17 sites, comprising 1.7% of the project area. It is most prevalent in the Carbondale River watershed along the mainstem of the Carbondale River (**Photo g** – page 20) and O'Haggen Creek. It is also beginning to encroach along Allison Creek. Canada thistle and tall buttercup occur in up to 10 sites but only in trace amounts except for 3% cover of tall buttercup along a tributary to Todd Creek. Perennial sow-thistle and common mullein have trace occurrence in 2 sites each.
- **Collectively, invasive plants comprise almost 2% of the 2012 project area.** Combined weed cover is highest along the main stem of the Carbondale River and along a tributary to Todd Creek. Only 4 of the 17 sites were found to be free of invasive species at the time of the RHI inventory, including all 3 sites along Silvester Creek and the Gorge Creek and Syncline Brook sites.
- **Invasive plants are widely distributed throughout the project area** with 9 sites (i.e. 53%) 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 abundant (i.e. >25% cover) in 4 of the 17 sites.** This includes fire-disturbed sites along the Carbondale River (**Photo h** – page 20) and sites with historic agricultural land use impacts along Pekisko Creek (**Photo i** – page 20) and the Todd Creek tributary. Combined, disturbance-caused plants cover approximately 18% of the project area.

Photo g: Ox-eye daisy the white flower along the bank in this photo is an invasive noxious week. It is prevalent along this reach of the Carbondale River (CRB1). (*Photographer: S. Elchuk, Catalogue No: RHIP01CRB011*)

Photo h: Disturbance-caused herbaceous plants like Kentucky bluegrass and others in addition to ox-eye daisy have encroached into fire disturbed areas along the Carbondale River (CRB2). (*Photographer: K. Low, Catalogue No: RHIP02CRB016*)

Photo i: This reach of Pekisko Creek (PEK15) has been historically converted to tame forages like timothy and clover, reducing bank stability along this reach. (*Photographer: K. Low , Catalogue No: RHIP15PEK012*)

Photo j: Natural regeneration of willows and balsam poplars along this reach of O'Hagen Creek is an important indicator of a sustainable, healthy woody plant community. (*Photographer: S. Elchuk, Catalogue No: RHIP01OHA004*)

Photo k: Browse use is negligible to light for most sites, although some selective use of willows is apparent likely from wildlife browse. (*Photographer: K. Stebanuk , Catalogue No: RHIP01GOR008*)

Photo l: A large portion of the spruce canopy along this reach of the Carbondale River is dead due to fire kill. Rooted, standing dead trees continue to maintain some level of erosion control although they are easily subject to wind damage. (*Photographer: K. Low , Catalogue No: RHIP02CRB005*)

VEGETATION HEALTH PARAMETER PHOTOGRAPHS

- Of the 24 disturbance-caused plants present, 6 are grasses and 18 are forbs. Most of these are introduced species such as timothy, smooth brome and clover, but 9 are native species that naturally colonize areas of exposed soil (e.g. wild strawberry). The most abundant disturbance-caused plants are timothy, Kentucky bluegrass, smooth brome, common dandelion, white clover and wild strawberry.

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.
- A wide variety of native trees and shrubs in combination cover about 80% of the project area. Refer to page 18 and Appendix B 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.

Most sites have healthy or near healthy levels of tree and shrub regeneration (**Photo j** – page 20), except for one of the sites along a tributary to Todd Creek. Haying along the outer edge of this riparian site is preventing establishment of young trees and shrubs.

- ***Browse Pressure / Woody Plant Removal***

The majority of sites (71%) have light to negligible levels of browse use from livestock and wildlife (**Photo k** – page 20). Woody plants can sustain low levels of use but greater browse pressure can deplete root reserves and inhibit establishment and regeneration. Five sites (including SIL1, SIL3, ALL1, CRB2 and TCT2) show signs of moderate to heavy browse pressure. Cattle and feral horse use

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

is apparent in most of these sites in addition to browse from wild ungulates (e.g. moose).

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.

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

With the exception of one site along the Carbondale River (CRB2) (**Photo l** – page 20), 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.

A widespread fire, the 2003 Lost Creek fire, impacted the upstream half of the CRB2 site contributing to a high level of dead/dying 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. Fire disturbance appears to have contributed to disturbance-caused and invasive species encroachment in the CRB2 site.

4.4 Soil and Hydrology Health Parameter Results

The average soil / hydrology health rating for the 2012 RHI sites is 90% (*Healthy*); this is similar to the average rating of 87% for the 2011 sites. The only parameter to rate less than *healthy* on average is human physical alteration to the riparian site (polygon) (Figure 9). Most sites have few human-caused impacts to the bank; low amounts of human-caused bare ground; adequate levels of streambank rootmass protection and un-incised channel profiles.

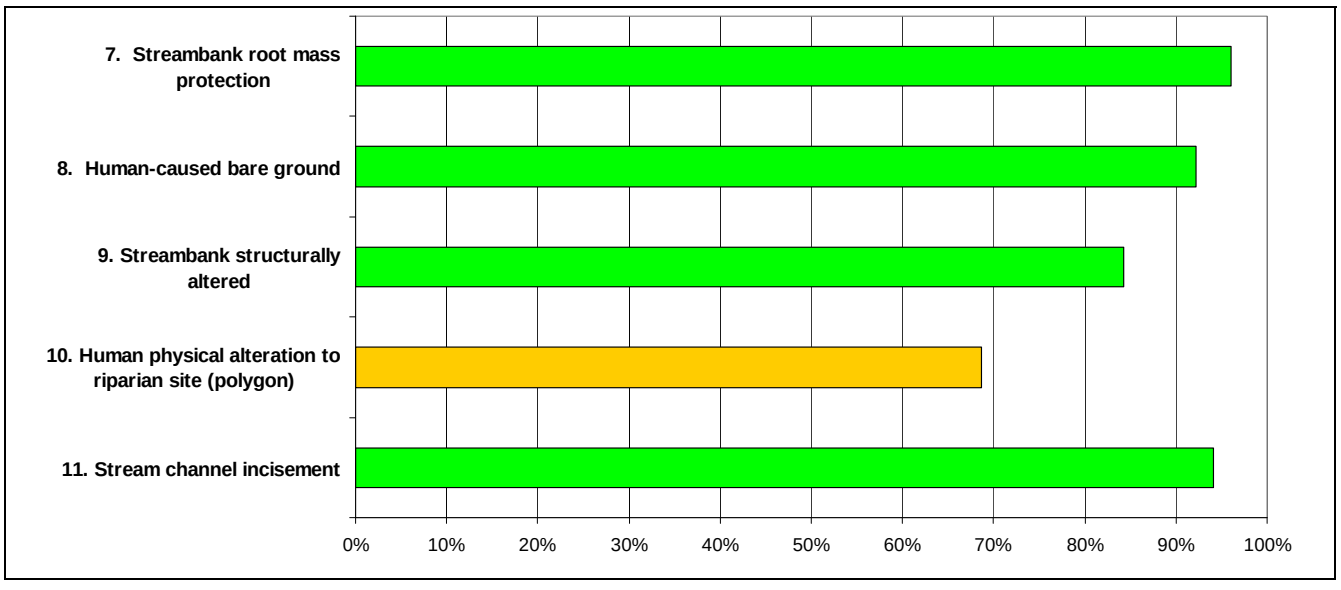


Figure 9 Soil / Hydrology Health Parameter Results

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.

- With one exception (CRB1), the majority of the 2012 RHI sites have healthy levels of streambank root mass protection (i.e. >85% of the reach has deep, binding root mass along the bank) (**Photo m** - page 25). Stream reaches with natural bedrock outcrops are naturally armoured against erosion (**Photo n** – page 25).
- The CRB1 site along the Carbondale River lacks adequate amounts of deep, binding root mass along at least 35% of the bank length of this reach. Part of this reach was impacted by a wild fire event in 2003. Other contributing factors to reduced rootmass protection include OHV trails and invasion of ox-eye daisy. Continued natural recovery (regeneration) of woody plants along the reach will improve root mass protection in the long-term.

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 2.5% (0.5 ha) of the total project area has bare ground, 39% of which is attributed to human rather than natural causes. Recreational land uses (including roads, trails and random camping impacts) account for the majority of human-caused bare ground (i.e. approximately 80% of the human-caused bare ground is from recreational activities). Livestock use is a secondary contributor to bare ground (i.e. approximately 18% of the human-caused bare ground is due to livestock trails or heavy use areas).
- 3 sites have elevated levels (i.e. >1%) of human-caused bare ground (PEK15, CRB1 and SIL3) mostly from OHV use in the riparian zone. Compacted OHV trails adjacent to waterways contribute to increased erosion and potential for increased sediment runoff into trout bearing streams. Trail braiding in the SIL3 site is contributing to bare ground and worsening gully erosion concerns along cutline and pipeline corridors that are not part of the designated access management plan.

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 (71%) have minimal (<5%) human-caused streambank alterations. Bedrock outcrops and very steeply sloping valley slopes (**Photos n and o** – page 25) reduce accessibility in some reaches, limiting the potential for human-caused alterations including impacts from livestock and motorized vehicle use.

- Three 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 0.6 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, slope gradient and the erodibility of the substrate at the crossing location.* Steeply sloping braided trails as shown in **Photo u** (page 26) present a particular concern to water quality.

- The dominant cause of bank alteration is livestock hoofshear and trampling to 0.5 km of bank length. Recreational trail crossings impact about 0.2 km of bank length in total.

- 9 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). 6 sites have severe levels of human-caused floodplain alterations (i.e. >15%), while the remaining 2 sites have minor levels of floodplain alterations (i.e. 5% to 15%).

- Overall, about 11% (2.3 ha) of the project area, away from the streambank, has human-caused alterations. Soil compaction from livestock and recreational use is the dominant kind of floodplain alteration. Livestock trampling impacts 1.7 ha of riparian habitat (i.e. 73% of the total compacted area) (e.g. **Photos p and q** – page 25). Recreational trails impact 0.4 ha of riparian habitat (i.e. 19% of the total compacted area) (e.g. **Photos r – v**, pages 25 and 26). A small percentage of the project area has also been altered due to road/bridge construction and due to haying (**Photo w**, page 26) in the riparian zone.

