Riparian Health Summary
Final Report

- Ghost River Watershed 2011 –
Phase 2

June 2012

Prepared for:

Ghost Watershed Alliance Society

Project Area:

Ghost River Watershed

Including Ghost River, South Ghost River, Lesueur Creek, Baymar Creek, Jamieson Creek, Robinson Creek and select wetlands

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A key to the success of this project was the exceptional level of interest and co-operation demonstrated by landowners and land managers in the Ghost River project area. Thank you to everyone who allowed access to their land and supported this riparian inventory initiative! Thank you also to TransAlta for their assistance with providing hydrology data.

Disclaimer

- Any release of the information contained in this report, in whole or in part, to parties other than the members of the Ghost Watershed Alliance Society will not be the responsibility of Cows and Fish. Liabilities with the release of this report or use of the information beyond the original intent of the work will be the responsibility of the Ghost Watershed Alliance Society.

- All information in this report is a summary reflecting the overall state of riparian health of the Ghost River project area. It does not share any specific information on private landholdings assessed, based on Cows and Fish's commitment of confidentiality with the landowners who participated. Only general findings, reflecting the overall state of riparian health of the Ghost River project area are presented in this report. Due to the broad-scale nature of this representative sampling methodology, there may be unique areas of riparian zone within each reach not represented by the overall health rating for that reach.

- **This report outlines findings from year two of the Ghost Watershed Alliance Society's riparian inventory initiative. Waiparous Creek watershed, a sub-basin of the Ghost River watershed, was inventoried in 2010. The results from that inventory can be found in a separate report: *2010 Riparian Health Inventory: Waiparous Creek Watershed. Cows and Fish 2011.***

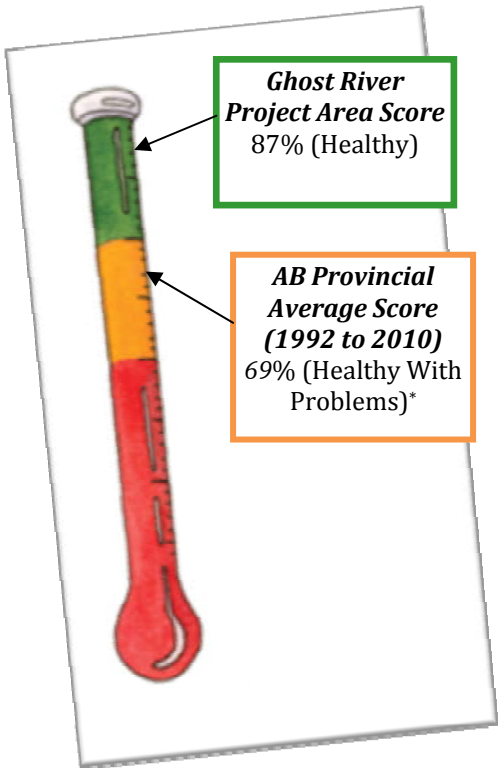
- The inventory and assessment of the functioning condition (health) of riparian habitat does not address any water quality parameters associated with the Ghost River project area.

Remember:

All information is confidential and is provided to each landowner through individual landowner reports. This is not a finger pointing exercise; it's an awareness process.

EXECUTIVE SUMMARY

In 2011, the Alberta Riparian Habitat Management Society (Cows and Fish) partnered with the Ghost Watershed Alliance Society to inventory riparian health within the Ghost River watershed (northwest of Cochrane, Alberta). This project was funded by the Alberta Conservation Association, the Land Stewardship Centre and Cows and Fish, and supported by the participating landowners, resource managers and community members within the Ghost River watershed. This initiative is part of the Ghost Watershed Alliance Society's watershed management planning and is the second year of riparian health sampling for the Ghost River watershed. In 2010, riparian health data was collected in the Waiparous Creek basin. Riparian health information collected in 2010 and 2011 is intended to help inform and facilitate landscape management planning and encourage private landowners and resource managers to better understand and effectively manage riparian areas under their care. The Ghost River watershed and associated riparian areas provide important fish and wildlife habitat, improve water quality and maintain water quantity on the landscape.



Alberta Provincial Average (1992 to 2010) and Ghost River Watershed Project Area Score Overall Riparian Health Comparison.

In July 2011, riparian health inventories were completed on representative portions of the Ghost River, South Ghost River, Lesueur Creek, Baymar Creek, Jamieson Creek and select wetlands. A total of 29 inventories were completed representing a cumulative total of 20 km of stream / shore length and 170 hectares of riparian area. Two sites on Robinson Creek were inventoried in 2010 and are included in this report. Efforts were made to sample representative land use types (proportionate to their frequency) within the Ghost River project area. Land use within the watershed including uplands is varied, consisting of livestock grazing, motorized recreation, horseback riding, camping, hiking, ice and rock climbing, forestry and natural resources exploration and extraction.

Based on the results of this riparian health inventory project, most riparian areas within the Ghost River watershed 2011 project area are in proper functioning (*healthy*) condition. The average health rating for the area is 87%. Twenty-six sites are in proper functioning condition (*healthy),* four sites are functional at risk *(healthy with problems)* and the remaining one site rated non-functional (*unhealthy*).

Next steps and management recommendations for riparian areas are provided in Section 5 of this report. Recommendations include maintaining native plant communities, especially trees and shrubs, in addition to monitoring and controlling invasive weeds, proper timing and amounts of livestock grazing or horse use, and improved management and monitoring of motorized recreation and random camping activities.

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

1 BACKGROUND

1.1 The Cows and Fish Program

In 1992, Cows and Fish was formed to foster a better understanding of how improvements in grazing management on riparian areas can enhance landscape health and productivity for the benefit of producers and others who use and value riparian areas. A key feature empowering Cows and Fish is the declaration of ownership of the riparian grazing issue by landowners, land managers, as well as user and community groups.

1.2 What Is A Riparian Area?

Riparian areas are the portions of the landscape strongly influenced by water and are recognised by water-loving vegetation along rivers, streams, lakes, springs, ponds and seeps (Figure 1). Riparian areas can be described as the "green zones" around lakes and wetlands and bordering rivers and streams.

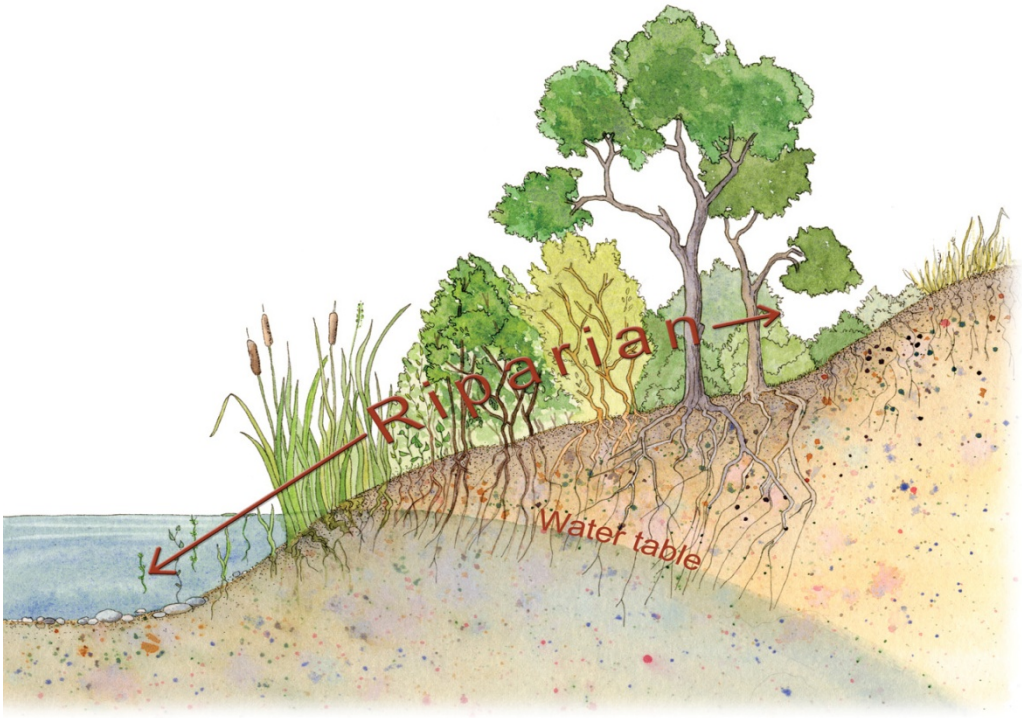


Figure 1 Diagrammatic Representation of a Riparian Area[1]

[1] Source: Fitch, L. and N. Ambrose 2003. Riparian Areas: A User's Guide to Health. Lethbridge, Alberta: Cows and Fish Program. ISBN No. 0-7785-2305-5.

1.3 Why Are Healthy Riparian Areas Important?

When in a properly functioning condition or *healthy* state, riparian areas are one of the most ecologically diverse ecosystems in the world. Healthy riparian areas sustain fish and wildlife populations, provide good water quality and stable water supplies, and support people on the landscape. In doing so they play a role that is disproportionately important to the amount of area that they encompass (approximately 2-5% of the landscape).

Important ecological functions performed by healthy riparian areas include trapping and storing sediment to maintain and build banks, recharging groundwater supplies, providing stable flows and flood protection, improving water quality by filtering runoff and reducing the amount of contaminants and nutrients reaching the water, providing habitat for fish and wildlife, and shelter and forage for livestock. Thus, despite occupying only a small percentage of the total land area within a watershed, riparian areas are critical to the long-term sustainability of a healthy landscape.

1.4 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:

- successful reproduction and establishment of seedling, sapling and mature trees and shrubs (if site has potential to grow them),
- lightly browsed trees and shrubs (by livestock or wildlife),
- floodplains and banks with abundant plant growth,
- banks with deep-rooted plant species (trees and shrubs),
- very few, if any, invasive weeds (e.g. Canada thistle),
- not many disturbance-caused plant species (e.g. Kentucky bluegrass, dandelion),
- very little bare ground or altered banks, and
- ability to frequently (i.e. every few years) access a floodplain at least double the channel width.

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*.

1.5 Why Assess Riparian Health?

The intent of riparian health inventory (RHI) is to provide a *state of the environment report* to the local community. Hopefully, this report will provide better information on riparian health or function to assist your community in making the best decisions on how to manage riparian resources most effectively. Combining this information with existing practical knowledge of rangeland resources will provide the best alternatives for the sustainability of healthy riparian areas within the Ghost River watershed. In general, this information will assist landowners, grazing permit holders, resource managers and other users to identify and effectively develop action plans to address specific riparian land use issues within the Ghost River watershed.

Assessing riparian health allows communities, landowners and professionals to:

- **Create awareness** amongst local producers and their communities and build common understanding on riparian management issues in their watersheds.
- **Take action** by assisting local decision-makers develop strategies to find local solutions to address riparian land use issues.
- **Monitor progress** in improving, maintaining and protecting riparian health for their operation or watershed.
- **Identify environmental risk** and integrate into watershed planning
- **Develop and maintain** watershed management plans for long-term productivity and ecological health.
- **Establish** benchmarks of riparian health from which change over time can be measured.

Working together on riparian management issues, including riparian health inventories, displays a proactive message to the public that your community is taking steps to ensure the health of our landscapes and water supply is being protected, maintained and improved.

2 PROJECT DESCRIPTION

2.1 Project Background

Funding and support for this project was provided by the Ghost Watershed Alliance Society (GWAS), the Alberta Conservation Association, the Land Stewardship Centre, and Cows and Fish members and supporters. Riparian health inventories for this project were conducted in July 2011. Riparian health inventory of streams and wetlands in the Ghost Watershed was initiated in 2010. Data collection in 2010 focussed on the main tributary to the Ghost River, Waiparous Creek, its major tributaries and select wetlands (Figure 2).

The primary purpose of this project is to continue with the riparian health inventory of the Ghost River watershed (Figure 2). Representative portions of the Ghost and South Ghost Rivers as well as select tributaries and wetlands were sampled (Figure 3). Because of the changes to the watershed that have occurred or may occur in the near future, it is important to obtain complete information about baseline riparian health status. It is hoped that riparian health information will be used to help inform land use management and planning in the watershed and government, community or agency led riparian habitat conservation / restoration projects.

Another aspect of this project is to work with the GWAS to provide landowners, land users and government natural resource managers in the watershed with a better understanding of riparian health through workshops, field days and presentations . Information provided by Cows and Fish focuses on awareness about the importance of riparian conservation and management.

2.2 Project Area

The Ghost River watershed drains an area of approximately 947 km^2. The Ghost River flows into the Ghost Reservoir at the confluence with the Bow River west of Cochrane, Alberta. The 2011 Ghost River project (Phase 2) area lies within the Montane Natural Subregion of the Rocky Mountains Natural Region. A large portion of the project area in Phase 2 (as was the case with Phase 1) lies within Alberta Forest Reserve, which is considered to be multi-use. Private land and public grazing lease land also form a component of the area inventoried in 2011. Three wetlands were also assessed; two within the Alberta Forest Reserve and one near the Hamlet of Benchlands (refer to project area map – Figure 3).

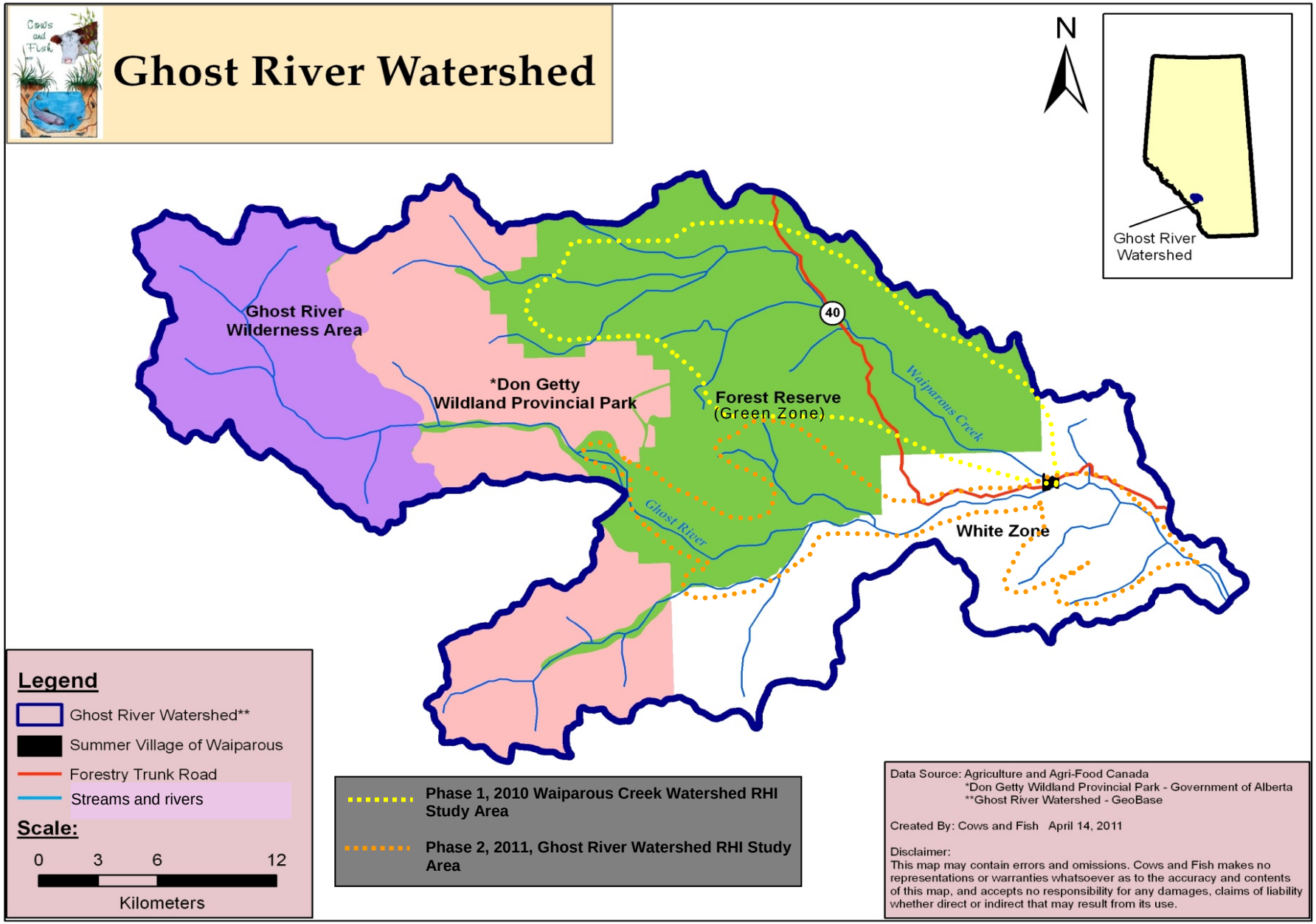


Figure 2 Ghost River watershed regional location and land use designations (2011)