Photo m: Most sites have healthy levels of deep-binding rootmass along the banks from native trees and shrubs. (*Photographer: S. Elchuk, Catalogue No: RHIP01ALL004*)

Photo n: Some stream reaches like this portion of Syncline Brook (SYN1) are naturally protected from erosion by bedrock outcrops. (*Photographer: S. Elchuk, Catalogue No: RHIP01SYN012*)

Photo o: This reach of Gorge Creek has characteristic, steeply sloping valley walls, restricting human / livestock access. (*Photographer: S. Elchuk, Catalogue No: RHIP01GOR004*)

Photo p: Feral horse use in combination with cattle and wildlife use have contributed to high amounts of pugging and hummocking trampling impacts in the soft, lush soils along this reach of Silvester Creek (SIL1). (*Photographer: S. Elchuk, Catalogue No: RHIP01SIL007*)

Photo q: A livestock watering access point along Pekisko Creek with erosion and bare soil concerns. Installing an off-stream water trough would allow this portion of the bank to naturally revegetate. (*Photographer: K. Hull, Catalogue No: RHIP15PEK020*)

Photo r: This vehicle crossing along Pekisko Creek presently receives low amounts of use as general public access is restricted. Ongoing monitoring of weeds and erosion is suggested here. If erosion and bare soil concerns worsen, bridge installation may be appropriate. (*Photographer: K. Hull, Catalogue No: RHIP15PEK020*)

SOIL AND HYDROLOGY HEALTH PARAMETER PHOTOS

Photo s: Recreational motorized vehicle use contributes to erosion and bare ground exposure, such as along this portion of the Allison Creek (ALL1) floodplain. (*Photographer: K. Low, Catalogue No: RHIP01ALL038*)

Photo t: Steeply sloping seismic trails used by motorized recreational vehicles pose a water quality risk to trout streams. (*Photographer: K. Low, Catalogue No: RHIP01ALL018*)

Photo u: Priority candidates for restoration include braided undesignated trail crossings on steep slope approaches. This pipeline-right-of-way crossing on Silvester Creek (SIL3) is not part of the designated McLean Creek PLUZ trails. (*Photographer: S. Elchuk, Catalogue No: RHIP03SIL021*)

Photo v: Unvegetated trails like this one are at high risk of erosion and contribute sediment into trout bearing streams. (*Photographer: S. Elchuk, Catalogue No: RHIP03SIL022*)

Photo w: Haying in the outer riparian zone of this Todd Creek tributary contributes to soil compaction alterations in addition to spread of weedy species. (*Photographer: K. Low, Cat No: RHIP02TCT011*)

Photo x: Most of the stream reaches in the 2012 project area are un-incised, like this reach of Flat Creek (FLA1). Floodwaters can easily access the riparian zone here. (*Photographer: S. Yuckin, Cat No: RHIP01FLA005*)

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.

- Most sites in the project area rate healthy for this parameter (e.g. **Photo x**, page 26). This means that high water events can periodically access the highest terraces of the floodplain indicating that these stream reaches are not incised.
- The only stream reaches with slightly incised channel profiles include the Pekisko Creek and O'Haggen Creek 2012 RHI sites. High levels of disturbance-caused plants along Pekisko Creek due to historic land uses may be a contributing factor. Higher than normal rates of outward and downward channel erosion can occur due to human-caused alterations and removal of deep rooted plants. It is unclear if upstream human land uses have contributed to slight incisement along O'Haggen Creek or if it has resulted from natural hydrological influences.

4.5 Additional Westslope Cutthroat Trout Habitat Data

Channel Substrate Data

The 2012 RHI stream channel reaches are mainly comprised of a mix of coarse gravel (23%), small cobbles (21%), fine gravel (14%) and large cobbles (12%) (Table 7, Figure 10).

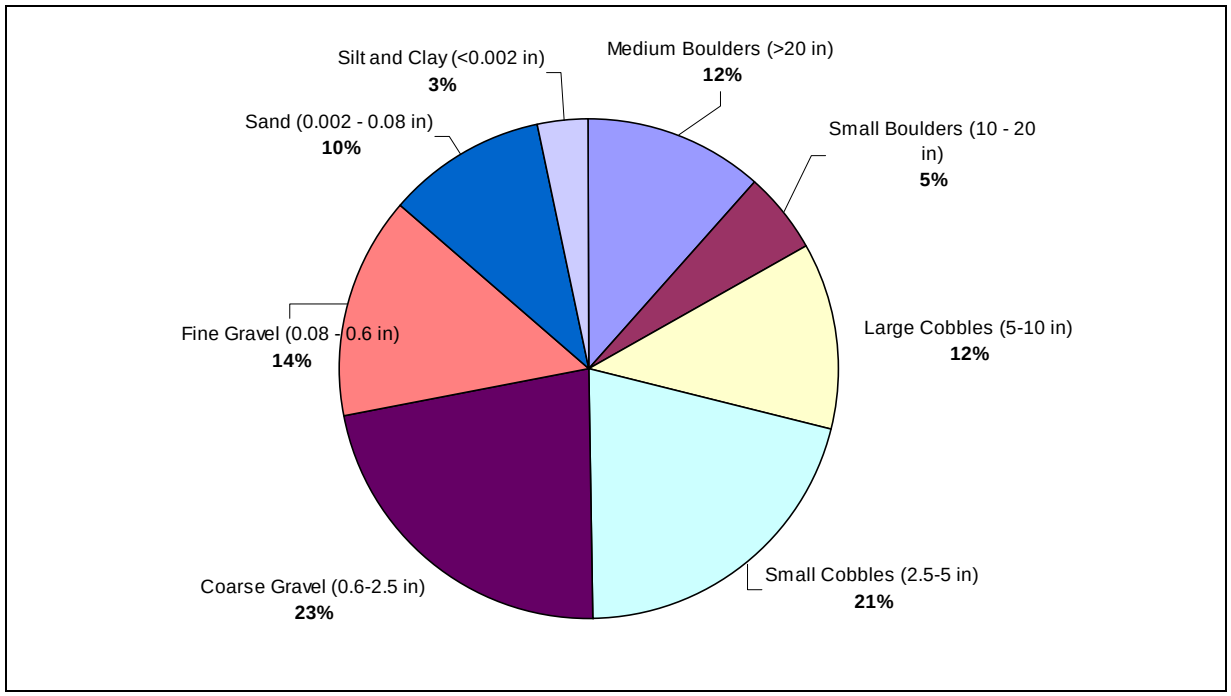


Figure 10 Average Channel Substrate Composition in the 2012 RHI Project Area

On average, most of the 2012 RHI reaches have channel bottoms comprised of less than 5% silt and clay (Table 7). Exceptions include small tributary streams such as the upper reaches of Silvester Creek and the Todd Creek tributary sites which flow through beaver modified valleys with organic, fine textured soils.

Table 7 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)
ALL1	3%	4%	13%	28%	30%	14%	4%	3%
ALL2	6%	1%	30%	35%	17%	5%	3%	2%
CRB1	11%	2%	20%	27%	21%	10%	7%	1%
CRB2	10%	1%	8%	27%	33%	14%	8%	0%
CTH1	8%	4%	17%	18%	18%	19%	15%	1%
FLA1	22%	15%	21%	19%	14%	8%	1%	0%
GOR1	40%	3%	5%	22%	14%	8%	6%	2%
OHA1	0%	1%	4%	26%	36%	22%	11%	1%
PEK15	40%	13%	10%	12%	16%	8%	2%	0%
PEK17	17%	19%	18%	18%	13%	10%	4%	0%
SIL1	0%	0%	0%	0%	1%	22%	62%	15%
SIL2	0%	0%	2%	21%	44%	21%	11%	0%
SIL3	10%	1%	7%	16%	16%	13%	26%	12%
SYN1	16%	10%	14%	20%	24%	12%	4%	0%
TCT1	0%	0%	0%	0%	25%	16%	49%	10%
TCT3	0%	0%	0%	0%	13%	56%	23%	8%

*Channel substrate data was not collected for TCT2 due to navigability and accessibility constraints posed by a narrow channel and dense overhanging shrubs.

Note: *Detailed stream channel substrate data are given in Appendix C.*

Embeddedness and Cementedness

Coarse estimates of 'embeddedness' and 'cementedness' were collected in 10 of the 17 sites (Table 8). These measures are aimed at assessing the degree to which small cobble and gravel substrate have become embedded or cemented by the long-term accumulation of fine sediment. Most sites had relatively unembedded cobble / gravel substrate in riffle reaches where less than 25% of the rock surface was embedded in fine sediment (Table 8). Three sites including two reaches along Pekisko Creek (PEK15, PEK17) and one reach along Silvester Creek (SIL2) had some minor evidence of cementedness as indicated by 'intermediate' or 'cemented' poke test results (Table 8).

Of note, more robust techniques have recently been field tested by AESRD, Fish & Wildlife to more accurately monitor sedimentation of spawning gravels in Westslope Cutthroat Trout stream reaches. This includes the use of freeze-core sampling techniques to quantitatively collect and measure the percentage of fine sediment (silt and clay <0.063 mm) in the total mass of a streambed soil core. This technique is likely to provide a more repeatable monitoring metric for sedimentation than metrics used in this RHI study.

Table 8 Average "Embeddedness" and "Cementedness" Results

		Average "Cementedness"		
RHI Site ID	**Average Embeddedness" (%)**	**Loose (%)**	**Intermediate (%)**	**Cemented (%)**
ALL1	NC	NC	NC	NC
ALL2	NC	NC	NC	NC
CRB1	NC	NC	NC	NC
CRB2	NC	NC	NC	NC
CTH1	7%	100%	0%	0%
FLA1	NC	NC	NC	NC
GOR1	25%	100%	0%	0%
OHA1	NC	NC	NC	NC
PEK15	7%	90%	7%	3%
PEK17	26%	77%	17%	7%
SIL1	1%	100%	0%	0%
SIL2	12%	64%	36%	0%
SIL3	3%	100%	0%	0%
SYN1	NC	NC	NC	NC
TCT1	11%	100%	0%	0%
TCT2	NA	100%	0%	0%
TCT3	9%	100%	0%	0%

NC = Not collected; NA = Not Available

Potential Barriers to Fish Movement

Three possible barriers to fish movement were observed within the 2012 RHI stream reaches (Table 9). This includes three natural barriers formed by the accumulation of woody debris or fallen logs along Allison Creek and Silvester Creek (Photos **y**, **z** and **bb** [page 30], Table 9).