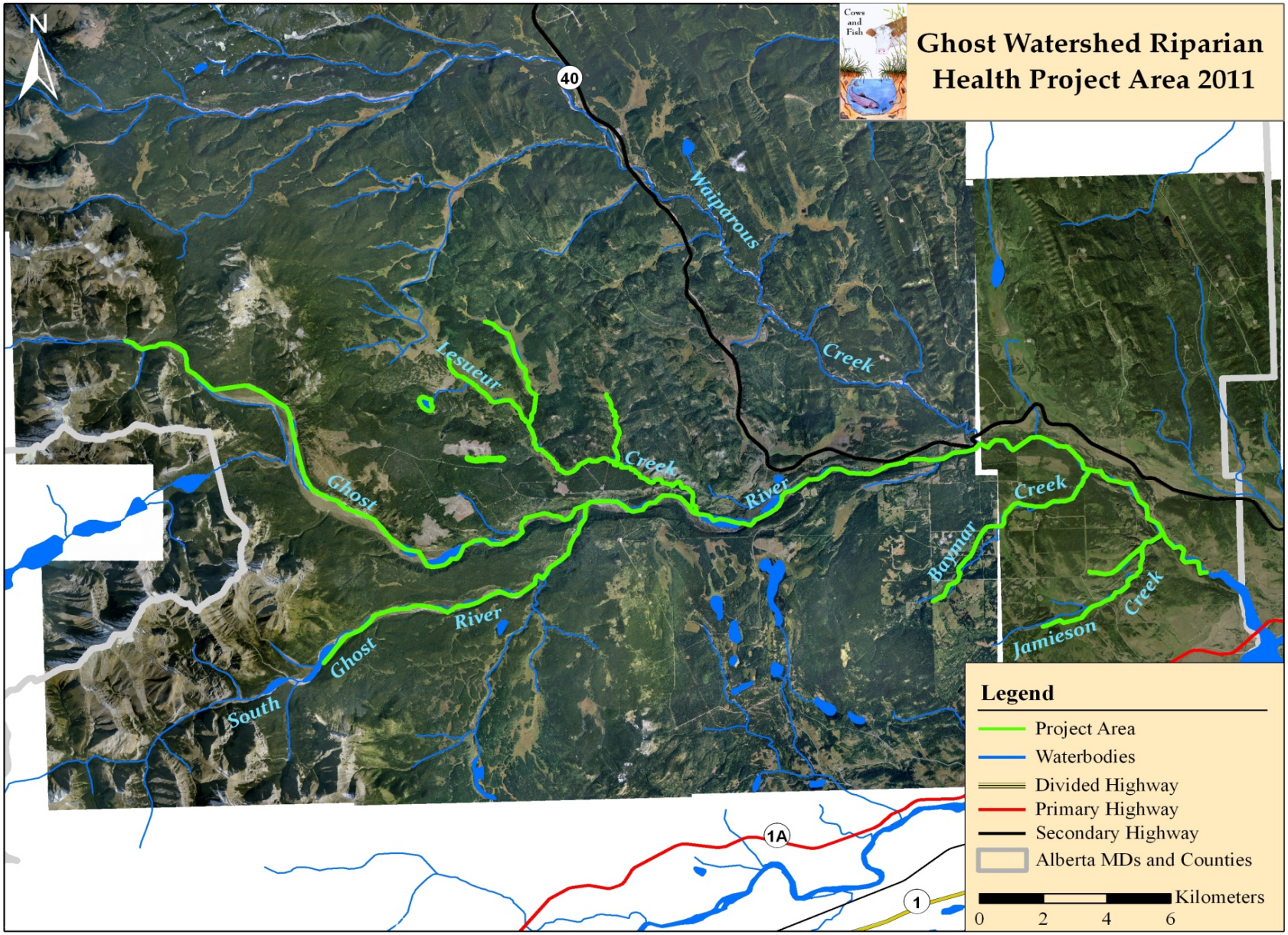


Figure 3 Ghost River watershed streams, rivers and wetlands assessed for riparian health (2011)

2.3 Land Use and Land Management

The headwaters of the Ghost River and several tributaries are provincially protected. Approximately 375 km^2 of the watershed is within the Ghost River Wilderness Area and Don Getty Wildland Provincial Park (Figure 2). The remainder of the watershed lies within the provincial Ghost Public Land Use Zone (PLUZ) and privately owned land. Multiple land use activities within the Ghost PLUZ are managed by Alberta Sustainable Resource Development (ASRD). The watershed is used for livestock grazing within provincial grazing allotments, logging, oil and gas exploration and recreation. The area is popular with both non-motorized (horseback riding, hiking, biking, rock climbing and ice climbing) and motorized recreational users (various types of off-highway vehicles). A Ghost Waiparous Operational Access Management Plan (2005) and the Ghost Stewardship Monitoring Group (2006) were established as a result of environmental damage, illegal activities and conflict in the area associated with recreational activity. Old seismic lines, resource roads and access routes not intended for long-term or recreational use have, over time, been increasingly utilized by off-highway vehicles (OHVs). Several of these old routes and newly disturbed trails are not ideally located or cannot sustain OHV use or random camping. The responsibility of the Ghost Stewardship Monitoring Group is to use an integrated land management approach to reduce impacts on public land for present and future generations.

Commercial timber harvest within the Ghost River watershed is facilitated through a Forest Management Agreement (FMA) with Spray Lake Sawmills, Cochrane, Alberta. The Ghost PLUZ within the 2011 project area also contains two Forest Grazing Allotments, including the Devil's Head and the Lesueur Grazing Allotment. In addition to active forestry operations there are several oil and gas wells and associated facilities in the project area. The Ghost River Sub-Regional Integrated Resource Plan (1988) was developed by ASRD to be used as a guide for resource managers, industry and public with responsibility or interests in the area in order to manage these activities.

Stream flows in the Ghost watershed are maintained by snowmelt and a network of wetlands and alluvial aquifers. This is an important component of providing consistent water supply for users within the watershed and downstream. In addition to water quantity and quality benefits, the watershed provides many important ecological services including air quality, carbon storage and sequestration, stormwater control and recreation, to name a few. The Ghost River watershed also provides important fish and wildlife habitat. It has been identified as having some of the little remaining suitable habitat for bull trout and westslope cutthroat trout in Alberta[2,3]. It is also considered important habitat for grizzly bear, an "At Risk" species in the province[4].

The need for comprehensive management planning is critical to ensure these uses may continue in a planned way while ensuring that the watershed continues to provide the ecological goods and services that those in the watershed and downstream rely on.

[2] Fitzsimmons, K. 2008. Assessment of trout abundance and distribution in the Waiparous Creek drainage, Alberta, 2006. Data Report, D - 2008 - 011, produced by the Alberta Conservation Association, Cochrane, Alberta, Canada.

[3] Alberta Sustainable Resource Development and Alberta Conservation Association. 2006. Status of the westslope cutthroat trout (*Oncorhynchus clarkii lewisii*) in Alberta. Alberta Sustainable Resource Development, Wildlife Status Report No. 61. Edmonton, Alberta. 34 pp.

[4] Alberta Sustainable Resource Development and Alberta Conservation Association. 2010. Status of the Grizzly Bear (*Ursos arctos*) in Alberta: Update 2010. Alberta Sustainable Resource Development. Wildlife Status Report No. 37 (Update 2010). Edmonton Alberta. 44 pp.

3 RIPARIAN HEALTH INVENTORY METHODS

3.1 Representative Riparian Health Sampling

The RHI 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. Application of riparian health inventory on a watershed basis is based on stratification of physical and vegetation features and selection of sites that offer representative examples of riparian zones within the watershed area. Reaches selected for representative sampling have similar valley type, slope, sinuosity and land use / management. They may not necessarily characterize sensitive areas, problem management spots or key habitat concerns for plants, fish or wildlife that represent a relatively small portion of a riparian health inventory site.

Riparian health inventories provide comprehensive information about the diversity, structure and health of plant communities within the project area. The health inventory establishes an important baseline to compare to in the future, to keep track of whether riparian health is being maintained, improved or is declining. For streams, rivers and wetlands, riparian health scores are derived from an evaluation of key vegetation and soil / hydrology health parameters (Table 1). With the exception of two large river hydrology parameters related to flood control and removal / addition of water, the parameters listed in Table 1 are largely based on ocular (visual) estimations made in the field by trained observers. A detailed description of each of these parameters and how they are evaluated is given in Appendix K - River Health Assessment, Appendix L - Lotic Health Assessment and Appendix M - Lentic Health Assessment.

Table 1 List of Riparian Health Parameters Assessed for Streams, Rivers and Wetlands in the Ghost River Project Area in 2011

Riparian Health Parameter Assessed		***Streams and Small Rivers***	***Large Rivers***	***Wetlands***
Vegetation	vegetation cover	☑		☑
	cottonwood and poplar regeneration		☑	
	regeneration of other tree species		☑	
	preferred shrub regeneration		☑	
	preferred tree/shrub regeneration	☑		☑
	preferred tree/shrub utilization and woody vegetation removal by other than browsing	☑	☑	☑
	dead/decadent woody material	☑	☑	
	total canopy cover of woody plants		☑	
	invasive plants	☑	☑	☑
	disturbance plants	☑	☑	☑
	Human-caused alteration of vegetation			☑
Physical	root mass protection	☑	☑	
	human-caused alterations to banks	☑	☑	
	human-caused bare ground	☑	☑	☑
	human-caused alterations to rest of site	☑	☑	☑
	floodplain accessibility		☑	
	channel incisement	☑		
	Removal or addition of water from / to system		☑	☑
	control of flood peak and timing by upstream dam(s)		☑	

Riparian health scores (ratings) are expressed as a percentage and a health category (*healthy*, *healthy, but with problems*, or *unhealthy*) (Table 2).

Table 2 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

3.2 Site Selection

Using current aerial photography and in consultation with the GWAS, the local watershed was delineated into sections of stream/river with similar physical, vegetation and management influences. Each section is referred to as a reach. Riparian inventory sites, or polygons, were identified within individual landholdings after one-on-one discussions with landowners and land managers who described the different management practices used in the riparian area. Select wetlands were chosen for inventory within the Lesueur Creek basin based on land use and accessibility.

3.3 General Inventory Protocol

Riparian health parameters are visually assessed by trained observers in the field. A health rating is derived from this field data using a computer software program (FileMaker Pro).

A hand-held Garmin GPS60™ Global Positioning System (GPS) receiver is used to record strategic locations of the boundaries of a site. For monitoring purposes, benchmark photographs 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 of the riparian area is determined in the field and mapped on an airphoto (1: 5,500 to 1: 9,000 scale). A combination of indicators including change from hydrophytic (water loving) plants to upland plant species, topographic breaks and flood evidence are used to delineate the outer boundary of the riparian area. The inner boundary of the ripairan area includes the portion of the wetted channel with persistent emergent vegetation (e.g. cattails and sedges).

On creeks and small rivers both sides of the waterbody are inventoried as these generally have the same ownership and type of management. Only one side of a river site is inventoried. Landmarks such as fence lines, tributaries or other identifiable features are used, where possible, to delineate the ends of the site in order to facilitate monitoring the same section of stream in the future. Inventory sites encompass a minimum of two meander cycles. A complete meander cycle has equal inside and outside curvature.

3.4 Classification of Riparian Plant Communities

Where appropriate, the *Riparian Classification for the Parkland and Dry Mixedwood Natural Region of Alberta*[5] and / or ASRD's *Range Plant Community Types for the Montane Subregion*[6] were used to classify the riparian plant communities in the project area.

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

Understanding the type of riparian plant communities a stream, lake, or wetland system has the potential to grow is important for a number of reasons. Firstly it allows land managers to know if the desired plant communities are present, an indication of sustainable management practices. Secondly it provides insight into the feasibility of improving existing site conditions and recovering desired and healthier plant communities, if the desired plant community does not exist or is limited. Knowing how existing plant communities differ from the potential natural community of the riparian area allows managers to:

i. set realistic goals to either improve or maintain existing riparian health,
ii. understand how long recovery may take if improvement is needed, and
iii. obtain insight into what management strategies need to be implemented for improvement to occur or to maintain existing riparian health.

Ghost River
(Catalogue Number: RHIP04GHR005)

[5] Thompson, William H. and Paul L. Hansen. 2003. Classification and management of riparian and wetland sites of Alberta's Parkland Natural Region and Dry Mixedwood Natural Subregion. Bitterroot Restoration, Inc. Prepared for the Alberta Riparian Habitat Management Program-Cows and Fish, Lethbridge, Alberta.

[6] Willoughby, M., M. Alexander and B. Adams. 2005. Range Plant Community Types and Carrying Capacity for the Montane Subregion. Sixth Approximation. Publication Number: T/ 071. ISBN: 0-7785-4062-4 (On-line edition). Alberta Sustainable Resource Development, Public Lands Division. Edmonton Alberta. http://www.srd.alberta.ca/LandsForests/GrazingRangeManagement/documents/MontaneSubregionRangePlantCommunityTypes.pdf

4 RIPARIAN HEALTH RESULTS

4.1 Project Area Summary

Thirty-one sites were assessed on 14 landholdings within the project area, including 29 sites inventoried by Cows and Fish in 2011 and 2 sites (along Robinson Creek) inventoried in 2010. Overall the riparian health of Ghost River watershed, excluding the Waiparous Creek sub-basin, is *healthy* (87%). The Waiparous Creek basin was inventoried in 2010 and results from that project area can be found in the Cows and Fish Report *"2010 Riparian Health Inventory: Waiparous Creek Watershed"*. In the Ghost River project area 28 lotic (flowing water) sites and 3 lentic (wetland) sites were inventoried. Twenty-six of the sites rated *healthy*, 4 rated *healthy but with problems* and 1 rated *unhealthy* (**Figure 4**).

Since riparian health inventory sites vary in size, the relative health of the project area (or watershed) based on the area assessed, compared to the number of sites assessed, may differ. However, a representative sampling approach to select sites, as used in the Ghost River project area, should give an appropriate perspective of health by site type. For the 31 sites evaluated in the project area, the area-weighted riparian health rating is 90%. On average riparian sites were 5.7 ha in size. The largest riparian sites inventoried were on the Ghost River at 16.8 ha, 14.5 ha and 37.4 ha. These sites had relatively high health scores of 93%, 92% and 90%, respectively.

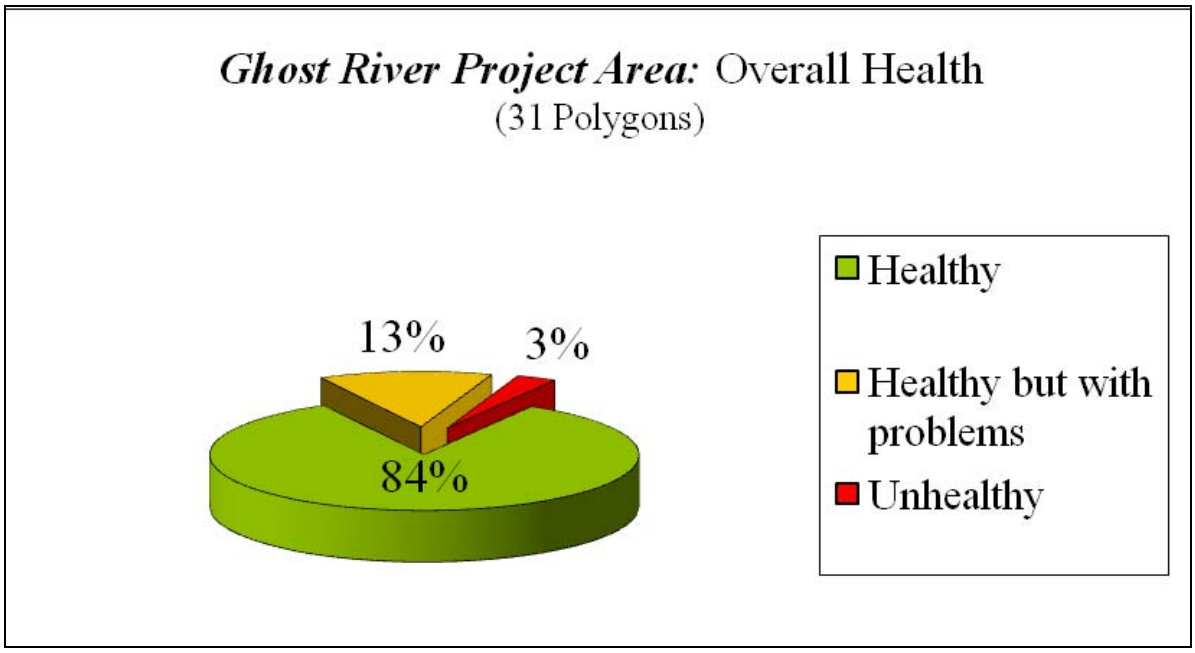


Figure 4 Ghost River Project Area Riparian Health Score Results

Looking at each of the stream, river and wetland systems individually, they all have similar average scores in the *healthy* category (Table 3). The two sites assessed on the South Ghost River have the highest health scores for the project area. Two of the wetland sites assessed also rate in the *healthy* category. The only site to score *unhealthy* is a site on the Ghost River within the Hamlet of Benchlands. A dike built for flood protection of the lower Benchlands community runs the entire length of this site. It is important to note that the natural riparian area extends past this dike, but was not included in the inventory as the river has been disconnected from its historical floodplain. Riverbank reaches with dikes are considered to be entirely structurally altered and usually are devoid of natural riparian vegetation. A narrow band of native

riparian plants is establishing at the base of the dike through Benchlands along newly deposited sediment bars.

Table 3 Project Area Description

Stream/Waterbody	# RHI Participants	# Riparian Inventories	Bank Distance Inventoried (km)	Average Riparian Health Score
Ghost River	10	12	8.7	88%
South Ghost River	1	2	2.1	96%
Lesueur Creek (and tributaries)	2	6	4.5	85%
Baymar Creek	3	3	1.9	86%
Jamieson Creek	1	3	1.9	87%
Robinson Creek (2010)	2	2	2.0	84%
Lesueur Creek wetlands	2	2	0.8	95%
Wetland near Ghost River	1	1	0.4	63%

Photos a to e (pages 11-12) show examples of riparian sites in the Ghost River project area within various health categories. Refer to **Appendix B** for derived health scores for the entire project area. Riparian plant species lists for each of the stream and wetland systems are given in **Appendices C to J**.

Examples of "*healthy*" riparian areas in Ghost River project area.

Photo a: A healthy white spruce and shrub community along the banks of the Ghost River. This type of plant community is typical for healthy river riparian areas within the Ghost River project area. (*Catalogue Number RHIP09GHR009*).

Photo b: A sedge meadow along the banks of a small stream channel; a tributary to Lesueur Creek. This is a wide, wet valley dominated by sedges and water-loving forbs with willows scattered throughout. These kinds of plant communities are only slightly resistant to compaction. (*Catalogue Numbe*r RHIP01LEY001).

Example of a "*healthy but with problems*" wetland

Photo c: A variety of plant community types occur around this wetland including a disturbance-caused type as a result of recreation. This is an artificially occurring wetland, created when the construction of a dike along the Ghost River cut off this section of the floodplain. (*Catalogue Number RHIP01GHX013*).

A "*healthy but with problems*" riparian area

Photo d: Past construction of a trail through the riparian area appears to have introduced invasive and disturbance plant species. Structural alterations to the streambank and compaction also reduced the overall score for this site. (*Catalogue Number RHIP04GHR008*).

Example of an "unhealthy" riparian area

Photo e: Constructed dike (flood control berm) adjacent to the community of Benchlands. (*Catalogue Number RHIP07GHR009*).

To better understand the overall health ratings for the project area, it is helpful to take a closer look at which pieces of the riparian area are intact and functioning and which area not. These parameters will be discussed individually for the main stem (Ghost and South Ghost River), for each of the major tributaries (Lesueur, Robinson, Baymar and Jamieson creeks) and for wetlands. Each health parameter assessed has a range of values associated with it. The breaks between the values represent inflections or thresholds significant enough to indicate change. The health parameters are weighted differently, indicating that they do not all contribute equally to ecological function. Some characteristics, such as the ability of a stream to access its floodplain are critical to ensure that most, or all, other functions occur.