Table 9 Potential Barriers to Trout Movement in the 2012 RHI Project Area

RHI Site ID	Waypoint	UTM Easting	UTM Northing	Zone	Fish barrier Height (m)	Fish barrier type
ALL1	ALL1K	672487	5507409	11U	0.2	fallen logs
ALL1	ALL1BARRIER	672485	5507720	11U	1.0	logs
CRB1	CRB1A	684967	5478229	11U	0.3	log / rock weir
SIL2	SIL2E	660061	5637025	11U	n/a	woody debris pile

Only one obviously man-made barrier was observed in the project area along the CRB1 reach of the Carbondale River (Photo **aa**). This barrier is comprised of logs and rocks placed across the channel, but it is not very tall (~ 0.3 m in height). All of the observed potential barriers are likely passable by fish during high flow periods.

Photo y: A natural log barrier along Allison Creek (ALL1K waypoint). (*Photographer: K. Low, Cat No: RHIP01ALL030*)

Photo z: A 1 m tall (approximate) natural log barrier along Allison Creek (ALL1Barrier waypoint). (*Photographer: K. Low, Cat No: RHIP01ALL036*)

Photo aa: A man-made log / rock weir across the Carbondale River (CRB1A waypoint). (*Photographer: S. Elchuk, Cat No: RHIP01CRB005*)

Photo bb: A large woody debris pile along Silvester Creek (SIL2E waypoint). (*Photographer: K. Low, Cat No: RHIP02SIL017*)

5 LANDOWNER AND MULT-STAKEHOLDER CONSULTATION

As part of ongoing stakeholder engagement efforts following on from the February 29, 2012 workshop, two additional public education and awareness events were coordinated as part of this project by Cows and Fish in 2012 and 2013. This included an outdoor field day conducted in the Todd Creek watershed on October 18, 2012 and a second multi-stakeholder workshop held on February 25, 2013. A total of 36 people attended the October field day. The February 2013 workshop was attended by 46 people. Both events included representatives from the local community, anglers, consultants, livestock producers, ranch managers, industry, Watershed Stewardship Groups, the Alberta Conservation Association, Fisheries and Oceans Canada and AESRD department representatives from Water Approvals, Forestry, Public Lands, and Fish & Wildlife.

The October 18, 2012 field day included presentations from Cows and Fish and Matthew Coombs, the Senior Fisheries for the Southern Rockies Area (AESRD, Fish & Wildlife). Westslope Cutthroat Trout electro-fishing demonstrations and a streambed freeze-coring demonstration were conducted by Fish & Wildlife staff. The intent of the workshop was to discuss riparian health and ongoing fisheries assessment efforts in aid of Westslope Cutthroat Trout recovery through hands-on demonstrations and discussion. Group discussions focussed on conservation challenges and habitat conservation needs for Westslope Cutthroat Trout.

The February 25, 2013 workshop was again held at the M.D. of Ranchlands Administration Building in Chain Lakes Provincial Park. The workshop included presentations on the AESRD Regional Planning and Biodiversity Strategy and the Oldman Watershed Headwaters Action Plan as well as updates from the Westslope Cutthroat Trout Recovery Team and the Cows and Fish Westslope Cutthroat Trout riparian health assessment project. Additional update presentations were given by landowners, industry and Non-Government Organization representatives showcasing recent or ongoing endeavours to protect, manage or restore Westslope Cutthroat Trout habitat within the Bow River and Oldman River basins in Alberta. Another component of the workshop was a “Collaborative Solution Building” round-table discussion session. Participants were asked to break-out into round-table groups based on their geographic region of interest to identify key issues and come up with collaborative ideas to address these issues through individual or partnership projects. The break-out groups were organized by sub-basins within the Westlope Cutthroat Trout project area as follows:

- Ghost/Elbow River Watershed;
- Sheep/Highwood River Watersheds;
- Castle/Crown Area;
- Crowsnest Pass; and the
- Upper Oldman River and Porcupine Hills.

Cows and Fish will endeavour to continue to work with groups within each of these sub-basins in the coming years to help move forward some of the collaborative project ideas brought forward.

October 18, 2012 Westslope Cutthroat Trout Field Day in the Todd Creek Watershed

February 25, 2013 Westslope Cutthroat Trout Workshop

6 THE NEXT STEPS

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 continue to be expanded over the next few years. The long-term goal is to complete a few additional RHIs in priority Westslope Cutthroat Trout habitat in addition to follow-up stakeholder consultation workshops and facilitation of habitat improvement projects.

Results from the 2012 RHI project will be shared with AESRD, DFO, ACA and Trout Unlimited Canada to assist with land use management and planning decisions in the Westslope Cutthroat Trout project area. Site specific project results will also be shared with the respective landowner or grazing allotment holders. Reports detailing riparian health results and management suggestions have been prepared for each participating landowner / grazing allotment holder.

Below is an overview of general management suggestions (as per Cows and Fish 2011) that will assist with maintaining and improving riparian health within 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 (*Hieracium aurantiacum*) 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 AESRD Public Lands and / or the local Municipal / County Agricultural Fieldman.

  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).

  The table below provides a summary of control strategies and facts for noxious weeds found within the 2012 RHI project area (https://www.invasiveplants.ab.ca/fact-sheets):

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.
 **Perennial sow-thistle**	Perennial sow-thistle reproduces by seed and creeping roots (rhizomes), making it difficult to control once it is well established. Early control of perennial sow-thistle is important before extensive root systems develop. Seedlings may be easily hand-pulled. It grows best in moist, fertile soils with direct sunlight. Promoting native woody re-growth in disturbed sites may help to shade it out over time. Biological control agents are available.
 **Common mullein**	Common mullein readily colonizes burned or disturbed areas with well drained, sandy or gravelly soils. It is a prolific seed producer (a singe plant can produce over 240,000 seeds); seeds usually fall close to the parent plant but can remain viable in the soil for more than 100 years. It is considered highly unpalatable to sheep and cattle. Key to control is preventing the use of contaminated soil for building / road construction projects. Small infestations may be hand-pulled or hoed; if flower heads or seeds are present, plants should be bagged and burned. Chemical and biological control agents are available, although care must be taken to protect non-target native vegetation if non-selective herbicides are approved for use by AESRD or the local Agricultural Fieldman.

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.**
  AESRD, 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 AESRD 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. AESRD 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.**

  AESRD, 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.

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.

Riffle –*A riffle is a short, relatively shallow and coarse-bedded reach where the stream flows at higher velocity and higher turbulence than it normally does in comparison to a pool* (source: http://en.wikipedia.org/wiki/Riffle)

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

RHI UPSTREAM AND DOWNSTREAM UTM LOCATIONS (FOR PUBLIC LAND RHI SITES ONLY)

RHI Site ID	UPSTREAM UTM COORDINATE (Zone: 11U)		DOWNSTREAM UTM COORDINATE (Zone: 11U)	
	Easting	Northing	Easting	Northing
ALL1	672464	5507758	672837	5506375
ALL2	673469	5505653	673555	5505228
CRB1	684939	5478221	685653	5478608
CRB2	683402	5477340	683791	5477683
CTH1	676908	5593600	677167	5594064
FLA1	672647	5593326	673173	5593414
GOR1	663961	5614974	664205	5614527
OHA1	689161	5478109	688961	5478679
PEK17	681687	5578911	681749	5579423
SIL1	660349	5634789	660541	5635065
SIL2	660008	5636831	660135	5637157
SIL3	660540	5635075	660689	5635394
SYN1	686467	5467738	686855	5468051
TCT1	0692999	5517308	0693009	5517333
TCT3	693577	5517555	693724	5517515

APPENDIX B

WESTSLOPE CUTTHROAT TROUT PROJECT AREA, 2012 RIPARIAN PLANT SPECIES INVENTORY

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
ALL SPECIES LISTED IN ORDER OF DECREASING ABUNDANCE								
TREES								
white spruce (Picea glauca)	native	18.5	7.6	38.3%	0.0%	90.0%	94.1%	36.9%
balsam poplar (Populus balsamifera)	native	8.2	3.4	17.2%	0.0%	50.0%	94.1%	16.3%
lodgepole pine (Pinus contorta)	native	1.5	0.6	4.1%	0.0%	10.0%	52.9%	3.0%
aspen (Populus tremuloides)	native	0.8	0.3	2.1%	0.0%	50.0%	76.5%	1.6%
balsam fir (Abies balsamea)	native	0.5	0.2	2.3%	0.0%	20.0%	29.4%	1.0%
SHRUBS								
river alder (Alnus tenuifolia)	native	3.7	1.6	11.4%	0.0%	40.0%	52.9%	7.5%
basket willow (Salix petiolaris)	native	3.5	1.5	12.5%	0.0%	40.0%	41.2%	6.9%
beaked willow (Salix bebbiana)	native	3.2	1.3	7.6%	0.0%	20.0%	76.5%	6.4%
green alder (Alnus crispa)	native	1.8	0.8	5.4%	0.0%	20.0%	41.2%	3.7%
Canada buffaloberry (Shepherdia canadensis)	native	1.8	0.7	4.6%	0.0%	30.0%	58.8%	3.5%
yellow willow (Salix lutea)	native	1.7	0.7	6.2%	0.0%	10.0%	47.1%	3.5%
flat-leaved willow (Salix planifolia)	native	1.5	0.6	5.9%	0.0%	20.0%	58.8%	2.9%
bunchberry (Cornus canadensis)	native	1.4	0.6	4.7%	0.0%	30.0%	41.2%	2.8%
pussy willow (Salix discolor)	native	1.4	0.6	15.9%	0.0%	30.0%	17.6%	2.7%
Drummond's willow (Salix drummondiana)	native	1.1	0.5	9.1%	0.0%	30.0%	35.3%	2.2%
dewberry (Rubus pubescens)	native	1.0	0.4	7.9%	0.0%	20.0%	41.2%	2.0%
thimbleberry (Rubus parviflorus)	native	0.9	0.4	3.2%	0.0%	40.0%	35.3%	1.9%
prickly rose (Rosa acicularis)	native	0.9	0.4	2.0%	0.0%	10.0%	70.6%	1.7%
hoary willow (Salix candida)	native	0.8	0.3	2.8%	0.0%	10.0%	29.4%	1.6%
twinflower (Linnaea borealis)	native	0.7	0.3	12.4%	0.0%	20.0%	11.8%	1.4%
false mountain willow (Salix pseudomonticola)	native	0.7	0.3	2.0%	0.0%	20.0%	64.7%	1.4%
wild red raspberry (Rubus idaeus)	native	0.7	0.3	1.8%	0.0%	3.0%	52.9%	1.4%
smooth willow (Salix glauca)	native	0.7	0.3	5.0%	0.0%	20.0%	35.3%	1.3%
sandbar willow (Salix exigua)	native	0.6	0.3	2.1%	0.0%	10.0%	41.2%	1.3%
silverberry (Elaeagnus commutata)	native	0.5	0.2	8.0%	0.0%	20.0%	23.5%	1.0%
bog birch (Betula glandulosa)	native	0.4	0.1	3.7%	0.0%	10.0%	29.4%	0.7%
buckbrush/snowberry (Symphoricarpos occidentalis)	native	0.4	0.1	1.6%	0.0%	3.0%	35.3%	0.7%
bracted honeysuckle (Lonicera involucrata)	native	0.3	0.1	2.0%	0.0%	3.0%	35.3%	0.6%
snowberry (Symphoricarpos albus)	native	0.3	0.1	1.1%	0.0%	10.0%	47.1%	0.6%

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
SHRUBS Continued								
ground juniper (Juniperus communis)	native	0.3	0.1	0.7%	0.0%	3.0%	82.4%	0.6%
northern gooseberry (Ribes oxyacanthoides)	native	0.2	0.1	0.6%	0.0%	3.0%	76.5%	0.5%
shrubby cinquefoil (Potentilla fruticosa)	native	0.2	0.1	0.5%	0.0%	0.5%	64.7%	0.4%
Saskatoon (Amelanchier alnifolia)	native	0.2	0.1	0.5%	0.0%	0.5%	58.8%	0.4%
twining honeysuckle (Lonicera dioica)	native	0.2	0.1	0.7%	0.0%	3.0%	41.2%	0.4%
common bearberry (Arctostaphylos uva-ursi)	native	0.1	0.1	0.8%	0.0%	3.0%	29.4%	0.3%
velvet-fruited willow (Salix maccalliana)	native	0.1	0.1	10.0%	0.0%	10.0%	5.9%	0.3%
creeping juniper (Juniperus horizontalis)	native	0.1	0.05	0.5%	0.0%	0.5%	35.3%	0.2%
white meadowsweet (Spiraea betulifolia)	native	0.1	0.05	0.6%	0.0%	3.0%	23.5%	0.2%
common wild rose (Rosa woodsii)	native	0.1	0.05	0.5%	0.0%	0.5%	47.1%	0.2%
bristly black currant (Ribes lacustre)	native	0.1	0.04	0.5%	0.0%	0.5%	41.2%	0.2%
red-osier dogwood (Cornus stolonifera)	native	0.1	0.04	0.5%	0.0%	0.5%	29.4%	0.2%
mountain maple (Acer glabrum)	native	0.1	0.03	0.7%	0.0%	3.0%	17.6%	0.2%
purple clematis (Clematis occidentalis)	native	0.1	0.03	0.5%	0.0%	0.5%	29.4%	0.1%
meadowsweet (Spiraea spp.)	native	0.1	0.03	0.7%	0.0%	3.0%	11.8%	0.1%
creeping mahonia (Berberis repens)	native	0.1	0.03	0.5%	0.0%	0.5%	11.8%	0.1%
red twinberry (Lonicera utahensis)	native	0.05	0.02	0.5%	0.0%	0.5%	11.8%	0.1%
grouseberry (Vaccinium scoparium)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
low-bush cranberry (Viburnum edule)	native	0.03	0.01	0.5%	0.0%	0.5%	17.6%	0.1%
water birch (Betula occidentalis)	native	0.02	0.01	0.5%	0.0%	0.5%	17.6%	0.05%
yellow mountain avens (Dryas drummondii)	native	0.02	0.01	0.5%	0.0%	0.5%	11.8%	0.03%
thorny buffaloberry (Shepherdia argentea)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
mountain-lover (Pachistima myrsinites)	native	0.005	0.002	0.5%	0.0%	0.5%	5.9%	0.01%

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
GRASSES AND GRASS-LIKES								
marsh reed grass (Calamagrostis canadensis)	native	2.1	0.8	5.5%	0.0%	30.0%	58.8%	4.1%
small bottle sedge (Carex utriculata)	native	1.9	0.8	6.2%	0.0%	30.0%	64.7%	3.8%
redtop (Agrostis stolonifera)	introduced	1.8	0.7	5.8%	0.0%	20.0%	47.1%	3.6%
timothy (Phleum pratense)	disturbance, introduced	1.5	0.6	4.5%	0.0%	30.0%	76.5%	3.1%
water sedge (Carex aquatilis)	native	0.9	0.4	3.1%	0.0%	20.0%	41.2%	1.7%
rough hair grass (Agrostis scabra)	native	0.7	0.3	5.4%	0.0%	10.0%	35.3%	1.3%
wire rush (Juncus balticus)	native	0.6	0.3	2.7%	0.0%	10.0%	52.9%	1.2%
Kentucky bluegrass (Poa pratensis)	disturbance, introduced	0.5	0.2	1.9%	0.0%	3.0%	64.7%	1.1%
smooth brome (Bromus inermis)	disturbance, introduced	0.5	0.2	2.0%	0.0%	20.0%	23.5%	1.0%
reed canary grass (Phalaris arundinacea)	native	0.4	0.2	4.7%	0.0%	10.0%	11.8%	0.7%
graminoid (Graminoid)	unknown, not unique	0.3	0.1	1.9%	0.0%	3.0%	23.5%	0.6%
spike trisetum (Trisetum spicatum)	native	0.3	0.1	2.1%	0.0%	3.0%	17.6%	0.6%
Norway sedge (Carex norvegica)	native	0.3	0.1	3.0%	0.0%	3.0%	5.9%	0.5%
mountain timothy (Phleum commutatum)	native	0.3	0.1	3.0%	0.0%	3.0%	5.9%	0.5%
fescue (Festuca spp.)	unknown, not unique	0.2	0.1	4.2%	0.0%	10.0%	17.6%	0.4%
sweet grass (Hierochloe odorata)	native	0.2	0.1	0.7%	0.0%	3.0%	41.2%	0.4%
bluegrass (Poa spp.)	unknown, not unique	0.2	0.1	3.0%	0.0%	3.0%	5.9%	0.4%
tufted hair grass (Deschampsia cespitosa)	native	0.2	0.1	0.7%	0.0%	3.0%	52.9%	0.4%
alpine foxtail (Alopecurus occidentalis)	native	0.2	0.1	2.3%	0.0%	3.0%	17.6%	0.3%
northern reed grass (Calamagrostis inexpansa)	native	0.1	0.1	1.3%	0.0%	3.0%	35.3%	0.3%
sedge (Carex pachystachya)	native	0.1	0.1	0.5%	0.0%	0.5%	23.5%	0.3%
fowl bluegrass (Poa palustris)	native	0.1	0.05	0.5%	0.0%	0.5%	52.9%	0.2%
fringed brome (Bromus ciliatus)	native	0.1	0.04	0.7%	0.0%	3.0%	23.5%	0.2%
inland bluegrass (Poa interior)	native	0.1	0.04	0.5%	0.0%	0.5%	23.5%	0.2%
woolly sedge (Carex lanuginosa)	native	0.1	0.04	2.5%	0.0%	10.0%	17.6%	0.2%
slender wheat grass (Agropyron trachycaulum)	native	0.1	0.04	0.5%	0.0%	0.5%	23.5%	0.2%

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
GRASSES AND GRASS-LIKES Continued								
small-winged sedge (Carex microptera)	native	0.1	0.04	0.5%	0.0%	0.5%	52.9%	0.2%
quack grass (Agropyron repens)	disturbance, introduced	0.1	0.03	0.5%	0.0%	0.5%	35.3%	0.2%
purple oat grass (Schizachne purpurascens)	native	0.1	0.03	1.3%	0.0%	3.0%	17.6%	0.1%
small-flowered wood-rush (Luzula parviflora)	native	0.1	0.03	0.5%	0.0%	0.5%	29.4%	0.1%
purple sedge (Carex mertensii)	native	0.1	0.03	0.5%	0.0%	0.5%	23.5%	0.1%
wild rye (Elymus spp.)	unknown, not unique	0.1	0.02	0.5%	0.0%	0.5%	17.6%	0.1%
fowl manna grass (Glyceria striata)	native	0.05	0.02	0.5%	0.0%	3.0%	29.4%	0.1%
inland sedge (Carex interior)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
green sedge (Carex viridula)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
bluebunch fescue (Festuca idahoensis)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
manna grass (Glyceria spp.)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
simple bog-sedge (Kobresia simpliciuscula)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
sedge (Carex spp.)	native	0.04	0.02	0.5%	0.0%	0.5%	17.6%	0.1%
small-fruited bulrush (Scirpus microcarpus)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
green needle grass (Stipa viridula)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
hairy wild rye (Elymus innovatus)	native	0.04	0.01	0.5%	0.0%	0.5%	17.6%	0.1%
spangletop (Scolochloa festucacea)	native	0.03	0.01	0.5%	0.0%	0.5%	5.9%	0.1%
two-seeded sedge (Carex disperma)	native	0.03	0.01	0.5%	0.0%	0.5%	11.8%	0.1%
alpine bluegrass (Poa alpina)	native	0.03	0.01	0.5%	0.0%	0.5%	11.8%	0.1%
brome grass (Bromus spp.)	unknown, not unique	0.03	0.01	0.5%	0.0%	0.5%	5.9%	0.1%
nodding brome (Bromus anomalus)	native	0.03	0.01	0.5%	0.0%	0.5%	11.8%	0.05%
hair-like sedge (Carex capillaris)	native	0.02	0.01	0.5%	0.0%	0.5%	17.6%	0.05%
slender wheat grass (Agropyron trachycaulum var. unilaterale)	native	0.02	0.01	0.5%	0.0%	0.5%	5.9%	0.04%
red fescue (Festuca rubra)	native or introduced	0.02	0.01	0.5%	0.0%	0.5%	5.9%	0.04%
foxtail barley (Hordeum jubatum)	disturbance, native	0.02	0.01	0.5%	0.0%	0.5%	5.9%	0.04%