4.2 Ghost River

A) Overall Health and Riparian Area Discussion

Twelve riparian health inventories were completed for the main stem of the Ghost River. The average health score for these assessments is 88%. Ten sites are within the *healthy* category, one in the *healthy with problems* category and one in the *unhealthy* category. Riparian sites ranged in size from 0.35 to 37.9 hectares (0.9 to 92.5 acres) in size, with a total of 94 hectares (230 acres) assessed along 8.7 kilometres (5.4 miles) of riverbank.

Figure 5 provides an overview of the health ratings for each of the riparian health parameters that were assessed. Riparian areas are well vegetated with a diversity of plant species. Refer to **Appendix C** for a list of all plants found in Ghost River riparian areas. Plant communities along the Ghost River display a high amount of structure as evidenced by overlap in life form (plant type) layers. The abundance and distribution of invasive plants as well the extent of riverbank rootmass protection fell below the threshold of *healthy* for riparian areas.

Questions 11 ('dewatering of the river system') and 12 ('upstream dam water control') of the assessment require evaluation by Alberta Environment and Water (AEW) using hydrology data from available gauging stations. These questions pertain to impacts on riparian health from upstream diversions along the Ghost River. ***Health scores for these parameters could not be calculated for this project as hydrology data from AEW was not available at the time of reporting.*** Water licenses are managed by AEW and therefore the land manager or owner is not responsible for directly influencing the health of these parameters.

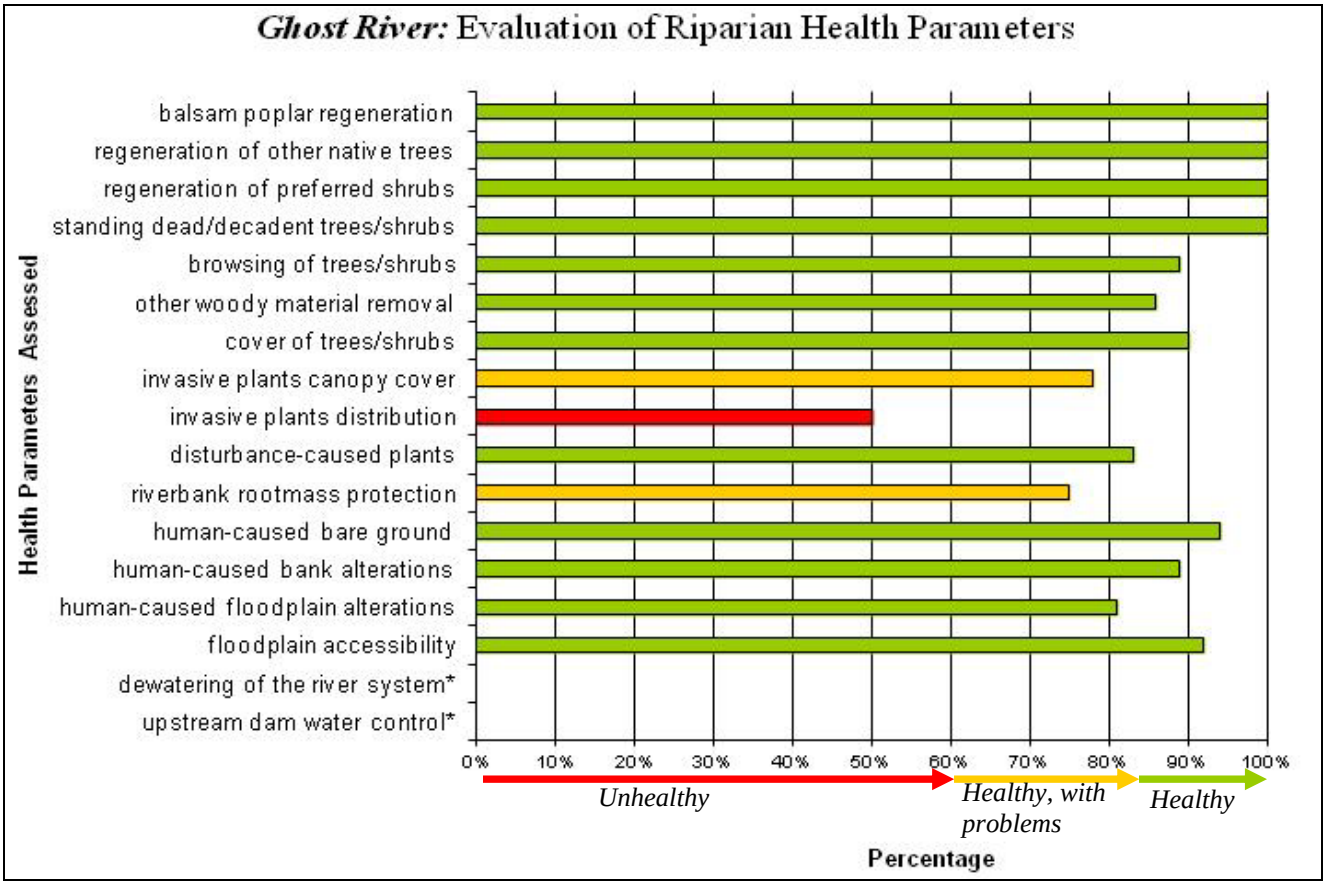


Figure 5 Riparian Health Parameter Ratings for Ghost River

B) Vegetation Health

Land management is varied within the project area along the Ghost River from the uppermost inventory near the border of Don Getty Wildland Park to the mouth of the Ghost Reservoir. However, the dominant plant community, a white spruce *(Picea glauca)*/ shrub habitat type, is prevalent along its length (Table 4). The yellow mountain avens (*Dryas drummondii)* / june grass (*Koeleria macrantha*) community type described in the ASRD Montane Range Plant Community Guide, is also prevalent along 40% of the Ghost River Riparian Area (Table 4). This community type is typical of dry, gravelly river flats with nutrient poor soils (Willoughby *et al.* 2003). Co-dominant shrubs in this community include silverberry (*Elaeagnus commutata*), bearberry (*Arctostaphylos uva-ursi)* and juniper (*Juniperus horizontalis*) which are all characteristic of dry, rapidly-drained soils. The majority (66%) of the riparian area along the Ghost is covered by trees and shrubs.

Table 4 Plant Community Types for Ghost River

Plant Community*	***Classification****	***Area Occupied***	***Area Occupied***
white spruce / shrub	Habitat Type	49 ha (121 ac)	53 %
white spruce / common horsetail	Habitat Type	3 ha (8 ac)	4%
balsam poplar / red-oiser dogwood	Community Type	1.4 ha (3.6 ac)	1.6 %
yellow willow / red-oiser dogwood	Habitat Type	0.4 ha (1.1 ac)	0.5 %
yellow mountain avens / june grass**	Not applicable	38 ha (93.7 ac)	40%
unclassified type: rip rap	Not applicable	0.3 ha (0.7 ac)	0.3%
unclassified type: gravel bar (disturbance species)	Not applicable	0.1 ha (0.2 ac)	0.1%

*Based on Thompson and Hansen 2003; **Based on Willoughby *et al.* 2003

All twelve sites include a diversity and abundance of native plant species. In total, 226 plant species were identified, including 187 (83%) native species and 16 (7%) disturbance-caused introduced species (Appendix C). Introduced species that are considered *disturbance-caused plants* include mainly tame forages such as smooth brome (*Bromus inermis*), quack grass (*Agropyron repens*), timothy (*Phleum pratense*), Kentucky bluegrass (*Poa pratensis*), clovers (*Trifolium* spp.) as well as common dandelion (*Taraxacum officinale*). These non-native grasses and forbs (broad leaf plants) aggressively displace native plants once the soil surface has been disturbed. Disturbance-caused plants like these tend to be shallow rooted and have limited value for bank binding, nutrient filtration and erosion prevention.

Five invasive species were identified along the Ghost River: **Canada thistle (*Cirsium arvense*), perennial sow-thistle (*Sonchus arvensis*), ox-eye daisy (*Chrysanthemum leucanthemum*), yellow clematis (*Clematis tangutica*)** and **yellow toadflax (*Linaria vulgaris*)**. These species are all listed *noxious weeds* on the Alberta *Weed Control Act* that spread rapidly and are difficult to control.

C) Soil and Hydrology Health

Only 7% of the riverbank consists of human-caused, physical alterations, and 88% of this is due to the construction, such as the berm along the Hamlet of Benchlands. Approximately 2% of the area assessed is bare of vegetation cover, and 16% of this is due to human-causes, such as recreation, livestock grazing and construction. The remainder of bare ground occurring in the riparian area is from natural causes, such as sediment deposition, erosion or wildlife.

A diversion was constructed in the 1940s on the Ghost River near the border of Don Getty Wildland Park and is operated by TransAlta. The structure was upgraded from a series of dikes to a permanent structure

in 1988. Water is diverted into a canal from the Ghost River to Lake Minnewanka for hydroelectric power generation purposes at the Cascade plant.

As mentioned, determining the impact of damming and diversion on riparian sites and the subsequent riparian health score requires flow data analysis, which is not currently available from TransAlta or AEW. Water gauging stations at the Ghost River diversion were abandoned in 1993, according to TransAlta, due to the braided, gravel nature of the channel and a constantly shifting flow within these channels. TransAlta did not have a high degree of confidence in the accuracy of the data being collected as a result of these factors[7]. Analysis of any available flow data collected by AEW was also not available at the time of reporting.

Removal or addition of water due to damming or diversion can negatively impact moisture replenishment in the floodplain during the critical growing season. This can result in drying out or inundation and loss of native tree and shrub communities, if severe. For riparian health inventory purposes, if more than 50% of average river flow volume during the critical growing season (May-August) is removed (or added) then this question receives a score of zero of out nine possible points, indicating severe impact to riparian health. Given the type of diversion structure in place along the Ghost River, the amount of flow that is licensed to be diverted by TransAlta, old flow data collected by TransAlta (1941-1993)[8], and based on our observation of dry channel conditions downstream of the diversion during this field work, more than 50% of the average flow is likely removed due to the diversion. The impacts of water diversion to riparian health are likely most severe immediately below the diversion and upstream of the confluence with the South Ghost River and other major tributaries.

The typical vegetation community along the Ghost River is a white spruce and willow habitat type. With the exception of the site immediately downstream of the diversion (Photo e), on average, trees cover 57% of the remaining 11 sites assessed along the Ghost River. Trees cover less than 5% of the site below the diversion, possibly as a result of long-term water diversion. At the time of assessment, the river channel was completely dry immediately downstream of the diversion although it was flowing well upstream of the diversion and elsewhere along the river.

Photo e: Riparian area immediately downstream of the Ghost River diversion. Catalogue No. *RHIP10GHR007*

The downstream end of the Ghost River project area occurs immediately upstream of the Ghost Reservoir, also operated by TransAlta. Ground disturbance and altered channel morphology and hydrology impacts from the reservoir have impacted this reach of the river. As sediment and gravels are deposited out at the mouth of the reservoir, this causes the river channel upstream to shift course and adjust to elevated water levels, creating erosion potential on inside meander bends that is not typical of lotic systems. Areas of deposited sediment and eroded bank has led to increased establishment of invasive and disturbance-caused plants and reduced bank stability along the affected reach of the Ghost River upstream of the reservoir.

[7] Scott Taylor, Manager of Water Resource. TransAlta, Calgary, Alberta. Personal Communication. February 2012.
[8] Water Survey of Canada. Archived Hydrometric Data. Environment Canada. http://www.wsc.ec.gc.ca/applications/H2O/index-eng.cfm.

4.3 South Ghost River

A) Overall Health and Riparian Area Discussion

Two riparian health inventories were completed on the South Ghost River. Both of these riparian sites rated *healthy*, with scores of 99% and 100% (Figure 6). This indicates these riparian sites are in a near-pristine condition. The riparian sites are 3.8 ha and 9.3 ha in size with lengths of 0.8 and 1.3 km, respectively. These sites had similar widths, ranging from one and two meters to 90 and 100 meters wide. Both sites occur within the Ghost PLUZ, however one of the sites is outside of the grazing allotment boundary and neither sites have any designated trails leading to or within them.

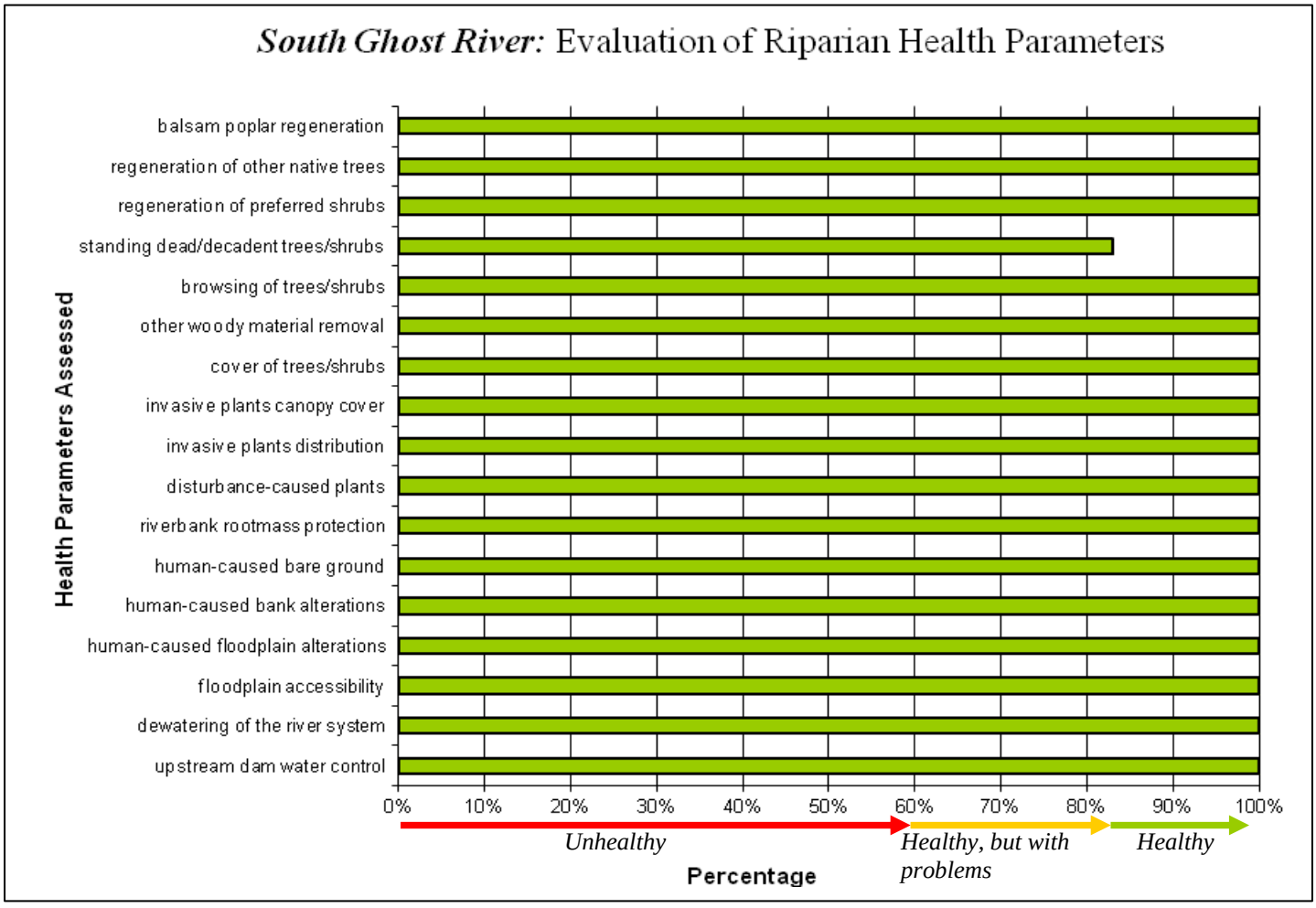


Figure 6 Riparian Health Parameter Ratings for South Ghost River.

B) Vegetation Health

Like the Ghost River, the South Ghost River riparian area is dominated by a white spruce habitat type (Table 5). White spruce dominates these sites, occupying 50% of the riparian area and is present in all age classes; young, middle-aged and mature. Balsam poplar occupies 13% of the area and is also regenerating well. Balsam poplar trees are particularly important indicators of riparian health on river systems. They provide stability to the riverbanks, as well as providing shelter and forage value for wildlife. Understory shrubs are mostly those representative of drier conditions, indicating the rapidly draining nature of gravel and cobble alluvial materials (Photo f). These shrubs include yellow mountain avens, common bearberry, shrubby cinquefoil (*Potentilla fruticosa*) and silverberry (Appendix D).

Photo f: Dry understory species including yellow mountain avens, bearberry and silverberry. Catalogue No. RHIP01SGH014.

Table 5 Plant Community Type for the South Ghost River

*Plant Community**	*Classification**	*Area Occupied*	*Area Occupied (%)*
white spruce / shrub	Habitat Type	13 ha (31 ac)	97.5

*Based on Thompson and Hansen 2003

C) Soil and Hydrology Health

No human-caused physical alterations were observed within the assessed reaches. Due to the gravel/cobble structure of the floodplain, alterations to the site may appear less severe than they would on softer, fine-textured soils. However, there are no signs to suggest the gravel/cobble floodplain masked any alterations. Avoiding the creation of any new designated trails leading to the South Ghost River will ensure the physical aspects of this site remain intact. When present, human-caused bare ground and altered riverbanks can accelerate erosion, cause sedimentation within the water, inhibit the establishment of riparian plants and create opportunities for the establishment of invasive and disturbance plant species. Approximately 8% of the area assessed consists of exposed soil; however, this was all due to natural causes, such as sediment deposition and wildlife use.

4.4 Lesueur Creek

A) Overall Health and Riparian Area Discussion

Four riparian health inventories were completed on Lesueur Creek and two on tributaries to Lesueur Creek (Figure 3). Lesueur Creek flows into the Ghost River from the north and the watershed occurs entirely within the Ghost PLUZ. Overall, these riparian sites rated *healthy*, with an average health score of 85% (Figure 7). The area-weighted health score is 90%. Riparian sites ranged from 0.5 to 13.7 hectares (1.1 to 33.5 acres) in size, with a total of 36.5 hectares (89 acres) assessed along 4.5 kilometres of streambank.