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
GRASSES AND GRASS-LIKES Continued								
Canada wild rye (Elymus canadensis)	native	0.02	0.01	0.5%	0.0%	0.5%	11.8%	0.03%
Bebb's sedge (Carex bebbii)	native	0.01	0.01	0.5%	0.0%	0.5%	5.9%	0.03%
meadow sedge (Carex praticola)	native	0.01	0.01	0.5%	0.0%	0.5%	5.9%	0.03%
toad rush (Juncus bufonius)	native	0.01	0.01	0.5%	0.0%	0.5%	5.9%	0.03%
short sedge (Carex curta)	native	0.01	0.01	0.5%	0.0%	0.5%	5.9%	0.02%
bog bluegrass (Poa leptocoma)	native	0.01	0.01	0.5%	0.0%	0.5%	5.9%	0.02%
purple reed grass (Calamagrostis purpurascens)	native	0.01	0.005	0.5%	0.0%	0.5%	5.9%	0.02%
golden sedge (Carex aurea)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
meadow foxtail (Alopecurus pratensis)	introduced	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
awned sedge (Carex atherodes)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
orchard grass (Dactylis glomerata)	introduced	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
common tall manna grass (Glyceria grandis)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
alpine rush (Juncus alpinoarticulatus)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
Canada bluegrass (Poa compressa)	disturbance, introduced	0.01	0.003	0.5%	0.0%	0.5%	11.8%	0.01%
Hooker's oat grass (Helictotrichon hookeri)	native	0.005	0.002	0.5%	0.0%	0.5%	5.9%	0.01%
FORBS								
wild strawberry (Fragaria virginiana)	disturbance, native	4.6	1.9	9.6%	0.0%	30.0%	94.1%	9.1%
common horsetail (Equisetum arvense)	native, poisonous	4.4	1.8	9.2%	0.0%	60.0%	94.1%	8.7%
white clover (Trifolium repens)	disturbance, introduced	3.7	1.5	7.8%	0.0%	30.0%	82.4%	7.4%
common dandelion (Taraxacum officinale)	disturbance, introduced	1.9	0.8	4.0%	0.0%	10.0%	94.1%	3.8%
ox-eye daisy (Chrysanthemum leucanthemum syn. Leucanthemum vulgare)	invasive, introduced	1.1	0.4	3.7%	0.0%	10.0%	29.4%	2.1%
smooth aster (Aster laevis)	native	0.9	0.4	1.7%	0.5%	10.0%	100.0%	1.7%
common fireweed (Epilobium angustifolium)	native	0.8	0.3	1.7%	0.0%	10.0%	88.2%	1.7%
white angelica (Angelica arguta)	native	0.6	0.3	1.9%	0.0%	3.0%	70.6%	1.2%
pearly everlasting (Anaphalis margaritacea)	native	0.5	0.2	1.7%	0.0%	3.0%	35.3%	1.0%

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
FORBS Continued								
veiny meadow rue (Thalictrum venulosum)	native	0.5	0.2	1.1%	0.0%	3.0%	88.2%	1.0%
red and white baneberry (Actaea rubra)	native, poisonous	0.4	0.2	1.2%	0.0%	10.0%	52.9%	0.8%
broad-leaved fireweed (Epilobium latifolium)	native	0.4	0.2	3.8%	0.0%	10.0%	29.4%	0.8%
cow parsnip (Heracleum lanatum)	native	0.4	0.2	1.2%	0.0%	3.0%	76.5%	0.8%
large-leaved yellow avens (Geum macrophyllum)	native	0.4	0.2	3.2%	0.0%	10.0%	35.3%	0.8%
purple-stemmed aster (Aster puniceus)	native	0.4	0.2	1.7%	0.0%	3.0%	47.1%	0.8%
western Canada violet (Viola canadensis)	native	0.4	0.2	1.1%	0.0%	3.0%	64.7%	0.8%
purple avens (Geum rivale)	native	0.4	0.2	2.1%	0.0%	10.0%	29.4%	0.8%
northern willowherb (Epilobium ciliatum)	native	0.3	0.1	0.9%	0.0%	3.0%	64.7%	0.7%
Canada goldenrod (Solidago canadensis)	native	0.3	0.1	1.4%	0.0%	3.0%	29.4%	0.6%
fringed grass-of-parnassus (Parnassia fimbriata)	native	0.3	0.1	2.0%	0.0%	3.0%	23.5%	0.6%
alsike clover (Trifolium hybridum)	disturbance, introduced	0.3	0.1	0.9%	0.0%	3.0%	58.8%	0.6%
clasping-leaved twisted-stalk (Streptopus amplexifolius)	native	0.3	0.1	1.0%	0.0%	3.0%	35.3%	0.6%
yellow avens (Geum aleppicum)	native	0.3	0.1	2.4%	0.0%	3.0%	17.6%	0.5%
black medick (Medicago lupulina)	disturbance, introduced	0.3	0.1	1.3%	0.0%	3.0%	23.5%	0.5%
common yarrow (Achillea millefolium)	native	0.3	0.1	0.5%	0.0%	0.5%	94.1%	0.5%
cream-colored vetchling (Lathyrus ochroleucus)	native	0.2	0.1	0.6%	0.0%	3.0%	82.4%	0.5%
variegated horsetail (Equisetum variegatum)	native	0.2	0.1	7.3%	0.0%	10.0%	11.8%	0.5%
geranium (Geranium spp.)	native	0.2	0.1	5.9%	0.0%	10.0%	11.8%	0.5%
Canada anemone (Anemone canadensis)	native	0.2	0.1	0.5%	0.0%	0.5%	88.2%	0.5%
harebell (Campanula rotundifolia)	native	0.2	0.1	0.5%	0.0%	0.5%	88.2%	0.5%
northern bedstraw (Galium boreale)	native	0.2	0.1	0.5%	0.0%	0.5%	82.4%	0.4%
wild vetch (Vicia americana)	native	0.2	0.1	0.5%	0.0%	0.5%	64.7%	0.4%
tall buttercup (Ranunculus acris)	invasive, introduced	0.2	0.1	0.6%	0.0%	3.0%	52.9%	0.4%

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
FORBS Continued								
Canada thistle (Cirsium arvense)	invasive, introduced	0.2	0.1	0.5%	0.0%	0.5%	58.8%	0.4%
tall lungwort (Mertensia paniculata)	native	0.2	0.1	0.9%	0.0%	3.0%	58.8%	0.4%
yellow lucerne (Medicago falcata)	introduced	0.2	0.1	1.6%	0.0%	3.0%	11.8%	0.4%
red clover (Trifolium pratense)	disturbance, introduced	0.2	0.1	0.7%	0.0%	3.0%	47.1%	0.4%
star-flowered Solomon's-seal (Smilacina stellata)	native	0.2	0.1	0.5%	0.0%	0.5%	64.7%	0.3%
common red paintbrush (Castilleja miniata)	native	0.1	0.1	0.5%	0.0%	0.5%	47.1%	0.3%
heal-all (Prunella vulgaris)	native	0.1	0.1	0.5%	0.0%	0.5%	29.4%	0.3%
arrow-leaved coltsfoot (Petasites sagittatus)	native	0.1	0.1	1.4%	0.0%	3.0%	23.5%	0.3%
small wood anemone (Anemone parviflora)	native	0.1	0.1	0.5%	0.0%	0.5%	41.2%	0.3%
hedysarum (Hedysarum spp.)	native	0.1	0.1	10.0%	0.0%	10.0%	5.9%	0.3%
graceful cinquefoil (Potentilla gracilis)	native	0.1	0.1	0.5%	0.0%	0.5%	58.8%	0.2%
wild white geranium (Geranium richardsonii)	native	0.1	0.05	0.5%	0.0%	0.5%	47.1%	0.2%
brook ragwort (Senecio triangularis)	native	0.1	0.05	0.6%	0.0%	3.0%	29.4%	0.2%
orange false dandelion (Agoseris aurantiaca)	native	0.1	0.05	0.5%	0.0%	0.5%	29.4%	0.2%
heart-leaved arnica (Arnica cordifolia)	native	0.1	0.04	3.0%	0.0%	3.0%	5.9%	0.2%
sticky purple geranium (Geranium viscosissimum)	native	0.1	0.04	0.5%	0.0%	0.5%	23.5%	0.2%
common pink wintergreen (Pyrola asarifolia)	native	0.1	0.04	0.5%	0.0%	0.5%	58.8%	0.2%
elephant's-head (Pedicularis groenlandica)	native	0.1	0.04	0.5%	0.0%	0.5%	35.3%	0.2%
curled dock (Rumex crispus)	introduced	0.1	0.04	0.5%	0.0%	0.5%	29.4%	0.2%
willowherb (Epilobium glaberrimum)	native	0.1	0.04	0.5%	0.0%	0.5%	17.6%	0.2%
sweet coltsfoot (Petasites nivalis)	native	0.1	0.04	1.8%	0.0%	3.0%	11.8%	0.2%
forb (Forb)	unknown, not unique	0.1	0.04	0.5%	0.0%	0.5%	23.5%	0.2%
narrow-leaved hawkweed (Hieracium umbellatum)	native	0.1	0.03	0.5%	0.0%	0.5%	35.3%	0.2%
northern green bog orchid (Habenaria hyperborea)	native	0.1	0.03	0.5%	0.0%	0.5%	41.2%	0.2%