The Lesueur Creek sites are well vegetated and have an abundance of woody vegetation. Invasive plant species are present on three of the six sites, but have minimal cover overall. Disturbance-caused plants are present on all six sites. **Recreational activities, such as random camping and OHV use are currently having the greatest impact on the health and function of riparian areas along Lesueur Creek and its tributaries.**

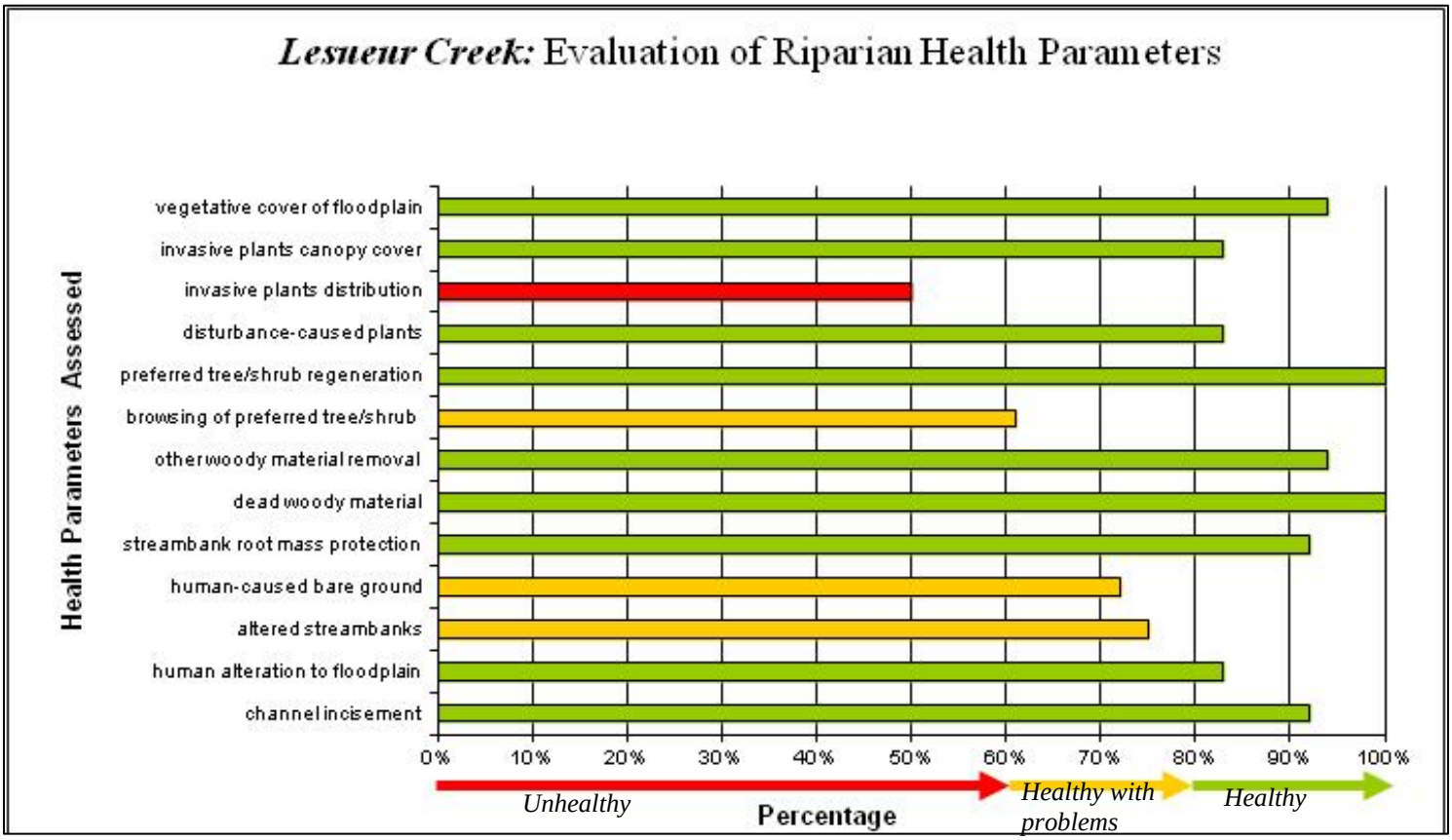


Figure 7 Riparian Health Parameter Ratings for Lesueur Creek

B) Vegetation Health

All six Lesueur Creek sites display an abundance and diversity of native vegetation. Approximately 53% of the riparian area is covered by woody plants. In total 169 plant species were identified, including 4 trees, 35 shrubs, 37 grasses and 93 forbs (Appendix E). Of these, 2 are invasive noxious weed species (**Canada thistle** and **tall buttercup** [*Ranunculus acris*]) and 14 are disturbance-caused, undesirable plant species. Only one tall buttercup plant was observed, however Canada thistle was found in a few patches

as well as several sporadically occurring plants on three of the six sites. The most abundant disturbance-caused species is Kentucky bluegrass; other notable disturbance-caused species include wild strawberry (a native, early colonizer species) and common dandelion. Five of the native species recorded in the Lesueur Creek watershed are considered to be poisonous if ingested in high quantities, including common horsetail (*Equisetum arvense*), white camas (*Zigadenus elegans*), and a variety of locoweeds (*Oxytropis* spp.). These species usually do not pose a risk to livestock in healthy, well managed rangelands.

The two most downstream sites on Lesueur Creek as well the tributary assessed to the east of Lesueur Creek are dominated by a white spruce community, with an understory comprised of willows and a variety of other shrub species (Table 6). Sites further upstream on Lesueur Creek are dominated by willow and sedge communities. Two sites also have a portion of the riparian area dominated exclusively by sedges.

Browse utilization of preferred shrubs (e.g. willows) was evident at most of the sites assessed but was mostly attributed to wildlife rather than livestock use. Heavy utilization can deplete root reserves and cause woody plants to die out. However, regeneration of these important woody species is occurring on these sites and all age classes are present. Recent beaver activity (i.e. dams and chewed stems) was observed at one site, but it does not appear to be negatively impacting riparian health. The site assessed closest to confluence with the Ghost River has a relatively high amount of woody vegetation removal as a result of random camping.

Table 6 Plant Community Types for Lesueur Creek

Plant Community*	***Classification****	***Area Occupied***	***Area Occupied (%)***
Flat-leaved willow / water sedge	Habitat Type	ha (35.7 ac)	40.1
Bebb willow / awned sedge	Habitat Type	ha (28.9 ac)	32.5
White spruce / shrub	Habitat Type	ha (23.2 ac)	26.0
Beaked sedge	Habitat Type	ha (1.9 ac)	2.2

*Based on Thompson and Hansen 2003

C) Soil and Hydrology Health

Recreational activities, such as camping and off-highway vehicle use, are having the greatest impact on the Lesueur Creek sites. These activities have caused physical alteration to 6% of the streambank and 3% of the remainder of the riparian area in these sites (Photo g). OHV use and random camping has also caused bare soil exposure in approximately 2% of the area assessed. Areas of bare soil and physically altered riparian areas impacted by recreational uses have compacted soil and higher rates of erosion and runoff which are contributing sediment inputs into the creek, potentially damaging fish habitat and downstream water quality. These areas are also susceptible to encroachment from weedy plant species.

One of the sites, a tributary, has a slightly incised stream channel profile due to downward erosion of the channel related to the natural breach of upstream beaver dams. This is a natural ecological process that is not likely to be a long-term riparian health concern. Beavers have for thousands of years been part of this highly dynamic riparian ecosystem.

Photo g: Exposed soil and streambank alterations are having the greatest impact on Lesueur Creek. *Catalogue No. RHIP03LEU009.*

4.5 Baymar Creek

A) Overall Health and Riparian Area Discussion

Three sites were assessed along Baymar Creek. Baymar Creek flows into the Ghost River from the south, downstream of the Hamlet of Benchlands. Two of these sites are on private land and one on provincial grazing lease. The presence of invasive weeds is having the greatest impact on riparian health along this system. Other factors affecting riparian health are disturbance-caused plants, browsing and reduced root mass protection along parts of the stream channel (Figure 8). Long-term livestock use may have contributed to some of these health concerns. Two sites are in the *healthy* category and one in the *healthy but with problems* category with an average score of 86%. The area weighted score is 80%, indicating that the *healthy but with problems* site is larger than the *healthy* sites. Riparian sites assessed were 0.3, 0.5 to 5.5 hectares (0.7, 1.2 and 13.5 acres) in size, along 1.9 kilometres of streambank.

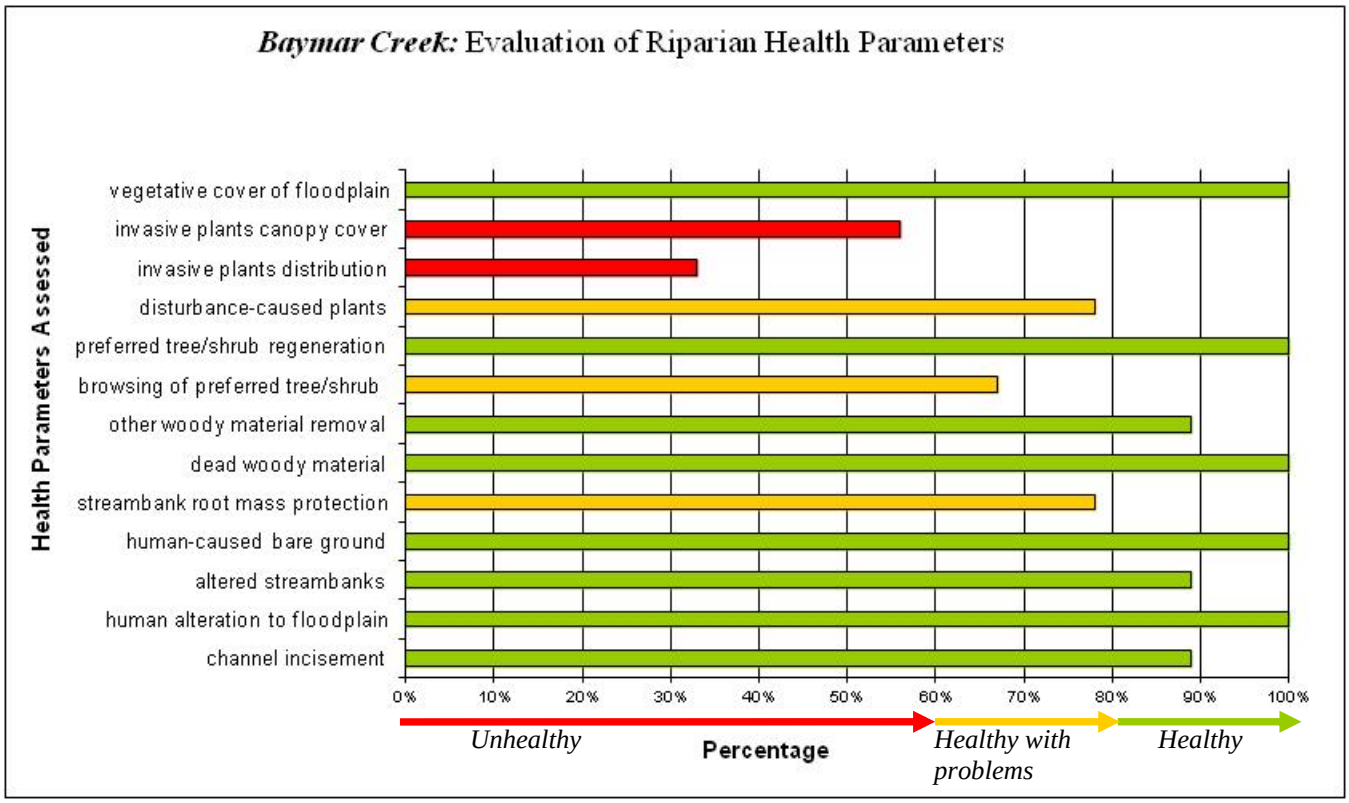


Figure 8 Riparian Health Parameter Ratings for Baymar Creek

B) Vegetation Health

Tributaries to the Ghost River including Baymar Creek tend to be dominated by willow/sedge plant communities in the upper reaches and then by white spruce as the streams reach the confluence with the river (Table 7). Baymar Creek appears to be a beaver modified valley type where plant communities are adapted to saturated soil conditions due to beaver dams. In total, 116 plant species were identified, including 3 trees, 23 shrubs, 25 grasses and 65 forbs. Of these, 2 are invasive and 11 are disturbance-caused, undesirable species (Appendix F). Slightly more than half of the area assessed is covered by trees and shrubs.

Table 7 Plant Community Types for Baymar Creek

*Plant Community**	*Classification**	*Area Occupied*	*Area Occupied (%)*
Flat-leaved willow / water sedge	Habitat Type	4.4 ha (10.8 ac)	70
White spruce / shrub	Habitat Type	1.3 ha (3.3 ac)	21
White spruce / common horsetail	Habitat Type	1.1 ha (0.5 ac)	7
Water sedge	Habitat Type	0.03 ha (0.07 ac)	0.5
Shrubby cinquefoil / disturbance species (unclassified wetland type)	n/a	0.03 ha (0.07 ac)	0.5

*Based on Thompson and Hansen 2003

The two invasive species observed along Baymar Creek include **Canada thistle** and **perennial sow-thistle**. Overall, they cover 3% of the riparian area and were found individually as well as in several patches. Disturbance-caused plants, including Kentucky bluegrass, smooth brome and common dandelion, cover 8% of the area assessed. Overall, browse pressure is light; indicating that there is 5-25% utilization of the available second year leaders of preferred woody species. Browse was attributed mostly to wildlife use, indicating the importance of these riparian habitats to moose and other ungulates.

C) Soil and Hydrology Health

Very few physical alterations were observed, with only 2% of the streambank and less than 1% of the remainder of the riparian area altered due to human activities. Bare ground was only observed on one site and it was mostly due to recent sediment deposition, which helps heal past physical alterations and build riparian soils. Despite the lack of human alterations and bare ground, a portion of the streambank (15-34%) is lacking deep, binding root mass to prevent bank erosion. These areas would benefit from more dense cover by willows and other woody species as well as sedges. The natural establishment of woody plant communities should help to improve the amount of deep, binding root mass over time.

4.6 Jamieson Creek

A) Overall Health and Riparian Area Discussion

Two sites were assessed along Jamieson Creek and one site was assessed along an unnamed tributary to Jamieson Creek. Jamieson Creek flows into the Ghost River from the south. All three sites are *healthy* with an average score of 87%. The area weighted score is similar at 88%. The presence of invasive and disturbance-caused plants, along with tree and shrub utilization and human alterations to the riparian area, are causing the greatest detriment to riparian health on these systems (Figure 9). Riparian sites assessed were 1.8, 6.7 and 10.2 hectares (4.4, 16.4 and 24.9 acres) in size, along a total of 1.9 kilometres of streambank.

B) Vegetation Health

Approximately 61% of the area assessed is covered by woody plant species, including 3 tree and 5 shrubs species. A wide variety of 24 grasses and 59 forbs were also recorded in the area (Appendix G). Of these, 2 are invasive and 13 are disturbance-caused, undesirable species. **Canada thistle** and **perennial sow-thistle** are the two invasive species occurring here. They cover less than 1% of the riparian area and

occur in patches as well as scattered individual plants. Disturbance-caused species, such as Kentucky bluegrass and quack grass occur in all three sites covering a total of 27% of the area assessed. In areas where these species are dominant, lateral erosion is often occurring leaving the streambank unstable. The utilization of preferred woody plants is light overall. Although the herbaceous plant community has been modified due to grazing use, there is an excellent diversity and cover of native trees and shrubs. Dominant habitat types include beaked willow / water sedge and white spruce / shrub (Table 8).

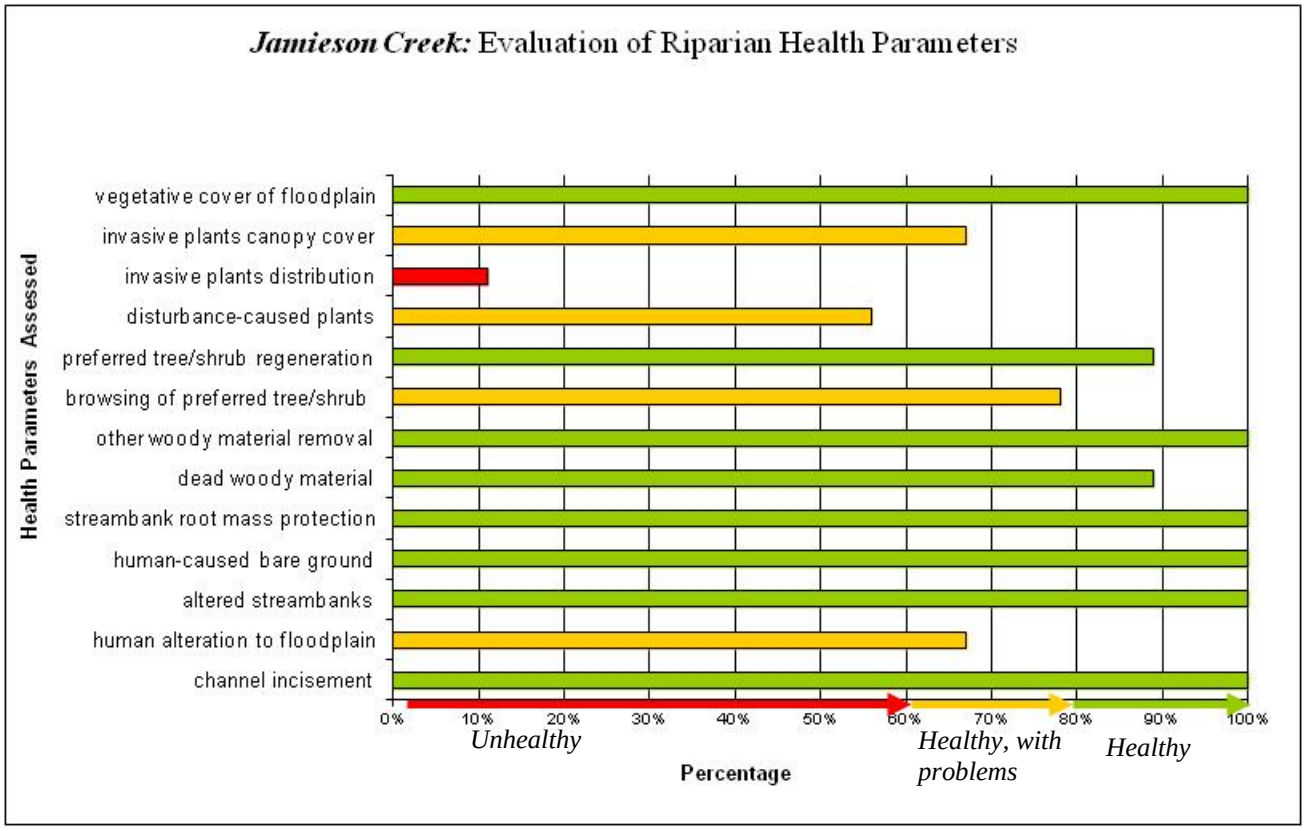


Figure 9 Riparian Health Parameter Ratings for Jamieson Creek

Table 8 Plant Community Types for Jamieson Creek

Plant Community*	***Classification****	***Area Occupied***	***Area Occupied (%)***
Beaked willow / water sedge	Habitat Type	7.8 ha (19.0 ac)	42
White spruce / shrub	Habitat Type	5.2 ha (12.6 ac)	28
White spruce / common horsetail	Habitat Type	2.0 ha (5.0 ac)	11
Water sedge	Habitat Type	2.0 ha (5.0 ac)	11
Clover / disturbance species (unclassified wetland type)	n/a	1.0 ha (2.5 ac)	5.5
Beaked sedge	Habitat Type	0.7 ha (1.6 ac)	3.6
Awned sedge	Habitat Type	0.3 ha (0.8 ac)	1.6
Balsam poplar	Community Type	0.3 ha (0.8 ac)	1.6

*Based on Thompson and Hansen 2003

C) Soil and Hydrology Health

Alterations to the streambank and floodplain appear to have resulted from past grazing use. No sign of current livestock impacts were observed. Approximately 3% of the streambank and 12% of the remainder of the riparian area shows signs of trampling impacts from past livestock use. A minor amount of alteration has also resulted from construction of a lease road through one of the sites. However, less than 1% of the area assessed consists of human-caused bare ground.

4.7 Robinson Creek

A) Overall Health and Riparian Area Discussion

Riparian health overall for the two sites assessed is 84%, or *healthy* (Figure 10). Both sites have excellent total vegetation cover provided mainly by native plant species. **Canada thistle** and **perennial sow-thistle** were found on both sites and an additional invasive species, **cleavers** (*Galium aparine*), was found on only one site. These plants occupy less than 1% of each site. Disturbance-caused undesirable plants, such as smooth brome, are also present on both sites but currently occupy only a small portion of the riparian area.

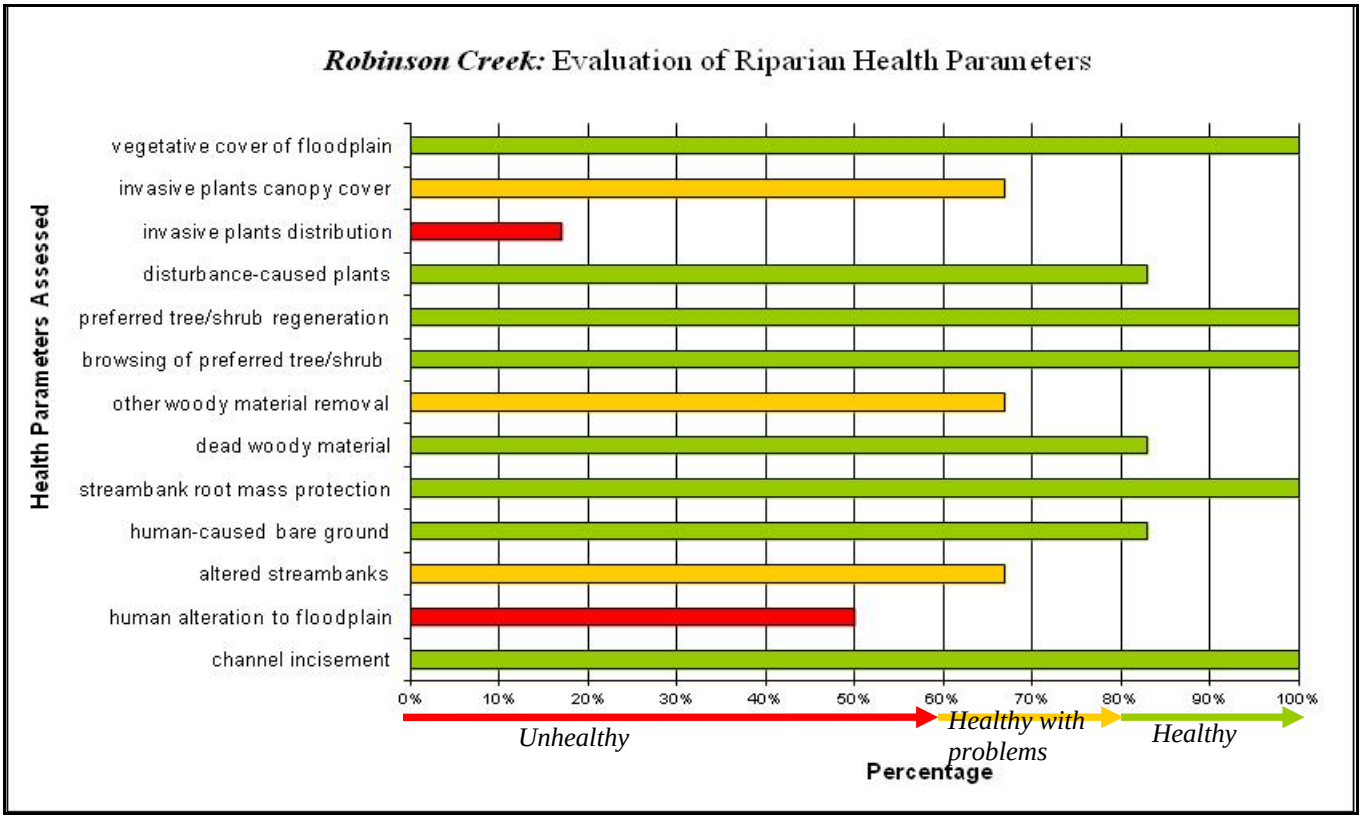


Figure 10 Riparian Health Parameter Ratings for Robinson Creek

B) Vegetation Health

The characteristics of the two sites are quite different. The upstream site is in a relatively low gradient valley that has been heavily modified by beaver activity. There is only a small amount of woody vegetation cover present due to tree and shrub removal and flooding by beaver. Sedges are by far the most dominant plant species at the upstream site (Table 9). The downstream site is located in a deep valley with a steep stream gradient. Nearly the entire site (90%) is covered by white spruce with herbaceous cover in the understory being fairly sparse (Appendix H). Steep slopes limiting accessibility and rocky soils have helped to limit physical alterations to the site.

Table 9 Plant Community Types for Robinson Creek

*Plant Community**	*Classification**	*Area Occupied*	*Area Occupied (%)*
white spruce / shrub	Habitat Type	1.3 ha (3.3 ac)	43.5
White spruce / common horsetail	Habitat Type	0.8 ha (2.0 ac)	27.2
Flat-leaved willow / water sedge	Habitat Type	0.7 ha (1.7 ac)	22.0
Beaked sedge	Habitat Type	0.2 ha (0.5 ac)	7.3

*Based on Thompson and Hansen 2003

C) Soil and Hydrology Health

Positive impacts of beavers coupled with rest from grazing pressure have allowed for natural recovery of historical trampling impacts from livestock use in the upstream site. Beaver dams help to raise the water table and trap sediment, contributing to in-fill of previously compacted areas and new establishment of native plants like sedges. However, additional recovery is needed before grazing resumes in this area and timing of any future grazing pressure is an important consideration as the fine textured soils found throughout this site are highly susceptible to compaction. Limited use and accessibility of the downstream site have allowed this site to remain in a relatively natural condition. Some impacts to the vegetation community and physical structure of the site are present at the upstream end of this site near the road as well as at two livestock access points. These impacts affect only a small portion of the overall site.

4.8 Wetlands in Lesueur Creek Basin

A) Overall Health and Riparian Area Discussion

Two wetland (lentic) RHIs were completed in the Lesueur Creek watershed. These wetlands are both within the Ghost PLUZ; one within the Lesueur Creek Grazing Allotment and the other on the Enviros Wilderness camp wetland. When assessing lentic sites, such as these, nine riparian health parameters are evaluated (Appendix M), a few of which differ from lotic riparian health parameters. Not only are human impacts on the physical structure of the site evaluated, the severity of those alterations to the vegetation community are considered. Artificial changes in water level are also assessed.

Most of the lentic parameters for the Lesueur Creek basin wetlands are *healthy* (Figure 11). The average riparian health score for these two lentic sites is 95% (*healthy*). The total area assessed for wetland sites in the Ghost PLUZ is 2.6 ha (6.3 ac) along 0.8 km (0.5 miles) of shoreline. At present, impact to riparian health from livestock use and recreational activities appears minimal. Invasive species monitoring, careful management of livestock stocking rates and restricted expansion of recreational facilities (trails etc.) will help maintain these sites in a healthy condition.

A) Vegetation Health

Both wetlands in the Lesueur Creek basin have a diversity of plant life ranging from 39 to 79 plant species, most of which are native species (Appendix I). Combined, 83% of their area is covered by woody plant species. Both sites have less than 5% cover from disturbance-caused herbaceous species. A trace amount of **Canada thistle** (a single patch and a few scattered individual plants) was observed at the Enviros wilderness camp wetland. Livestock use has not altered the vegetation plant community in either site. A minor amount of vegetation clearing due to recreational activities has occurred at the wilderness camp site. There is evidence of light browse of preferred trees and shrubs at both sites, likely mainly from wildlife use.

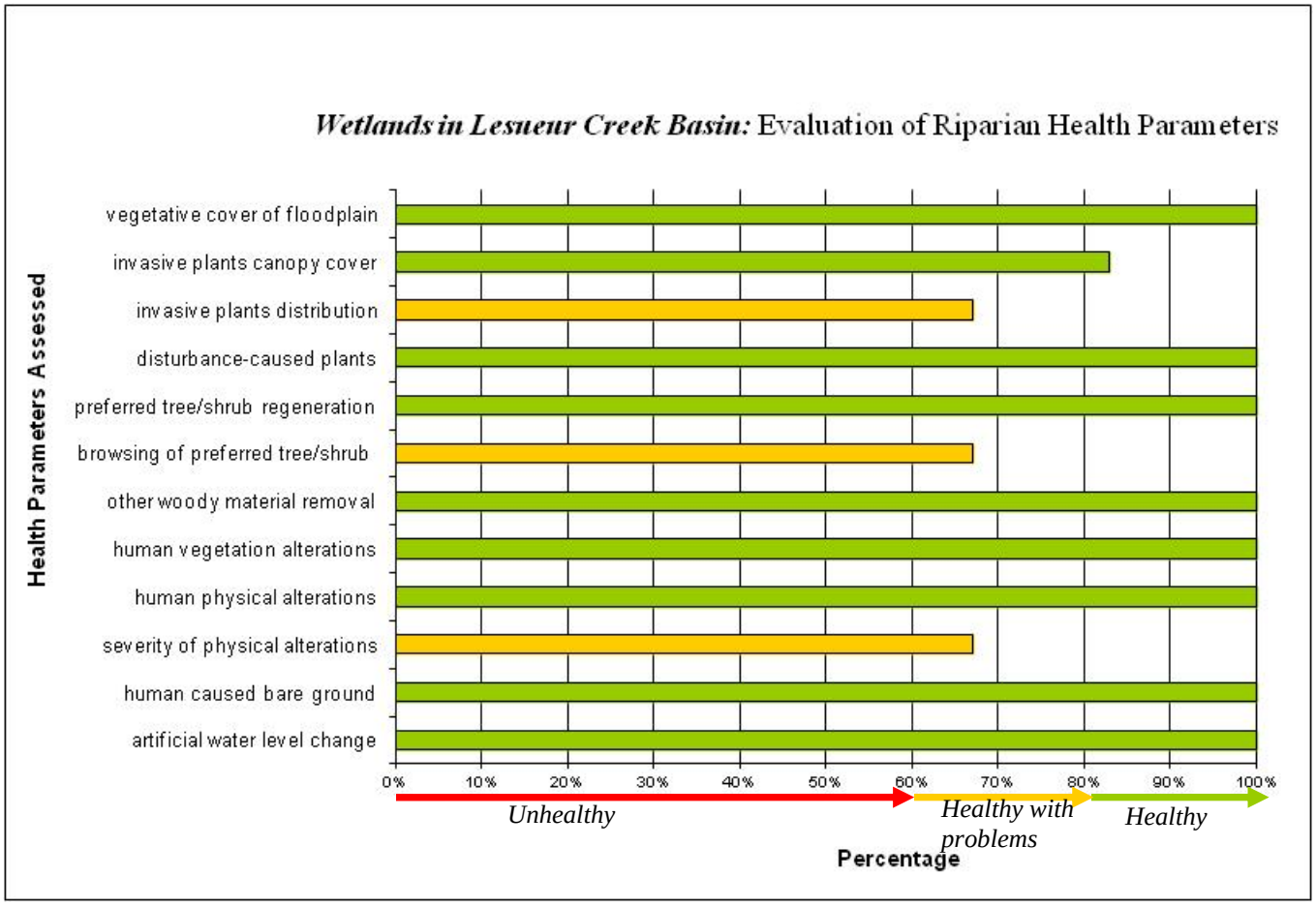


Figure 11 Riparian Health Parameter Ratings for Wetlands in the Lesueur Creek Basin

Table 10 Plant Community Types for wetlands in the Lesueur Creek Basin

*Plant Community**	*Classification**	*Area Occupied*	*Area Occupied (%)*
Flat-leaved willow / water sedge	Habitat Type	1.5 ha (3.7 ac)	58.9
White spruce / shrub	Habitat Type	1.1 ha (2.6 ac)	41.1

*Based on Thompson and Hansen 2003

C) Soil and Hydrology Health

Very few physical alterations were observed in either site; 3% on one site and less than 1% on the other. The severity of these alterations is slight as the vegetation community and hydrological function of the area altered remains near natural. There is some evidence of minor, localized livestock and wildlife trampling / trailing impacts, however, it appears that cattle do not loiter in the riparian area. A recreational trail runs along much of the length of the outer edge of the wilderness camp, but portions of this trail remain vegetated. The small canoe launch/floating dock also causes minimal disturbance. These few alterations are not significant enough to reduce riparian health.

4.9 Wetland near Ghost River

A) Overall Health and Riparian Area Discussion

A third wetland RHI was conducted in the Hamlet of Benchlands. Due to a dike that was constructed along the Ghost River, a small backchannel has been cut off from the river creating a man-made wetland ('lagoon') that is now utilised for recreational purposes. The overall health score for this site is 63%, *healthy but with problems* (Figure 12). At this site, 0.26 ha (0.63 ac) along 0.43 km (0.27 miles) of shoreline was assessed. Management priorities for this site should be to control and prevent the spread of invasive species, protect existing native plant communities at the back edge of the wetland, and maintain a buffer of sedges and rushes around the entire wetland perimeter except at designated recreational access points. Maintaining a buffer of native plants around the wetland will help to filter and absorb sediment, nutrients and pollutants, helping to maintain water quality in the wetland. *Since this is an artificially created, recreational use site, the riparian health potential for this site is inherently less than a natural, undisturbed wetland site.*

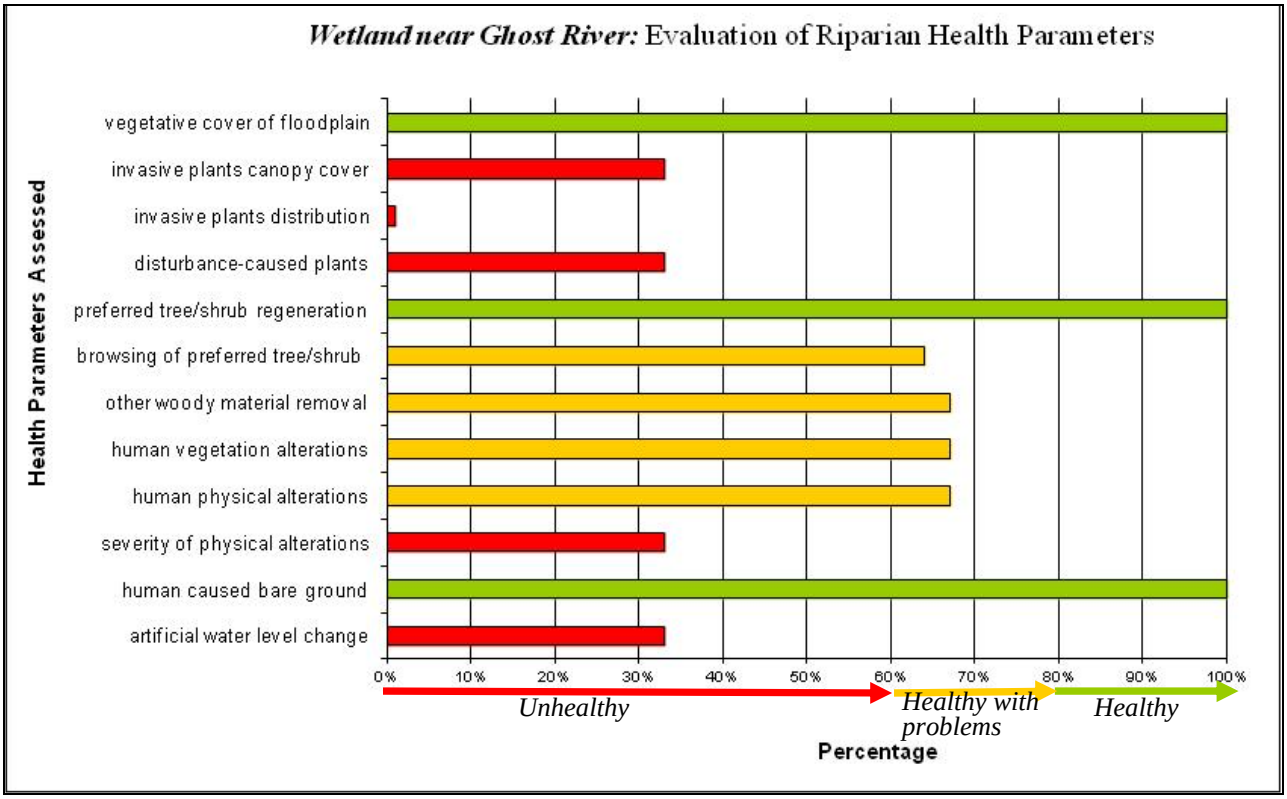


Figure 12 Riparian Health Parameter Ratings for wetland near Ghost River

B) Vegetation Health

A total of 79 plant species were identified in this site, including 2 trees, 16 shrubs, 19 grasses and 42 forbs (Appendix J). Of these, 3 are invasive and 12 are disturbance-caused, undesirable species. Invasive plant species cover more than 3% of this site, including **garden bluebell (*Campanula rapunculoides*)**, **Canada thistle** and **perennial sow-thistle**. Approximately 40% of the riparian area is covered by disturbance-caused species, such as Kentucky bluegrass and smooth brome. Invasive weeds and disturbance-caused plants mainly occur along the south and east edges of the wetland on and at the toe of the berm. Approximately 40% of the riparian area (mainly along the north and west perimeter) is covered by native trees and shrubs.