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
FORBS Continued								
common nettle (Urtica dioica)	native	0.1	0.03	0.5%	0.0%	0.5%	23.5%	0.2%
three-flowered avens (Geum triflorum)	native	0.1	0.03	0.5%	0.0%	0.5%	17.6%	0.1%
bronzebells (Stenanthium occidentale)	native	0.1	0.03	0.5%	0.0%	0.5%	23.5%	0.1%
nodding onion (Allium cernuum)	native	0.1	0.03	0.5%	0.0%	0.5%	23.5%	0.1%
woodland strawberry (Fragaria vesca)	disturbance, native	0.1	0.03	0.5%	0.0%	0.5%	23.5%	0.1%
cut-leaved anemone (Anemone multifida)	native	0.1	0.03	0.5%	0.0%	0.5%	23.5%	0.1%
mountain goldenrod (Solidago spathulata)	native	0.1	0.03	0.5%	0.0%	0.5%	23.5%	0.1%
heart-leaved Alexanders (Zizia aptera)	native	0.1	0.03	0.5%	0.0%	0.5%	23.5%	0.1%
common plantain (Plantago major)	disturbance, introduced	0.1	0.03	0.5%	0.0%	0.5%	29.4%	0.1%
yellow false dandelion (Agoseris glauca)	native	0.1	0.02	0.5%	0.0%	0.5%	17.6%	0.1%
alfalfa (Medicago sativa)	introduced	0.1	0.02	3.0%	0.0%	3.0%	5.9%	0.1%
narrow-leaved dock (Rumex triangulivalvis)	native	0.1	0.02	0.5%	0.0%	0.5%	11.8%	0.1%
common mullein (Verbascum thapsus)	invasive, introduced	0.1	0.02	0.5%	0.0%	0.5%	11.8%	0.1%
bishop's-cap (Mitella nuda)	native	0.1	0.02	0.5%	0.0%	3.0%	35.3%	0.1%
sweet-scented bedstraw (Galium triflorum)	native	0.1	0.02	0.5%	0.0%	0.5%	23.5%	0.1%
false Solomon's-seal (Smilacina racemosa)	native	0.1	0.02	0.5%	0.0%	0.5%	17.6%	0.1%
mustard (Brassica spp.)	introduced	0.1	0.02	0.5%	0.0%	0.5%	11.8%	0.1%
late goldenrod (Solidago gigantea)	native	0.1	0.02	0.5%	0.0%	0.5%	11.8%	0.1%
perennial sow-thistle (Sonchus arvensis)	invasive, introduced	0.1	0.02	0.5%	0.0%	0.5%	11.8%	0.1%
alpine bistort (Polygonum viviparum)	native	0.05	0.02	0.5%	0.0%	0.5%	23.5%	0.1%
wild sarsaparilla (Aralia nudicaulis)	native	0.05	0.02	0.5%	0.0%	0.5%	11.8%	0.1%
western lousewort (Pedicularis bracteosa)	native	0.05	0.02	0.5%	0.0%	0.5%	11.8%	0.1%
American brooklime (Veronica americana)	native	0.05	0.02	0.5%	0.0%	0.5%	29.4%	0.1%
felwort (Gentianella amarella)	native	0.04	0.02	0.5%	0.0%	0.5%	17.6%	0.1%
wild chives (Allium schoenoprasum)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
FORBS Continued								
wild licorice (Glycyrrhiza lepidota)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
common blue-eyed grass (Sisyrinchium montanum)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
white camas (Zigadenus elegans)	native, poisonous	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
creeping white prairie aster (Aster falcatus)	native	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
bull thistle (Cirsium vulgare)	introduced	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
showy locoweed (Oxytropis splendens)	native, poisonous	0.04	0.02	0.5%	0.0%	0.5%	5.9%	0.1%
western dock (Rumex occidentalis)	native	0.04	0.02	0.5%	0.0%	0.5%	17.6%	0.1%
Philadelphia fleabane (Erigeron philadelphicus)	native	0.04	0.02	0.5%	0.0%	0.5%	17.6%	0.1%
yellow beardtongue (Penstemon confertus)	native	0.04	0.01	0.5%	0.0%	0.5%	11.8%	0.1%
tall white bog orchid (Habenaria dilatata)	native	0.03	0.01	0.5%	0.0%	0.5%	11.8%	0.1%
alpine everlasting (Antennaria alpina)	disturbance, native	0.03	0.01	0.5%	0.0%	0.5%	5.9%	0.1%
leafy-bracted aster (Aster subspicatus)	native	0.03	0.01	0.5%	0.0%	0.5%	5.9%	0.1%
meadow horsetail (Equisetum pratense)	native	0.03	0.01	0.5%	0.0%	0.5%	5.9%	0.1%
white sweet-clover (Melilotus alba)	disturbance, introduced	0.03	0.01	0.5%	0.0%	0.5%	5.9%	0.1%
yellow sweet-clover (Melilotus officinalis)	disturbance, introduced	0.03	0.01	0.5%	0.0%	0.5%	5.9%	0.1%
long-leaved chickweed (Stellaria longifolia)	native	0.03	0.01	0.5%	0.0%	0.5%	11.8%	0.1%
one-flowered wintergreen (Moneses uniflora)	native	0.03	0.01	0.5%	0.0%	0.5%	17.6%	0.1%
palmate-leaved coltsfoot (Petasites palmatus)	native	0.03	0.01	0.5%	0.0%	0.5%	17.6%	0.1%
fairybells (Disporum trachycarpum)	native	0.03	0.01	0.5%	0.0%	0.5%	11.8%	0.1%
few-flowered ragwort (Senecio pauciflorus)	native	0.03	0.01	0.5%	0.0%	0.5%	11.8%	0.1%
western willow aster (Aster hesperius)	native	0.03	0.01	0.5%	0.0%	0.5%	11.8%	0.1%
dwarf scouring-rush (Equisetum scirpoides)	native	0.03	0.01	0.5%	0.0%	0.5%	17.6%	0.1%

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
FORBS Continued								
annual hawk's-beard (Crepis tectorum)	disturbance, introduced	0.03	0.01	0.5%	0.0%	0.5%	5.9%	0.1%
silky perennial lupine (Lupinus sericeus)	native	0.03	0.01	0.5%	0.0%	0.5%	5.9%	0.1%
green false hellebore (Veratrum eschscholtzii)	native	0.03	0.01	0.5%	0.0%	0.5%	5.9%	0.1%
spreading sweet cicely (Osmorhiza depauperata)	native	0.02	0.01	0.5%	0.0%	0.5%	17.6%	0.04%
stellaria (Stellaria spp.)	native	0.02	0.01	0.5%	0.0%	0.5%	11.8%	0.04%
long-fruited anemone (Anemone cylindrica)	native	0.02	0.01	0.5%	0.0%	0.5%	11.8%	0.04%
late yellow locoweed (Oxytropis monticola)	native, poisonous	0.02	0.01	0.5%	0.0%	0.5%	11.8%	0.04%
locoweed (Oxytropis spp.)	native	0.02	0.01	0.5%	0.0%	0.5%	11.8%	0.04%
cicer milk vetch (Astragalus cicer)	introduced	0.02	0.01	0.5%	0.0%	0.5%	5.9%	0.04%
pale coralroot (Corallorhiza trifida)	native	0.02	0.01	0.5%	0.0%	0.5%	5.9%	0.04%
one-sided wintergreen (Orthilia secunda)	native	0.02	0.01	0.5%	0.0%	0.5%	5.9%	0.04%
reflexed locoweed (Oxytropis deflexa)	native, poisonous	0.02	0.01	0.5%	0.0%	0.5%	5.9%	0.04%
greenish-flowered wintergreen (Pyrola chlorantha)	native	0.02	0.01	0.5%	0.0%	0.5%	5.9%	0.04%
wintergreen (Pyrola spp.)	native	0.02	0.01	0.5%	0.0%	0.5%	11.8%	0.03%
common scouring-rush (Equisetum hyemale)	native	0.02	0.01	0.5%	0.0%	0.5%	11.8%	0.03%
wild bergamot (Monarda fistulosa)	native	0.02	0.01	0.5%	0.0%	0.5%	11.8%	0.03%
twisted-stalk (Streptopus streptopoides)	native	0.02	0.01	0.5%	0.0%	0.5%	11.8%	0.03%
Canadian milk vetch (Astragalus canadensis)	native, poisonous	0.01	0.01	0.5%	0.0%	0.5%	5.9%	0.03%
alpine aster (Aster alpinus)	native	0.01	0.01	0.5%	0.0%	0.5%	5.9%	0.02%
aster (Aster spp.)	native	0.01	0.01	0.5%	0.0%	0.5%	5.9%	0.02%
brook cinquefoil (Potentilla rivalis)	native	0.01	0.01	0.5%	0.0%	0.5%	5.9%	0.02%
early blue violet (Viola adunca)	native	0.01	0.01	0.5%	0.0%	0.5%	5.9%	0.02%
yellow anemone (Anemone richardsonii)	native	0.01	0.005	0.5%	0.0%	0.5%	5.9%	0.02%
broad spinulose shield fern (Dryopteris assimilis)	native	0.01	0.005	0.5%	0.0%	0.5%	5.9%	0.02%
Labrador bedstraw (Galium labradoricum)	native	0.01	0.005	0.5%	0.0%	0.5%	5.9%	0.02%

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
FORBS Continued								
blunt-leaved bog orchid (Habenaria obtusata)	native	0.01	0.005	0.5%	0.0%	0.5%	5.9%	0.02%
senecio (Senecio spp.)	native	0.01	0.005	0.5%	0.0%	0.5%	11.8%	0.02%
Lindley's aster (Aster ciliolatus)	native	0.01	0.004	0.5%	0.0%	0.5%	11.8%	0.02%
sparrow's-egg lady's-slipper (Cypripedium passerinum)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
bladder fern (Cystopteris spp.)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
hooded ladies'-tresses (Spiranthes romanzoffiana)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
kidney-leaved violet (Viola renifolia)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
water-hemlock (Cicuta maculata)	native, poisonous	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
tall larkspur (Delphinium glaucum)	native, poisonous	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
hemp-nettle (Galeopsis tetrahit)	disturbance, introduced	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
fringed loosestrife (Lysimachia ciliata)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
water parsnip (Sium suave)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
common goat's-beard (Tragopogon dubius)	introduced	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
Flodman's thistle (Cirsium flodmanii)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
fragile bladder fern (Cystopteris fragilis)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
showy fleabane (Erigeron speciosus)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
cut-leaved ragwort (Senecio eremophilus)	native	0.01	0.004	0.5%	0.0%	0.5%	5.9%	0.02%
brown-bracted mountain everlasting (Antennaria umbrinella)	disturbance, native	0.01	0.003	0.5%	0.0%	0.5%	5.9%	0.01%
smooth scouring-rush (Equisetum laevigatum)	native	0.01	0.003	0.5%	0.0%	0.5%	5.9%	0.01%
smooth fleabane (Erigeron glabellus)	native	0.01	0.003	0.5%	0.0%	0.5%	5.9%	0.01%
small-leaved everlasting (Antennaria parvifolia)	disturbance, native	0.01	0.003	0.5%	0.0%	0.5%	5.9%	0.01%
showy everlasting (Antennaria pulcherrima)	disturbance, native	0.01	0.003	0.5%	0.0%	0.5%	5.9%	0.01%
silver-leaved scorpionweed (Phacelia hastata)	native	0.01	0.003	0.5%	0.0%	0.5%	5.9%	0.01%