Table 11 Plant Community Types for wetland near Ghost River

*Plant Community**	*Classification**	*Area Occupied*	*Area Occupied (%)*
White spruce / shrub	Habitat Type	0.21 ha (0.5 ac)	80
Beaked sedge	Habitat Type	0.03 ha (0.06 ac)	10
Kentucky bluegrass	Community Type	0.03 ha (0.06 ac)	10
Yellow willow / red-oiser dogwood	Habitat Type	0.01 ha (0.02 ac)	3

*Based on Thompson and Hansen 2003

C) Soil and Hydrology Health

Due to construction of the berm and recreational activities, approximately 10% of the physical structure of the site has been altered. Recreation is causing soil compaction on the south side of the wetland and at the east end. Soil compaction reduces the rate at which water can be absorbed into the soil, increasing pooling and surface runoff, accelerating erosion and sedimentation, and inhibiting the development of riparian plants allowing weedy species to encroach and establish. Although these alterations affect only a small portion of the site, they are considered to be moderately severe, as they restrict infiltration of rain and surface water runoff and alter the natural plant community. Given that this is an artificially created wetland, allowing for recreational use at this site helps to alleviate pressure along the main stem of the Ghost River. Continuing to limit use to the south and east sides of this artificial wetland will help protect the more sensitive native plant communities along the remainder of the site. Additionally, allowing for a buffer of native emergent vegetation (sedges / rushes) along the water's edge will help to absorb and filter runoff from compacted areas.

Disturbed berm at the east end of the man-made wetland ('lagoon'). Weeds and disturbance-caused grasses occur along the berm. Catalogue number: RHIP01GHX009

Diverse, undisturbed native plant communities remain intact along the west and north edge of the man-made wetland. Catalogue number: RHIP01GHX010

5 THE NEXT STEPS

5.1 Community and Individual Action

- ***Take stock of current and past conditions.*** The first step in addressing riparian management issues has been made; the collection of baseline information on riparian health and a review of historical land use practices have answered the question ***"Where are we now?"***

- ***Highlight and profile what's working on the landscape right now.*** The next step is to use this knowledge, along with the application of sound range and riparian management techniques, towards the restoration of riparian health. By working with landowners and resource managers wanting to improve riparian health, practical examples of proper riparian management can be demonstrated to other landowners and communities. Landowners already managing healthy riparian areas in the area can be profiled, meaning their "good news" stories can be shared with others to speed up our knowledge of what works. As these sites yield results, the landowners of the *Ghost Watershed Alliance Society* will be closer to answering the question ***"Where do we want to go?"***

- ***Take control of the reins.*** Every participating landowner has received a report on the riparian health for their landholding indicating what pieces of riparian health are there and what might be missing. Within these landowner reports are some basic range management principles specific to their riparian areas, providing insight into the question ***"How do we get there?"***

- ***Continue riparian inventory work over the long-term.*** Monitor progress of community and individual effort to address riparian land use issues. With the application of sound range management principles on an individual and watershed basis, it is inevitable that the trend in riparian health will be positive over time. Long-term riparian monitoring and refinement in management will answer the question ***"Did we make it?"***

  - To measure riparian health trend, we typically suggest re-evaluating riparian health at 3 to 5 year intervals. Riparian health may be evaluated more frequently at 'hotspot' or 'demonstration profile' sites, where appropriate, to assess the effectiveness of management changes.

  - The field workbooks *Riparian Health Assessment for Streams & Small Rivers* and *Riparian Health Assessment for Lakes and Wetlands* are available from Cows and Fish. These workbooks explain how to conduct a riparian health assessment, or rapid survey, to quickly check the health status of your riparian area. These tools will allow landowners and managers to monitor and track their own progress regarding riparian health.

  - Restoration of heavily impacted, disturbed riparian sites will be slow, however, some improvement should be recognised within a few years, depending on the riparian site potential and the riparian management strategy implemented.

5.2 Management Objectives

To implement the management objectives listed below will require the support, leadership and cooperation of government and non-government agencies, all land users (including industry and forestry companies, public recreational users and grazing leaseholders) and landowners in the Ghost River watershed. By continuing to spearhead and coordinate research, education and awareness activities, multi-stakeholder workshops and ecological monitoring projects, the GWAS has an important role to play in helping to promote positive management changes in the watershed. Cows and Fish will continue to work closely with the GWAS, ASRD, grazing leaseholders and individual landowners to assist with education and awareness activities and providing input into watershed improvement activities (e.g. focus areas for trail improvements, restoration, and weed control).

- **Monitor recreational/human activities, restrict OHV use in riparian areas, and promote beneficial trail improvements (e.g. bridge crossings, erosion control structures etc.).** Careful use, maintenance and monitoring of designated trails is required to ensure these trails are sustainable. Enforcement and monitoring is also needed to help ensure that random camping sites are at least 30 m from the water and that they are not on the alluvial aquifers. A lack of sanitation facilities means that there is an increased risk of river water contamination on alluvial deposits associated with riverine systems. The further that trails occur into mountainous environments the more susceptible the vegetation is to damage and the longer the recovery period.

  Limiting recreational activities within riparian areas, especially those activities that cause removal and alteration of native plant communities, is important for maintaining the performance of riparian functions. Seasonal closures / trail restrictions should be considered for areas with fine textured organic soils. Areas that are dominated by willow – sedge communities are generally water saturated for the majority of the growing season. These plant communities are only slightly resistant to trampling by livestock, big game, hikers and vehicles[9]. Rutting can be severe when use occurs on wet soils. This can result in the development of wide, multi-path (braided) trails. Off road vehicle use causes serious long-term damage on these sites. Plant communities such as this occur frequently in the Lesueur Creek drainage area of the Ghost PLUZ (Table 6, page 19) and are not suitable to livestock or recreational use during wet conditions and generally the duration of the growing season. Identification and avoidance of these sites should be a priority for maintaining watershed function.

  To be sustainable designated recreational use trails in the Ghost River Watershed should avoid areas with saturated, fine textured organic soils and sensitive (rare / unique) native plant communities. Appropriate erosion control structures (e.g. cross ditches and diversion berms) should be installed where necessary to shed water off designated trails to limit erosion and runoff of sediment directly into waterways. ASRD, ACA and Fisheries and Oceans Canada are encouraged to work with the GWAS and OHV volunteer groups to help facilitate trail improvement and erosion control workshops to help promote volunteer driven projects and identify stream crossing improvement priorities. Priorities for bridge installation along existing, designated forded stream crossings include waterways with sensitive fish habitat (e.g. westslope cutthroat trout and bull trout spawning streams).

[9] Thompson, W.H. and P.L. Hansen. 2003. Classification and management of riparian and wetland sites of Alberta's Parkland Natural Region and Dry Mixedwood Natural Subregion. Bitterroot Restoration Inc. Prepared for the Alberta Riparian Habitat Management Society. Lethbridge, AB. 340 pp.

- **Avoid spring grazing in the riparian area.** Riparian areas are vulnerable to compaction in the spring, so avoid grazing when banks are saturated. Grazing regrowth too soon severely impacts the amount of forage that is produced by that plant community throughout the rest of the growing season.

- **Limit future development within the riparian area**. This management objective pertains to private property as well as to the Ghost PLUZ in general. Alteration of the riparian area can lead to an increase in bare ground and soil compaction, reducing the moisture holding capacity of the riparian area. Creating additional exposed soil surfaces also increases the potential for invasive weed infestations to spread. If a change to current development, or a new development, is planned, consider doing it in the uplands away from the sensitive riparian area. Minimising or localising existing, or future, recreational use, while allowing the majority of the riverbank to remain in its natural state, will ensure ongoing riparian function.

- **Control invasive weeds**. Contact your **Agricultural Fieldman** (Dwight Tannas, Agricultural Fieldman, M.D. of Bighorn, (403) 673-3611, dwight.tannas@mdbighorn.ca) for assistance. For more information refer to the Alberta Invasive Plant Council website: www.invasiveplants.ab.ca. While it may not be possible to ever eradicate already widespread weeds such as Canada thistle and perennial sow-thistle, it is important to eradicate other invasive species that are not yet widespread in the watershed. Ongoing weed monitoring is important as new weed threats are introduced each year to Alberta from surrounding areas. High use recreation areas or heavily grazed areas with disturbed ground are especially susceptible to weed invasion. Cows and Fish may be contacted to assist with planning weed pull events organized through the GWAS.

- **Install water monitoring gauges along the Ghost River.** To facilitate long-term monitoring of river flows, it would be beneficial to install water monitoring gauges at and below the TransAlta diversion structure along the upper reach of the Ghost River.

- **Maintain certain areas as benchmarks of riparian health in the Ghost River project area**. To understand the potential for ecological integrity of an area as well as the dynamics of natural disturbance and subsequent fluctuations in riparian plant communities, it is important to maintain areas of relative non-use. Sites with high riparian health scores, particularly those on the South Ghost River, are good candidates for benchmarking. Benchmark sites provide important measuring sticks with which to compare our impact on the landscape.

5.3 How to Contact Us

The Cows and Fish emphasis is to help individuals, 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. Riparian management tools developed with the community allow people to improve landscape health, for their benefit and for others who use and enjoy these green zones.

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

Amanda Bogen Halawell, Range/Riparian Specialist

Alberta Riparian Habitat Management Society – Cows and Fish
Tel: (403) 275-4400 Fax: 274-0007 Email: ahalawell@cowsandfish.org

APPENDIX A: GLOSSARY OF TERMS

Alluvial – deposited by running water. Recent alluvial bars are an accumulation of sediments deposited by floodwater in the current season.

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.

Climax (plant) community – Refers to the final or steady state plant community which is self-perpetuating and in dynamic equilibrium with its environment. Also known as *Potential Natural Community.*

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).

Hoof shear – pieces of bank broken off as a result of hoofed animals walking along the stream edge.

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 – these are typically weed species classified as *noxious* or *restricted* by your municipal district or county and have the potential to infest riparian areas.

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

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 or alluvial bar*.

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.

Pugging and Hummocking – the depressions (pugging) and raised mounds of soil (hummocking) resulting from large animals walking through soft or moist soil.

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

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

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

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

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

APPENDIX B: RIPARIAN HEALTH SCORE SHEET – GHOST RIVER PROJECT AREA PHASE 2

	Average		
Riparian Parameter	**Actual Score**	**Possible Score**	
Vegetation			
1. Vegetation Cover of Floodplain and Streambanks	5.3	6	
2a. Invasive Plant Species Canopy Cover	2.3	3	
2b. Invasive Plant Species Density Distribution	1.4	3	
3. Disturbance-Caused Undesirable Herbaceous Species	2.4	3	
4. Preferred Tree and Shrub Establishment and Regeneration	5.9	6	
5a. Utilization of Preferred Trees and Shrubs	2.5	3	
5b. Woody Vegetation Removal by Other than Browsing	2.7	3	
6. Decadent and Dead Woody Material	2.9	3	
Vegetation Subtotal:	***25.4***	***30***	***84.6 %***
Soil/Hydrology			
7. Streambank Root Mass Protection	5.1	6	
8. Human-Caused Bare Ground	5.4	6	
9. Streambank Structurally Altered	5.2	6	
10. Human Alteration to Site	2.4	3	
11. Stream Channel Incisement	8.8	9	
Soil/Hydrology Subtotal:	***25.6***	***30***	***89.7 %***
Project Area Total:	***89.7***	***60***	***87.1 %***

APPENDIX C: GHOST RIVER RIPARIAN PLANT INVENTORY

Life Form	Plant Status[1]	Area by Species (ha)	Percent Canopy Cover[2] (Avg)	Constancy[3]
TREES				
white spruce (Picea glauca)	native	34.01	36.0%	100.00%
balsam poplar (Populus balsamifera)	native	3.96	4.2%	100.00%
aspen (Populus tremuloides)	native	0.47	2.2%	41.67%
lodgepole pine (Pinus contorta)	native	0.07	0.5%	8.33%
Douglas-fir (Pseudotsuga menziesii)	native	0.002	0.5%	8.33%
SHRUBS				
yellow mountain avens (Dryas drummondii)	native	26.44	28.2%	91.67%
silverberry (Elaeagnus commutata)	native	10.49	12.0%	91.67%
creeping juniper (Juniperus horizontalis)	native	7.73	8.2%	91.67%
shrubby cinquefoil (Potentilla fruticosa)	native	6.32	6.7%	100.00%
common bearberry (Arctostaphylos uva-ursi)	native	6.18	6.5%	100.00%
Canada buffaloberry (Shepherdia canadensis)	native	1.37	1.6%	91.67%
ground juniper (Juniperus communis)	native	1.31	1.4%	100.00%
Drummond's willow (Salix drummondiana)	native	1.30	2.7%	50.00%
dusky willow (Salix melanopsis)	native	1.08	2.0%	75.00%
common wild rose (Rosa woodsii)	native	0.83	1.5%	91.67%
water birch (Betula occidentalis)	native	0.65	0.7%	75.00%
yellow willow (Salix lutea)	native	0.55	2.3%	50.00%
bog birch (Betula glandulosa)	native	0.40	0.9%	50.00%
smooth willow (Salix glauca)	native	0.29	0.8%	58.33%
hoary willow (Salix candida)	native	0.25	0.7%	33.33%
false mountain willow (Salix pseudomonticola)	native	0.20	0.6%	75.00%
firm leaf willow (Salix pseudomyrsinites syn. Salix myrtillifolia var. cordata)	native	0.18	0.7%	41.67%
dwarf birch (Betula pumila)	native	0.18	10.0%	8.33%
red-osier dogwood (Cornus stolonifera)	native	0.17	0.8%	16.67%
flat-leaved willow (Salix planifolia)	native	0.14	0.5%	41.67%
sandbar willow (Salix exigua)	native	0.10	2.0%	25.00%
twining honeysuckle (Lonicera dioica)	native	0.10	0.5%	33.33%
northern gooseberry (Ribes oxyacanthoides)	native	0.09	0.5%	25.00%
shining willow (Salix lucida)	native	0.08	0.5%	16.67%
snowberry (Symphoricarpos albus)	native	0.08	0.5%	16.67%
basket willow (Salix petiolaris)	native	0.07	0.5%	8.33%
beaked willow (Salix bebbiana)	native	0.06	0.6%	41.67%
willow (Salix spp.)	unknown, not unique	0.05	3.0%	8.33%
alpine bearberry (Arctostaphylos rubra)	native	0.03	0.5%	8.33%
Farr's willow (Salix farriae)	native	0.03	0.5%	8.33%
buckbrush/snowberry (Symphoricarpos occidentalis)	native	0.02	0.5%	25.00%
Saskatoon (Amelanchier alnifolia)	native	0.02	0.5%	16.67%
short-capsuled willow (Salix brachycarpa)	native	0.01	0.5%	8.33%
velvet-fruited willow (Salix maccalliana)	native	0.01	0.5%	8.33%

balsam willow (Salix pyrifolia)	native	0.01	0.5%	8.33%
twinflower (Linnaea borealis)	native	0.01	0.5%	8.33%
yellow clematis (Clematis tangutica)	**invasive, introduced**	0.01	0.5%	8.33%
wild red raspberry (Rubus idaeus)	native	0.002	0.5%	8.33%
GRASSES AND GRASS-LIKES				
northern wheat grass (Agropyron dasystachyum)	native	19.14	25.8%	41.67%
northern awnless brome (Bromus inermis ssp pumpellianus)	native	5.80	6.7%	66.67%
purple reed grass (Calamagrostis purpurascens)	native	3.79	10.0%	8.33%
wire rush (Juncus balticus)	native	2.86	5.1%	91.67%
rush-like sedge (Carex scirpoidea)	native	2.74	2.9%	83.33%
Kentucky bluegrass (Poa pratensis)	*disturbance*, introduced	1.88	3.3%	50.00%
June grass (Koeleria macrantha)	native	1.60	2.8%	33.33%
western wheat grass (Agropyron smithii)	native	1.23	2.2%	41.67%
northern reed grass (Calamagrostis inexpansa)	native	1.19	2.3%	75.00%
hairy wild rye (Elymus innovatus)	native	1.04	1.1%	91.67%
tufted hair grass (Deschampsia cespitosa)	native	0.93	1.9%	75.00%
Richardson's fescue (Festuca rubra ssp. arctica)	native	0.84	1.0%	66.67%
bristle-leaved sedge (Carex eburnea)	native	0.73	1.0%	58.33%
small bottle sedge (Carex utriculata)	native	0.72	1.5%	58.33%
smooth brome (Bromus inermis)	*disturbance*, introduced	0.71	1.7%	66.67%
red fescue (Festuca rubra)	native or introduced	0.62	1.8%	25.00%
white-grained mountain rice grass (Oryzopsis asperifolia)	native	0.44	3.0%	8.33%
dwarf bulrush (Scirpus pumilus)	native	0.39	1.9%	16.67%
water sedge (Carex aquatilis)	native	0.37	0.9%	75.00%
alpine bluegrass (Poa alpina)	native	0.37	0.9%	33.33%
golden sedge (Carex aurea)	native	0.29	0.5%	75.00%
sedge (Carex spp.)	unknown, not unique	0.28	0.5%	33.33%
sweet grass (Hierochloe odorata)	native	0.23	0.5%	58.33%
hair-like sedge (Carex capillaris)	native	0.23	0.5%	58.33%
broad-glumed wheat grass (Agropyron violaceum)	native	0.22	0.5%	16.67%
spike trisetum (Trisetum spicatum)	native	0.20	3.0%	8.33%
alpine rush (Juncus alpinoarticulatus)	native	0.14	0.5%	41.67%
inland sedge (Carex interior)	native	0.12	0.5%	25.00%
narrow reed grass (Calamagrostis stricta)	native	0.11	0.5%	16.67%
quack grass (Agropyron repens)	*disturbance*, introduced	0.11	0.5%	50.00%
knotted rush (Juncus nodosus)	native	0.08	0.5%	8.33%
mud rush (Juncus tracyi)	native	0.08	0.5%	16.67%
purple oat grass (Schizachne purpurascens)	native	0.07	0.5%	8.33%
foothills rough fescue (Festuca campestris)	native	0.06	1.3%	25.00%
timothy (Phleum pratense)	*disturbance*, introduced	0.04	0.5%	25.00%
Hood's sedge (Carex hoodii)	native	0.03	0.5%	8.33%
green sedge (Carex viridula)	native	0.03	0.5%	8.33%
creeping spike-rush (Eleocharis palustris)	native	0.03	0.5%	8.33%

thin-leaved cotton grass (Eriophorum viridi-carinatum)	native	0.03	0.5%	8.33%
plains muhly (Muhlenbergia cuspidata)	native	0.03	0.5%	8.33%
bluejoint (Calamagrostis canadensis)	native	0.03	0.5%	8.33%
fowl bluegrass (Poa palustris)	native	0.03	0.5%	25.00%
rough hair grass (Agrostis scabra)	native	0.02	0.5%	16.67%
slender wheat grass (Agropyron trachycaulum var. unilaterale)	native	0.02	0.5%	16.67%
slender wheat grass (Agropyron trachycaulum)	native	0.02	0.5%	8.33%
small-winged sedge (Carex microptera)	native	0.02	0.5%	8.33%
Canada brome (Bromus altissimus)	native	0.01	0.5%	8.33%
fowl manna grass (Glyceria striata)	native	0.01	0.5%	8.33%
bluegrass (Poa spp.)	unknown, not unique	0.01	0.5%	8.33%
long-styled rush (Juncus longistylis)	native	0.01	0.5%	16.67%
Canada bluegrass (Poa compressa)	*disturbance*, introduced	0.01	0.5%	8.33%
woolly sedge (Carex lanuginosa)	native	0.01	0.5%	8.33%
orchard grass (Dactylis glomerata)	introduced	0.01	0.5%	8.33%
needle-and-thread (Stipa comata)	native	0.01	0.5%	8.33%
crested wheat grass (Agropyron pectiniforme)	*disturbance*, introduced	0.004	0.5%	16.67%
redtop (Agrostis stolonifera)	introduced	0.002	0.5%	8.33%
rush (Juncus spp.)	unknown, not unique	0.002	0.5%	8.33%
small-fruited bulrush (Scirpus microcarpus)	native	0.002	0.5%	8.33%
green needle grass (Stipa viridula)	native	0.002	0.5%	8.33%
Russian wild rye (Elymus junceus)	introduced	0.002	0.5%	8.33%
fescue (Festuca spp.)	unknown, not unique	0.002	0.5%	8.33%
FORBS				
viscid locoweed (Oxytropis viscida)	native	7.58	20.0%	8.33%
northern hedysarum (Hedysarum boreale)	native	2.43	2.7%	75.00%
broad-leaved fireweed (Epilobium latifolium)	native	2.08	2.3%	83.33%
common horsetail (Equisetum arvense)	native, *poisonous*	1.91	2.0%	100.00%
yellow hedysarum (Hedysarum sulphurescens)	native	1.51	1.9%	50.00%
late yellow locoweed (Oxytropis monticola)	native, *poisonous*	1.45	1.6%	91.67%
yellow false dandelion (Agoseris glauca)	native	1.39	1.6%	75.00%
harebell (Campanula rotundifolia)	native	1.39	1.6%	66.67%
gaillardia (Gaillardia aristata)	native	1.35	1.7%	50.00%
bastard toadflax (Comandra umbellata)	native	1.24	2.1%	41.67%
smooth fleabane (Erigeron glabellus)	native	1.17	2.6%	16.67%
Indian milk vetch (Astragalus aboriginum)	native	1.14	3.0%	8.33%
Canada goldenrod (Solidago canadensis)	native	1.04	3.1%	66.67%
showy everlasting (Antennaria pulcherrima)	*disturbance*, native	0.95	2.0%	58.33%
variegated horsetail (Equisetum variegatum)	native	0.76	2.1%	58.33%
smooth aster (Aster laevis)	native	0.74	0.8%	100.00%
sticky false asphodel (Tofieldia glutinosa)	native	0.71	1.3%	91.67%
wild strawberry (Fragaria virginiana)	*disturbance*, native	0.69	1.2%	91.67%
common dandelion (Taraxacum officinale)	*disturbance*, introduced	0.50	0.5%	91.67%
mountain goldenrod (Solidago spathulata)	native	0.44	0.5%	75.00%
star-flowered Solomon's-seal (Smilacina stellata)	native	0.43	0.5%	83.33%
Arctic aster (Aster sibiricus)	native	0.42	0.8%	25.00%

northern bedstraw (Galium boreale)	native	0.42	0.5%	83.33%
common yarrow (Achillea millefolium)	native	0.40	0.5%	83.33%
wild blue flax (Linum lewisii)	native	0.40	0.5%	58.33%
common blue-eyed grass (Sisyrinchium montanum)	native	0.40	0.5%	50.00%
few-flowered milk vetch (Astragalus vexilliflexus)	native	0.39	0.5%	41.67%
cut-leaved anemone (Anemone multifida)	native	0.38	0.5%	83.33%
youngia (Crepis elegans)	native	0.38	0.5%	33.33%
white camas (Zigadenus elegans)	native, *poisonous*	0.36	0.5%	58.33%
sweet-flowered androsace (Androsace chamaejasme)	native	0.28	0.5%	33.33%
common pink wintergreen (Pyrola asarifolia)	native	0.28	0.5%	75.00%
plains wormwood (Artemisia campestris)	native	0.27	0.5%	33.33%
northern green bog orchid (Habenaria hyperborea)	native	0.26	0.5%	75.00%
small wood anemone (Anemone parviflora)	native	0.26	0.5%	66.67%
small-leaved everlasting (Antennaria parvifolia)	*disturbance*, native	0.26	0.7%	66.67%
Canada thistle (Cirsium arvense)	**invasive**, introduced	0.23	0.5%	66.67%
early yellow locoweed (Oxytropis sericea)	native, *poisonous*	0.22	0.5%	16.67%
whitlow-grass (Draba cana)	native	0.22	0.5%	16.67%
round-leaved orchid (Orchis rotundifolia)	native	0.22	0.5%	50.00%
common red paintbrush (Castilleja miniata)	native	0.22	0.5%	50.00%
balsam groundsel (Senecio pauperculus)	native	0.22	0.5%	50.00%
nodding onion (Allium cernuum)	native	0.19	0.5%	8.33%
tufted white prairie aster (Aster ericoides)	native	0.19	0.5%	8.33%
paintbrush (Castilleja spp.)	unknown, not unique	0.19	0.5%	8.33%
forb (Forb)	unknown, not unique	0.19	0.5%	8.33%
red-seeded sandwort (Minuartia rubella)	native	0.19	0.5%	8.33%
prairie groundsel (Senecio canus)	native	0.19	0.5%	8.33%
yellow lady's-slipper (Cypripedium calceolus)	native	0.18	0.5%	33.33%
saline shooting star (Dodecatheon pulchellum)	native	0.17	0.5%	25.00%
low goldenrod (Solidago missouriensis)	native	0.15	0.5%	50.00%
narrow-leaved hawkweed (Hieracium umbellatum)	native	0.13	0.5%	33.33%
lance-leaved stonecrop (Sedum lanceolatum)	native	0.13	0.5%	25.00%
alpine bistort (Polygonum viviparum)	native	0.13	0.5%	33.33%
sparrow's-egg lady's-slipper (Cypripedium passerinum)	native	0.13	0.5%	25.00%
tall lungwort (Mertensia paniculata)	native	0.12	0.5%	33.33%
rough cinquefoil (Potentilla norvegica)	*disturbance*, native	0.12	0.5%	16.67%
showy locoweed (Oxytropis splendens)	native, *poisonous*	0.11	0.5%	33.33%
perennial sow-thistle (Sonchus arvensis)	**invasive**, introduced	0.10	0.5%	41.67%
biennial sagewort (Artemisia biennis)	native	0.10	0.5%	16.67%
cream-colored vetchling (Lathyrus ochroleucus)	native	0.10	0.5%	33.33%
blue columbine (Aquilegia brevistyla)	native	0.10	0.5%	16.67%
purple-stemmed aster (Aster puniceus)	native	0.09	0.5%	25.00%
common scouring-rush (Equisetum hyemale)	native	0.09	0.5%	25.00%
common fireweed (Epilobium angustifolium)	native	0.09	0.5%	25.00%
bluebur (Lappula squarrosa)	*disturbance*, introduced	0.09	0.5%	16.67%
milk vetch (Astragalus eucosmus)	native	0.08	0.5%	8.33%
common plantain (Plantago major)	*disturbance*, introduced	0.08	0.5%	8.33%

common butterwort (Pinguicula vulgaris)	native	0.08	0.5%	33.33%
western wood lily (Lilium philadelphicum)	native	0.08	0.5%	16.67%
long-fruited anemone (Anemone cylindrica)	native	0.07	0.5%	8.33%
common mouse-ear chickweed (Cerastium vulgatum)	*disturbance*, introduced	0.07	0.5%	8.33%
scapose hawk's-beard (Crepis runcinata)	native	0.07	0.5%	8.33%
tufted fleabane (Erigeron caespitosus)	native	0.07	0.5%	8.33%
vine-leaved coltsfoot (Petasites vitifolius)	native	0.07	0.5%	8.33%
white sweet-clover (Melilotus alba)	*disturbance*, introduced	0.07	1.5%	25.00%
heart-leaved Alexanders (Zizia aptera)	native	0.05	0.5%	41.67%
elephant's-head (Pedicularis groenlandica)	native	0.05	0.5%	25.00%
spatulate bladderpod (Lesquerella alpina)	native	0.04	0.5%	16.67%
alpine hedysarum (Hedysarum alpinum)	native	0.04	0.5%	50.00%
wild vetch (Vicia americana)	native	0.04	0.5%	41.67%
mountain shooting star (Dodecatheon conjugens)	native	0.03	0.5%	8.33%
wild licorice (Glycyrrhiza lepidota)	native	0.03	0.5%	8.33%
sand bladderpod (Lesquerella arenosa)	native	0.03	0.5%	8.33%
shining arnica (Arnica fulgens)	native	0.03	0.5%	8.33%
broad-leaved arnica (Arnica latifolia)	native	0.03	0.5%	8.33%
alpine red paintbrush (Castilleja rhexifolia)	native	0.03	0.5%	8.33%
pale coralroot (Corallorhiza trifida)	native	0.03	0.5%	8.33%
grass-of-parnassus (Parnassia spp.)	native	0.03	0.5%	8.33%
greenish-flowered wintergreen (Pyrola chlorantha)	native	0.03	0.5%	8.33%
yellow rattle (Rhinanthus minor)	native	0.03	0.5%	8.33%
few-flowered ragwort (Senecio pauciflorus)	native	0.03	0.5%	8.33%
dwarf false asphodel (Tofieldia pusilla)	native	0.03	0.5%	8.33%
northern willowherb (Epilobium ciliatum)	native	0.03	0.9%	16.67%
northern grass-of-parnassus (Parnassia palustris)	native	0.02	0.5%	25.00%
ox-eye daisy (Chrysanthemum leucanthemum syn. Leucanthemum vulgare)	**invasive**, introduced	0.02	0.5%	33.33%
alsike clover (Trifolium hybridum)	*disturbance*, introduced	0.02	0.5%	25.00%
veiny meadow rue (Thalictrum venulosum)	native	0.02	0.5%	16.67%
white clover (Trifolium repens)	*disturbance*, introduced	0.02	0.5%	8.33%
arrow-leaved coltsfoot (Petasites sagittatus)	native	0.01	0.5%	8.33%
stiff yellow paintbrush (Castilleja lutescens)	native	0.01	0.5%	8.33%
palmate-leaved coltsfoot (Petasites palmatus)	native	0.01	0.5%	8.33%
yellow sweet-clover (Melilotus officinalis)	*disturbance*, introduced	0.01	0.5%	16.67%
golden bean (Thermopsis rhombifolia)	native	0.01	0.5%	16.67%
common goat's-beard (Tragopogon dubius)	introduced	0.01	0.5%	16.67%
white thistle (Cirsium hookerianum)	native	0.01	0.5%	8.33%
smooth scouring-rush (Equisetum laevigatum)	native	0.01	0.5%	8.33%
cordilleran arnica (Arnica mollis)	native	0.01	0.5%	8.33%
caraway (Carum carvi)	introduced	0.01	0.5%	8.33%
lance-leaved paintbrush (Castilleja occidentalis)	native	0.01	0.5%	8.33%
red clover (Trifolium pratense)	*disturbance*, introduced	0.01	0.5%	8.33%
mustard (Brassica spp.)	introduced	0.002	0.5%	8.33%
fringed gentian (Gentianella crinita)	native	0.002	0.5%	8.33%

butter-and-eggs/yellow toadflax (Linaria vulgaris)	**invasive**, introduced	0.002	0.5%	8.33%
puccoon; woolly gromwell (Lithospermum ruderale)	native	0.002	0.5%	8.33%
slender arrow-grass (Triglochin palustris)	native, *poisonous*	0.002	0.5%	8.33%
spiked speedwell (Veronica longifolia)	introduced	0.002	0.5%	8.33%
pasture sagewort (Artemisia frigida)	native	0.002	0.5%	8.33%
prairie sagewort (Artemisia ludoviciana)	native	0.002	0.5%	8.33%
aster (Aster spp.)	unknown, not unique	0.002	0.5%	8.33%
cinquefoil (Potentilla spp.)	unknown, not unique	0.002	0.5%	8.33%
stinkweed (Thlaspi arvense)	*disturbance*, introduced	0.002	0.5%	8.33%

APPENDIX D: SOUTH GHOST RIVER RIPARIAN PLANT INVENTORY

Life Form	Plant Status[1]	Area by Species (ha)	Percent Canopy Cover[2]	Constancy[3]
TREES				
white spruce (Picea glauca)	native	6.54	100.00%	50.0%
balsam poplar (Populus balsamifera)	native	1.69	100.005	12.9%
lodgepole pine (Pinus contorta)	native	0.02	50.00%	0.1%
aspen (Populus tremuloides)	native	0.02	**50.00%**	0.1%
SHRUBS				
yellow mountain avens (Dryas drummondii)	native	2.62	100.00%	20.0%
common bearberry (Arctostaphylos uva-ursi)	native	1.04	100.00%	8.0%
shrubby cinquefoil (Potentilla fruticosa)	native	0.95	100.00%	7.2%
silverberry (Elaeagnus commutata)	native	0.76	50.00%	5.8%
ground juniper (Juniperus communis)	native	0.39	100.00%	3.0%
Drummond's willow (Salix drummondiana)	native	0.38	50.00%	2.9%
Canada buffaloberry (Shepherdia canadensis)	native	0.30	100.00%	2.3%
common wild rose (Rosa woodsii)	native	0.11	50.00%	0.9%
dusky willow (Salix melanopsis)	native	0.11	50.00%	0.9%
smooth willow (Salix glauca)	native	0.07	100.00%	0.5%
Saskatoon (Amelanchier alnifolia)	native	0.02	50.00%	0.1%
water birch (Betula occidentalis)	native	0.02	50.00%	0.1%
red-osier dogwood (Cornus stolonifera)	native	0.02	50.00%	0.1%
creeping juniper (Juniperus horizontalis)	native	0.02	50.00%	0.1%
twinflower (Linnaea borealis)	native	0.02	50.00%	0.1%
twining honeysuckle (Lonicera dioica)	native	0.02	50.00%	0.1%
dewberry (Rubus pubescens)	native	0.02	50.00%	0.1%
Farr's willow (Salix farriae)	native	0.02	50.00%	0.1%
shining willow (Salix lucida)	native	0.02	50.00%	0.1%
false mountain willow (Salix pseudomonticola)	native	0.02	50.00%	0.1%
low-bush cranberry (Viburnum edule)	native	0.02	50.00%	0.1%
GRASSES AND GRASS-LIKES				
hairy wild rye (Elymus innovatus)	native	1.31		10.0%
northern awnless brome (Bromus inermis ssp pumpellianus)	native	0.43	100.00%	3.3%
bristle-leaved sedge (Carex eburnea)	native	0.30	100.00%	2.3%
rush-like sedge (Carex scirpoidea)	native	0.30	100.00%	2.3%
northern reed grass (Calamagrostis inexpansa)	native	0.07	100.00%	0.5%
Richardson's fescue (Festuca rubra ssp. arctica)	native	0.07	100.00%	0.5%
smooth brome (Bromus inermis)	*disturbance*, introduced	0.05	50.00%	0.4%
graceful sedge (Carex praegracilis)	native	0.05	50.00%	0.4%
June grass (Koeleria macrantha)	native	0.05	50.00%	0.4%