Life Form[1]	Plant Status[2]	Area by Species		Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
		acres	hectares	Avg	Min Range	Max Range		
FORBS Continued								
black-tipped groundsel (Senecio lugens)	native	0.01	0.003	0.5%	0.0%	0.5%	5.9%	0.01%
balsam groundsel (Senecio pauperculus)	native	0.01	0.002	0.6%	0.0%	3.0%	11.8%	0.01%
Sitka columbine (Aquilegia formosa)	native	0.01	0.002	0.5%	0.0%	0.5%	5.9%	0.01%
yellow hedysarum (Hedysarum sulphurescens)	native	0.01	0.002	0.5%	0.0%	0.5%	5.9%	0.01%
blunt-fruited sweet cicely (Osmorhiza chilensis)	native	0.01	0.002	0.5%	0.0%	0.5%	5.9%	0.01%
rosy everlasting (Antennaria rosea)	disturbance, native	0.005	0.002	0.5%	0.0%	0.5%	5.9%	0.01%
field mouse-ear chickweed (Cerastium arvense)	disturbance, native	0.005	0.002	0.5%	0.0%	0.5%	5.9%	0.01%
fern (Fern spp. PTERIDOPHYTA)	native	0.005	0.002	0.5%	0.0%	0.5%	5.9%	0.01%
sticky alumroot (Heuchera cylindrica)	native	0.005	0.002	0.5%	0.0%	0.5%	5.9%	0.01%
yellow monkeyflower (Mimulus guttatus)	native	0.005	0.002	0.5%	0.0%	0.5%	5.9%	0.01%
beardtongue (Penstemon spp.)	native	0.005	0.002	0.5%	0.0%	0.5%	5.9%	0.01%
silvery cinquefoil (Potentilla argentea)	introduced	0.005	0.002	0.5%	0.0%	0.5%	5.9%	0.01%
coralroot (Corallorhiza spp.)	native	0.0003	0.0001	0.5%	0.0%	0.5%	5.9%	0.0005%

[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 C

WESTSLOPE CUTTHROAT TROUT 2012 RHI CHANNEL WIDTH AND CHANNEL SUBSTRATE DATA

Polygon Number	Waypoint	Easting	Northing	F9. Ave. non-vegetated channel width (m)	F2a. Is channel bottom visible? Y/N	>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)
ALL1	ALL1L	672837	5506375	3.8	Y	<1%	10%	20%	50%	10%	3%	3%	3%	0
ALL1	ALL1A	672763	5506418	4.2	Y	20%	3%	3%	40%	20%	10%	3%	3%	100
ALL1	ALL1B	672701	5506543	3.8	Y	10%	3%	40%	30%	10%	3%	3%	3%	200
ALL1	ALL1C	672671	5506624	2.9	Y	0	<1%	10%	30%	30%	20%	10%	3%	300
ALL1	ALL1D	672594	5506694	5.1	Y	0	10%	3%	20%	40%	20%	3%	3%	400
ALL1	ALL1E	672602	5506815	3.4	Y	0	<1%	3%	20%	40%	30%	3%	3%	500
ALL1	ALL1F	672585	5506921	3.2	Y	20%	10%	10%	30%	10%	3%	3%	3%	600
ALL1	ALL1G	672513	5506986	3.5	Y	0	0	20%	30%	30%	10%	10%	3%	700
ALL1	ALL1H	672530	5507124	5.3	Y	0	0	3%	20%	50%	20%	3%	3%	800
ALL1	ALL1I	672494	5507220	3	Y	0	3%	10%	40%	20%	20%	10%	3%	900
ALL1	ALL1J	672493	5507318	3	Y	0	3%	20%	30%	30%	10%	3%	3%	1000
ALL1	ALL1K	672487	5507409	5	Y	0	0	3%	30%	40%	20%	3%	3%	1100
ALL1	ALL1M	672492	5507523	3.7	Y	0	10%	20%	20%	40%	20%	3%	3%	1200
ALL1	ALL1N	672515	5507634	3.7	Y	0	0	10%	20%	50%	10%	3%	3%	1300
ALL1	ALL1BARRIER	672485	5507720	12	Y	0	3%	20%	10%	30%	30%	3%	3%	1400
ALL1	ALL1U	672464	5507758	4.1	Y	0	10%	20%	30%	30%	3%	3%	3%	1450
ALL2	ALL2UNEW	673469	5505653	4.7	Y	30%	<1%	3%	30%	30%	3%	<1%	<1%	0
ALL2	ALL2A	673479	5505535	4.2	Y	<1%	3%	50%	30%	3%	3%	3%	3%	100
ALL2	ALL2B	673518	5505445	4.9	Y	0	3%	50%	30%	3%	10%	10%	3%	200
ALL2	ALL2C	673539	5505338	3.4	Y	0	<1%	30%	40%	20%	10%	<1%	<1%	300
ALL2	ALL2LNEW	673555	5505228	7	Y	0	0	20%	50%	30%	<1%	3%	3%	400
CRB1	CRB1U	684939	5478221	15.8	Y	0	0	<1%	20%	30%	30%	20%	<1%	0
CRB1	CRB1B	685043	5478244	7.1	Y	<1%	<1%	30%	40%	30%	<1%	<1%	<1%	100
CRB1	CRB1C	685126	5478304	5	Y	<1%	<1%	40%	20%	20%	10%	10%	<1%	200
CRB1	CRB1D	685223	5478287	5.2	Y	<1%	3%	40%	30%	20%	10%	3%	<1%	300
CRB1	CRB1E	685344	5478276	6.1	Y	<1%	<1%	20%	30%	40%	10%	3%	<1%	400
CRB1	CRB1F	685440	5478319	10.5	Y	<1%	<1%	10%	40%	3%	10%	30%	10%	500
CRB1	CRB1G	685484	5478412	16.4	Y	<1%	3%	30%	50%	10%	10%	3%	<1%	600
CRB1	CRB1H	685512	5478510	13.6	Y	3%	3%	20%	40%	30%	10%	<1%	<1%	700
CRB1	CRB1I	685604	5478536	9.3	Y	40%	10%	20%	10%	10%	10%	<1%	<1%	800
CRB1	CRB1L	685653	5478608	5.7	Y	80%	0	0	0	10%	10%	<1%	0	850
CRB2	CRB1U	683462	5477340	4.8	Y	0	3%	20%	30%	40%	3%	3%	0	0
CRB2	CRB2A	683499	5477345	5.6	Y	0	3%	20%	40%	30%	3%	3%	0	100
CRB2	CRB2B	683587	5477412	7.4	Y	0	<1%	3%	40%	20%	20%	20%	<1%	200
CRB2	CRB2C	683682	5477435	7.1	Y	0	3%	10%	40%	20%	20%	10%	0	300
CRB2	CRB2D	683765	5477512	4.7	Y	0	0	10%	10%	50%	20%	10%	<1%	400
CRB2	CRB2E	683784	5477664	5.9	Y	10%	<1%	3%	30%	40%	20%	3%	<1%	500

Polygon Number	Waypoint	Easting	Northing	F9. Ave. non-vegetated channel width (m)	F2a. Is channel bottom visible? Y/N	>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)
CRB2	CRB2L	683791	5477683	4.7	Y	50%	0	0	3%	40%	3%	3%	<1%	600
CTH1	CTH1L	677167	5594064	5	Y	0	0	0	<1%	10%	40%	60%	3%	0
CTH1	CTH1A	677130	5593996	5.2	Y	10%	10%	30%	20%	10%	20%	3%	<1%	80
CTH1	CTH1C	677097	5593895	4.7	Y	0	0	3%	20%	50%	20%	10%	<1%	180
CTH1	CTH1D	677003	5593818	3.6	Y	0	0	20%	30%	30%	10%	10%	<1%	280
CTH1	CTH1E	676974	5593723	3.1	Y	10%	10%	30%	20%	10%	10%	10%	<1%	380
CTH1	CTH1F	676950	5593611	2.9	Y	30%	3%	20%	20%	3%	20%	3%	<1%	480
FLA1	FLA1L	673173	5593414	8.6	Y	3%	10%	20%	40%	30%	3%	<1%	<1%	0
FLA1	FLA1A	673072	5593413	12.3	Y	20%	10%	30%	10%	20%	10%	3%	<1%	100
FLA1	FLA1B	672980	5593441	12.2	Y	3%	20%	40%	20%	10%	10%	<1%	<1%	200
FLA1	FLA1C	672879	5593456	11.9	Y	20%	10%	20%	30%	10%	10%	<1%	<1%	300
FLA1	FLA1D	672807	5593389	7.4	Y	40%	20%	10%	10%	10%	10%	<1%	<1%	400
FLA1	FLA1F	672744	5593285	10.4	Y	60%	20%	10%	10%	3%	3%	<1%	<1%	515
FLA1	FLA1U	672647	5593326	10.6	Y	10%	20%	20%	20%	20%	10%	<1%	<1%	615
OHA1	OHA1UNEW	689161	5478109	3.7	Y	0	0	3%	20%	50%	20%	10%	3%	0
OHA1	OHA1A	689194	5478205	4.1	Y	0	<1%	3%	40%	30%	20%	10%	<1%	100
OHA1	OHA1B	689176	5478328	2.4	Y	<1%	<1%	3%	30%	40%	20%	10%	<1%	200
OHA1	OHA1C	689208	5478406	2.9	Y	0	<1%	10%	30%	40%	10%	10%	<1%	300
OHA1	OHA1D	689132	5478494	5.6	Y	0	0	<1%	3%	30%	50%	20%	3%	400
OHA1	OHA1E	689066	5478565	2.1	Y	<1%	0	10%	20%	40%	20%	10%	<1%	500
OHA1	OHA1G	688968	5478630	4	Y	<1%	3%	<1%	40%	30%	20%	10%	<1%	600
OHA1	OHA1L	688961	5478679	3.1	Y	0	<1%	3%	30%	40%	20%	10%	3%	650
PEK17	PEK17U	681321	5579828	9.2	Y	60%	20%	10%	<1%	3%	3%	3%	<1%	0
PEK17	PEK17A	681249	5579872	9.9	Y	10%	20%	40%	10%	10%	10%	3%	<1%	90
PEK17	PEK17B	681155	5579941	8	Y	3%	20%	3%	30%	20%	20%	10%	<1%	200
PEK17	PEK17C	681071	5579971	11.6	Y	10%	20%	10%	30%	20%	10%	3%	<1%	285
PEK17	PEK17D	680969	5580023	8	Y	3%	20%	30%	20%	20%	10%	3%	<1%	400
PEK17	PEK17E	680989	5580215	7.7	Y	20%	20%	20%	20%	10%	10%	3%	<1%	515
SIL1	SIL1U	660541	5635065	0.7	N	NC	NC	NC	NC	NC	NC	NC	NC	0
SIL1	SIL1A	660543	5635061	1.8	Y	0	0	0	0	3%	20%	50%	30%	6
SIL1	SIL1B	660486	5634982	1.1	Y	0	0	0	0	<1%	30%	60%	10%	100
SIL1	SIL1C	660429	5634901	0.5	Y	0	0	0	0	<1%	10%	80%	10%	200
SIL1	SIL1D	660379	5634800	1.7	Y	0	0	0	0	<1%	30%	60%	10%	310
SIL2	SIL2U	660008	5636831	3.7	Y	0	0	<1%	<1%	20%	40%	40%	<1%	0
SIL2	SIL2C	660033	5636924	3.5	Y	0	0	3%	40%	30%	20%	10%	<1%	100
SIL2	SIL2E	660061	5637025	5.5	Y	0	0	<1%	20%	60%	20%	3%	<1%	200
SIL2	SIL2F	660128	5637109	6.9	Y	0	<1%	3%	20%	70%	10%	3%	<1%	300
SIL2	SIL2L	660135	5637157	3.8	Y	0	0	3%	30%	50%	20%	3%	<1%	350
SIL3	SIL3U	660540	5635075	1.2	Y	0	0	0	<1%	<1%	10%	60%	30%	0

Polygon Number	Waypoint	Easting	Northing	F9. Ave. non-vegetated channel width (m)	F2a. Is channel bottom visible? Y/N	>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)
SIL3	SIL3C	660596	5635157	2.3	Y	0	0	<1%	40%	30%	20%	10%	3%	100
SIL3	SIL3F	660640	5635243	0.6	N	NC	NC	NC	NC	NC	NC	NC	NC	200
SIL3	SIL3G	660662	5635334	2.3	Y	30%	3%	20%	10%	20%	10%	10%	3%	300
SYN1	SYN1L	686855	5468051	4.5	Y	0	10%	10%	50%	20%	10%	3%	0	0
SYN1	SYN1A	686765	5468008	4.2	Y	20%	10%	20%	30%	20%	<1%	<1%	0	100
SYN1	SYN1B	686678	5467945	5.1	Y	0	3%	20%	10%	40%	20%	10%	0	200
SYN1	SYN1C	686629	5467848	5.3	Y	30%	10%	3%	3%	30%	20%	3%	0	300
SYN1	SYN1D	686564	5467775	3	Y	30%	20%	20%	10%	10%	10%	3%	0	400
TCT1	TCT1U	692999	5517308	2.8	Y	0	0	0	<1%	50%	30%	10%	10%	0
TCT1	TCT1L	693009	5517333	3.9	Y	0	0	0	0	<1%	3%	90%	10%	20
TCT2	TCT2U	694017	5517412	2.4	Y	0	0	0	0	0	0	<1%	>95%	0
TCT2	TCT2A	694103	5517356	1.7	N	NA	NA	NA	NA	NA	NA	NA	NA	100
TCT2	TCT2C	694215	5517379	0.7	N	NA	NA	NA	NA	NA	NA	NA	NA	200
TCT2	TCT2E	694317	5517414	2.6	N	NA	NA	NA	NA	NA	NA	NA	NA	300
TCT3	TCT3U	693577	5517555	2.1	Y	0	0	0	0	10%	40%	40%	10%	0
TCT3	TCT3A	693679	5517545	1.7	Y	0	0	<1%	<1%	20%	50%	20%	10%	100
TCT3	TCT3L	693724	5517515	2.4	Y	0	0	0	0	10%	80%	10%	3%	150
PEK15	PEK15L	681749	5579423	12.1	Y	<1%	10%	10%	30%	30%	20%	3%	<1%	0
PEK15	PEK15B	681718	5579300	8.1	Y	30%	10%	10%	10%	30%	10%	3%	<1%	140
PEK15	PEK15C	681711	5579205	9.9	Y	30%	20%	10%	10%	20%	10%	3%	<1%	222
PEK15	PEK15D	681708	5579122	7.5	Y	40%	20%	20%	10%	10%	3%	<1%	<1%	305
PEK15	PEK15E	681696	5578986	8.2	Y	80%	10%	3%	3%	3%	3%	<1%	<1%	440
PEK15	PEK15U	681687	5578911	7.5	Y	70%	10%	10%	10%	10%	3%	<1%	<1%	518
GOR1	GOR1U	663961	5614974	6	Y	80%	0	<1%	<1%	<1%	10%	10%	3%	0
GOR1	GOR1A	664001	5614904	9.2	Y	10%	10%	30%	20%	10%	10%	3%	3%	95
GOR1	GOR1B	663979	5614811	8.2	Y	40%	<1%	<1%	30%	10%	10%	10%	<1%	190
GOR1	GOR1C	664047	5614744	7.6	Y	20%	<1%	<1%	30%	30%	10%	10%	<1%	290
GOR1	GOR1D	664094	5614665	9.9	Y	30%	<1%	<1%	40%	20%	3%	3%	3%	390
GOR1	GOR1E	664095	5614553	7.4	Y	70%	10%	<1%	3%	10%	3%	3%	3%	495
GOR1	GOR1L	664205	5614527	8.4	Y	30%	<1%	3%	30%	20%	10%	3%	3%	595

APPENDIX D

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.

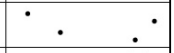
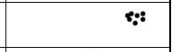
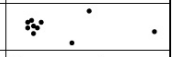
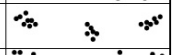
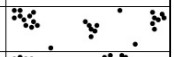
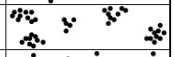
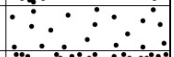
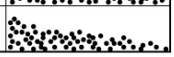
CLASS	DESCRIPTION OF ABUNDANCE	DISTRIBUTION PATTERN
0	No invasive plants on the polygon	
1	Rare occurrence	
2	A few sporadically occurring individual plants	
3	A single patch	
4	A single patch plus a few sporadically occurring plants	
5	Several sporadically occurring plants	
6	A single patch plus several 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.

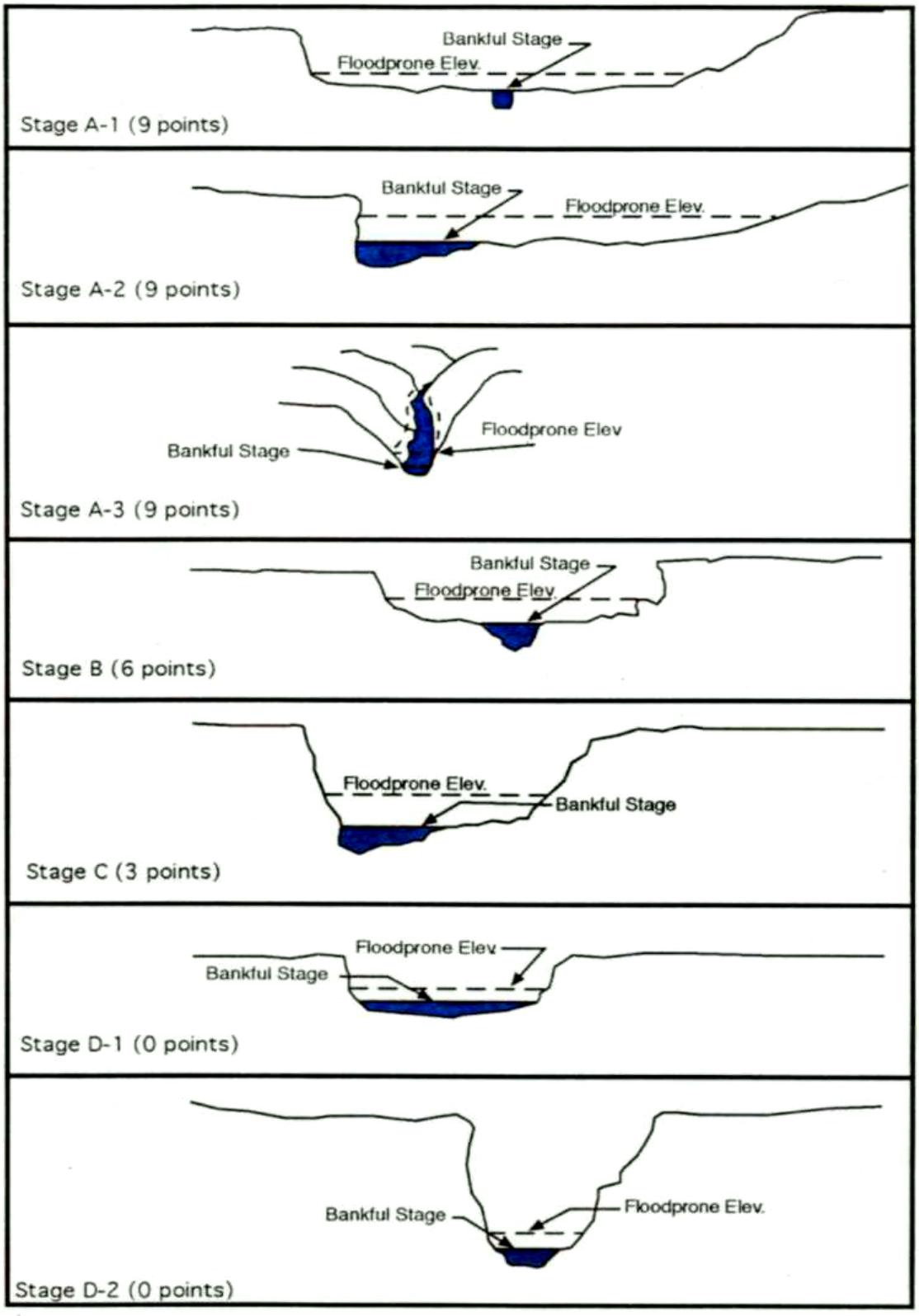


Figure 2. Guides for estimating stage of channel incisement.