northern wheat grass (Agropyron dasystachyum)	native	0.02	50.00%	0.1%
broad-glumed wheat grass (Agropyron violaceum)	native	0.02	50.00%	0.1%
hair-like sedge (Carex capillaris)	native	0.02	50.00%	0.1%
tufted hair grass (Deschampsia cespitosa)	native	0.02	50.00%	0.1%
sweet grass (Hierochloe odorata)	native	0.02	50.00%	0.1%
white-grained mountain rice grass (Oryzopsis asperifolia)	native	0.02	50.00%	0.1%
alpine bluegrass (Poa alpina)	native	0.02	50.00%	0.1%
FORBS				
yellow hedysarum (Hedysarum sulphurescens)	native	1.04		8.0%
late yellow locoweed (Oxytropis monticola)	native, *poisonous*	0.93	100.00%	7.1%
white camas (Zigadenus elegans)	native, *poisonous*	0.30	50.00%	2.3%
wild strawberry (Fragaria virginiana)	*disturbance*, native	0.16	100.00%	1.2%
northern hedysarum (Hedysarum boreale)	native	0.16	100.00%	1.2%
common horsetail (Equisetum arvense)	native, *poisonous*	0.11	100.00%	0.9%
yellow false dandelion (Agoseris glauca)	native	0.07	50.00%	0.5%
cut-leaved anemone (Anemone multifida)	native	0.07	100.00%	0.5%
plains wormwood (Artemisia campestris)	native	0.07	100.00%	0.5%
smooth aster (Aster laevis)	native	0.07	100.00%	0.5%
common red paintbrush (Castilleja miniata)	native	0.07	100.00%	0.5%
broad-leaved fireweed (Epilobium latifolium)	native	0.07	100.00%	0.5%
northern green bog orchid (Habenaria hyperborea)	native	0.07	100.00%	0.5%
sweet-flowered androsace (Androsace chamaejasme)	native	0.05	100.00%	0.4%
yellow columbine (Aquilegia flavescens)	native	0.05	50.00%	0.4%
hairy rock cress (Arabis hirsuta)	native	0.05	50.00%	0.4%
shining arnica (Arnica fulgens)	native	0.05	50.00%	0.4%
alpine aster (Aster alpinus)	native	0.05	50.00%	0.4%
bastard toadflax (Comandra umbellata)	native	0.05	50.00%	0.4%
forb (Forb)	unknown, not unique	0.05	50.00%	0.4%
common yarrow (Achillea millefolium)	native	0.02	50.00%	0.1%
small wood anemone (Anemone parviflora)	native	0.02	50.00%	0.1%
showy everlasting (Antennaria pulcherrima)	*disturbance*, native	0.02	50.00%	0.1%
blue columbine (Aquilegia brevistyla)	native	0.02	50.00%	0.1%
showy aster (Aster conspicuus)	native	0.02	50.00%	0.1%
Arctic aster (Aster sibiricus)	native	0.02	50.00%	0.1%
few-flowered milk vetch (Astragalus vexilliflexus)	native	0.02	50.00%	0.1%
youngia (Crepis elegans)	native	0.02	50.00%	0.1%
common fireweed (Epilobium angustifolium)	native	0.02	50.00%	0.1%
common scouring-rush (Equisetum hyemale)	native	0.02	50.00%	0.1%
variegated horsetail (Equisetum variegatum)	native	0.02	50.00%	0.1%
gaillardia (Gaillardia aristata)	native	0.02	50.00%	0.1%
northern bedstraw (Galium boreale)	native	0.02	50.00%	0.1%
spatulate bladderpod (Lesquerella alpina)	native	0.02	50.00%	0.1%
bishop's-cap (Mitella nuda)	native	0.02	50.00%	0.1%
viscid locoweed (Oxytropis viscida)	native	0.02	50.00%	0.1%
palmate-leaved coltsfoot (Petasites palmatus)	native	0.02	50.00%	0.1%
alpine bistort (Polygonum viviparum)	native	0.02	50.00%	0.1%
common pink wintergreen (Pyrola asarifolia)	native	0.02	50.00%	0.1%

greenish-flowered wintergreen (Pyrola chlorantha)	native	0.02	50.00%	0.1%
few-flowered ragwort (Senecio pauciflorus)	native	0.02	50.00%	0.1%
star-flowered Solomon's-seal (Smilacina stellata)	native	0.02	50.00%	0.1%
mountain goldenrod (Solidago spathulata)	native	0.02	50.00%	0.1%
common dandelion (Taraxacum officinale)	*disturbance*, introduced	0.02	50.00%	0.1%
sticky false asphodel (Tofieldia glutinosa)	native	0.02	50.00%	0.1%

APPENDIX E: LESUEUR CREEK RIPARIAN PLANT INVENTORY

Life Form	Plant Status[1]	Area by Species (ha)	Percent Canopy Cover[2] (Avg)	Constancy[3]
TREES				
white spruce (Picea glauca)	native	1.60	4.4%	100.0%
balsam poplar (Populus balsamifera)	native	1.00	4.3%	83.3%
lodgepole pine (Pinus contorta)	native	0.16	0.7%	66.7%
aspen (Populus tremuloides)	native	0.05	0.5%	66.7%
SHRUBS				
firm leaf willow (Salix pseudomyrsinites syn. Salix myrtillifolia var. cordata)	native	4.69	12.9%	100.0%
smooth willow (Salix glauca)	native	4.35	11.9%	100.0%
bog birch (Betula glandulosa)	native	3.35	9.3%	83.3%
beaked willow (Salix bebbiana)	native	2.76	13.1%	66.7%
flat-leaved willow (Salix planifolia)	native	2.18	6.0%	83.3%
shrubby cinquefoil (Potentilla fruticosa)	native	0.53	1.4%	100.0%
dwarf raspberry (Rubus arcticus)	native	0.52	1.5%	83.3%
Drummond's willow (Salix drummondiana)	native	0.51	2.9%	50.0%
false mountain willow (Salix pseudomonticola)	native	0.48	2.5%	66.7%
dwarf birch (Betula pumila)	native	0.41	2.5%	33.3%
velvet-fruited willow (Salix maccalliana)	native	0.39	3.0%	16.7%
silverberry (Elaeagnus commutata)	native	0.39	4.1%	66.7%
Canada buffaloberry (Shepherdia canadensis)	native	0.24	2.5%	66.7%
common bearberry (Arctostaphylos uva-ursi)	native	0.23	2.4%	66.7%
pussy willow (Salix discolor)	native	0.20	3.3%	50.0%
red-osier dogwood (Cornus stolonifera)	native	0.14	30.0%	16.7%
hoary willow (Salix candida)	native	0.13	0.5%	33.3%
common wild rose (Rosa woodsii)	native	0.12	0.6%	66.7%
water birch (Betula occidentalis)	native	0.09	20.0%	16.7%
twinflower (Linnaea borealis)	native	0.09	20.0%	16.7%
Farr's willow (Salix farriae)	native	0.07	0.5%	16.7%
northern gooseberry (Ribes oxyacanthoides)	native	0.05	0.5%	50.0%
shining willow (Salix lucida)	native	0.04	0.5%	33.3%
basket willow (Salix petiolaris)	native	0.04	0.5%	33.3%
ground juniper (Juniperus communis)	native	0.03	0.8%	33.3%
wild red raspberry (Rubus idaeus)	native	0.03	0.5%	33.3%
creeping juniper (Juniperus horizontalis)	native	0.02	0.5%	33.3%
prickly rose (Rosa acicularis)	native	0.01	0.5%	16.7%
balsam willow (Salix pyrifolia)	native	0.01	0.5%	16.7%
twining honeysuckle (Lonicera dioica)	native	0.002	0.5%	16.7%
dewberry (Rubus pubescens)	native	0.002	0.5%	16.7%
white meadowsweet (Spiraea betulifolia)	native	0.002	0.5%	16.7%
snowberry (Symphoricarpos albus)	native	0.002	0.5%	16.7%
bilberry (Vaccinium spp.)	native	0.002	0.5%	16.7%
low-bush cranberry (Viburnum edule)	native	0.002	0.5%	16.7%

GRASSES AND GRASS-LIKES				
water sedge (Carex aquatilis)	native	18.02	49.4%	100.0%
tufted hair grass (Deschampsia cespitosa)	native	3.82	10.5%	100.0%
small bottle sedge (Carex utriculata)	native	3.00	8.3%	83.3%
wire rush (Juncus balticus)	native	2.87	8.0%	83.3%
hay sedge (Carex siccata)	native	1.32	10.0%	16.7%
Kentucky bluegrass (Poa pratensis)	*disturbance*, introduced	0.98	4.3%	83.3%
red fescue (Festuca rubra)	native or introduced	0.43	7.8%	33.3%
sedge (Carex simulata)	native	0.41	3.0%	16.7%
hair-like sedge (Carex capillaris)	native	0.18	0.5%	100.0%
Richardson's fescue (Festuca rubra ssp. arctica)	native	0.15	0.5%	66.7%
sweet grass (Hierochloe odorata)	native	0.13	1.6%	50.0%
hairy wild rye (Elymus innovatus)	native	0.11	0.5%	83.3%
northern reed grass (Calamagrostis inexpansa)	native	0.10	0.5%	50.0%
Raymond's sedge (Carex raymondii)	native	0.09	0.5%	50.0%
sedge (Carex spp.)	native	0.09	0.5%	50.0%
graceful sedge (Carex praegracilis)	native	0.09	0.5%	50.0%
narrow reed grass (Calamagrostis stricta)	native	0.08	0.5%	33.3%
inland sedge (Carex interior)	native	0.07	0.5%	33.3%
mud sedge (Carex limosa)	native	0.07	0.5%	16.7%
livid sedge (Carex livida)	native	0.07	0.5%	16.7%
tufted bulrush (Scirpus cespitosus)	native	0.07	0.5%	16.7%
bluejoint (Calamagrostis canadensis)	native	0.07	0.5%	16.7%
fowl bluegrass (Poa palustris)	native	0.05	2.5%	16.7%
rush-like sedge (Carex scirpoidea)	native	0.05	0.6%	33.3%
alpine bluegrass (Poa alpina)	native	0.05	0.5%	50.0%
northern awnless brome (Bromus inermis ssp pumpellianus)	native	0.03	0.5%	50.0%
white-grained mountain rice grass (Oryzopsis asperifolia)	native	0.01	3.0%	33.3%
smooth brome (Bromus inermis)	*disturbance*, introduced	0.01	0.5%	16.7%
golden sedge (Carex aurea)	native	0.01	0.5%	33.3%
slender wheat grass (Agropyron trachycaulum)	native	0.01	0.5%	33.3%
sheathed sedge (Carex vaginata)	native	0.01	0.5%	16.7%
bristle-leaved sedge (Carex eburnea)	native	0.00	0.5%	16.7%
fowl manna grass (Glyceria striata)	native	0.00	0.5%	16.7%
timothy (Phleum pratense)	*disturbance*, introduced	0.00	0.5%	16.7%
bluegrass (Poa spp.)	unknown, not unique	0.00	0.5%	16.7%
purple oat grass (Schizachne purpurascens)	native	0.00	0.5%	16.7%
FORBS				
common yarrow (Achillea millefolium)	native	0.18	0.5%	83.3%
yellow false dandelion (Agoseris glauca)	native	0.07	0.5%	16.7%
nodding onion (Allium cernuum)	native	0.00	0.5%	16.7%
wild chives (Allium schoenoprasum)	native	0.11	0.5%	66.7%
sweet-flowered androsace (Androsace chamaejasme)	native	0.04	0.5%	50.0%
cut-leaved anemone (Anemone multifida)	native	0.00	0.5%	16.7%
small wood anemone (Anemone parviflora)	native	0.03	0.5%	50.0%
small-leaved everlasting (Antennaria parvifolia)	*disturbance*, native	0.04	0.5%	33.3%

showy everlasting (Antennaria pulcherrima)	*disturbance*, native	0.05	0.5%	66.7%
blue columbine (Aquilegia brevistyla)	native	0.00	0.5%	16.7%
hairy rock cress (Arabis hirsuta)	native	0.01	0.5%	16.7%
heart-leaved arnica (Arnica cordifolia)	native	0.02	1.0%	33.3%
smooth aster (Aster laevis)	native	0.29	0.8%	100.0%
purple-stemmed aster (Aster puniceus)	native	0.02	0.5%	16.7%
Arctic aster (Aster sibiricus)	native	0.00	0.5%	16.7%
few-flowered milk vetch (Astragalus vexilliflexus)	native	0.04	0.5%	33.3%
harebell (Campanula rotundifolia)	native	0.00	0.5%	16.7%
common red paintbrush (Castilleja miniata)	native	0.09	0.5%	66.7%
common mouse-ear chickweed (Cerastium vulgatum)	*disturbance*, introduced	0.01	0.5%	16.7%
Canada thistle (Cirsium arvense)	**invasive**, introduced	0.05	0.5%	50.0%
pale coralroot (Corallorhiza trifida)	native	0.00	0.5%	16.7%
yellow lady's-slipper (Cypripedium calceolus)	native	0.02	0.5%	16.7%
sparrow's-egg lady's-slipper (Cypripedium passerinum)	native	0.02	0.5%	33.3%
tall larkspur (Delphinium glaucum)	native, *poisonous*	0.07	0.5%	16.7%
flixweed; tansy mustard (Descurainia sophia)	*disturbance*, introduced	0.00	0.5%	16.7%
saline shooting star (Dodecatheon pulchellum)	native	0.18	0.5%	100.0%
common fireweed (Epilobium angustifolium)	native	0.26	1.1%	83.3%
northern willowherb (Epilobium ciliatum)	native	0.01	0.5%	16.7%
broad-leaved fireweed (Epilobium latifolium)	native	0.01	0.5%	33.3%
common horsetail (Equisetum arvense)	native, *poisonous*	0.41	1.1%	100.0%
common scouring-rush (Equisetum hyemale)	native	0.07	0.5%	16.7%
variegated horsetail (Equisetum variegatum)	native	0.02	0.5%	16.7%
wormseed mustard (Erysimum cheiranthoides)	*disturbance*, introduced	0.02	0.5%	16.7%
wild strawberry (Fragaria virginiana)	*disturbance*, native	0.46	2.0%	83.3%
northern bedstraw (Galium boreale)	native	0.13	0.6%	83.3%
northern bastard toadflax (Geocaulon lividum)	native	0.00	0.5%	16.7%
yellow avens (Geum aleppicum)	native	0.16	0.5%	66.7%
purple avens (Geum rivale)	native	0.10	0.5%	50.0%
northern green bog orchid (Habenaria hyperborea)	native	0.18	0.5%	100.0%
round-leaved bog orchid (Habenaria orbiculata)	native	0.02	0.5%	16.7%
alpine hedysarum (Hedysarum alpinum)	native	0.16	0.7%	83.3%
northern hedysarum (Hedysarum boreale)	native	0.01	0.5%	16.7%
yellow hedysarum (Hedysarum sulphurescens)	native	0.02	0.5%	16.7%
narrow-leaved hawkweed (Hieracium umbellatum)	native	0.00	0.5%	16.7%
cream-colored vetchling (Lathyrus ochroleucus)	native	0.03	0.5%	50.0%
western wood lily (Lilium philadelphicum)	native	0.02	0.5%	33.3%
buck-bean (Menyanthes trifoliata)	native	2.74	20.0%	16.7%
tall lungwort (Mertensia paniculata)	native	0.11	0.5%	66.7%
round-leaved orchid (Orchis rotundifolia)	native	0.07	0.5%	33.3%
one-sided wintergreen (Orthilia secunda)	native	0.00	0.5%	16.7%
reflexed locoweed (Oxytropis deflexa)	native, *poisonous*	0.00	0.5%	16.7%
late yellow locoweed (Oxytropis monticola)	native, *poisonous*	0.03	0.5%	50.0%
showy locoweed (Oxytropis splendens)	native, *poisonous*	0.02	0.5%	16.7%
northern grass-of-parnassus (Parnassia palustris)	native	0.04	0.5%	33.3%
elephant's-head (Pedicularis groenlandica)	native	0.18	0.5%	100.0%
arrow-leaved coltsfoot (Petasites sagittatus)	native	0.47	1.6%	50.0%
vine-leaved coltsfoot (Petasites vitifolius)	native	0.16	0.7%	66.7%

common butterwort (Pinguicula vulgaris)	native	0.02	0.5%	33.3%
common plantain (Plantago major)	*disturbance*, introduced	0.03	0.5%	33.3%
alpine bistort (Polygonum viviparum)	native	0.28	0.8%	100.0%
graceful cinquefoil (Potentilla gracilis)	native	0.02	0.5%	16.7%
rough cinquefoil (Potentilla norvegica)	*disturbance*, native	0.04	0.5%	33.3%
mealy primrose (Primula incana)	native	0.07	0.5%	16.7%
common pink wintergreen (Pyrola asarifolia)	native	0.03	0.5%	50.0%
greenish-flowered wintergreen (Pyrola chlorantha)	native	0.00	0.5%	16.7%
tall buttercup (Ranunculus acris)	**invasive**, introduced	0.01	0.5%	16.7%
seaside buttercup (Ranunculus cymbalaria)	native	0.03	0.5%	33.3%
western dock (Rumex occidentalis)	native	0.08	0.5%	33.3%
entire-leaved groundsel (Senecio integerrimus)	native	0.07	0.5%	16.7%
black-tipped groundsel (Senecio lugens)	native	0.10	0.5%	50.0%
balsam groundsel (Senecio pauperculus)	native	0.11	0.5%	66.7%
few-flowered ragwort (Senecio pauciflorus)	native	0.00	0.5%	16.7%
common blue-eyed grass (Sisyrinchium montanum)	native	0.04	0.5%	33.3%
water parsnip (Sium suave)	native	0.08	0.5%	33.3%
star-flowered Solomon's-seal (Smilacina stellata)	native	0.18	0.5%	100.0%
marsh hedge-nettle (Stachys palustris)	native	0.01	0.5%	16.7%
long-stalked chickweed (Stellaria longipes)	native	0.08	0.5%	33.3%
long-leaved chickweed (Stellaria longifolia)	native	0.07	0.5%	16.7%
bronzebells (Stenanthium occidentale)	native	0.00	0.5%	16.7%
common dandelion (Taraxacum officinale)	*disturbance*, introduced	0.30	1.3%	83.3%
veiny meadow rue (Thalictrum venulosum)	native	0.11	0.5%	66.7%
sticky false asphodel (Tofieldia glutinosa)	native	0.07	0.5%	16.7%
dwarf false asphodel (Tofieldia pusilla)	native	0.02	0.5%	33.3%
alsike clover (Trifolium hybridum)	*disturbance*, introduced	0.03	0.5%	33.3%
white clover (Trifolium repens)	*disturbance*, introduced	0.03	0.5%	50.0%
seaside arrow-grass (Triglochin maritima)	native, *poisonous*	0.46	1.7%	33.3%
flat-leaved bladderwort (Utricularia intermedia)	native	0.07	0.5%	16.7%
wild vetch (Vicia americana)	native	0.18	0.5%	100.0%
early blue violet (Viola adunca)	native	0.07	0.5%	16.7%
violet (Viola spp.)	native	0.00	0.5%	16.7%
western Canada violet (Viola canadensis)	native	0.02	0.5%	16.7%
white camas (Zigadenus elegans)	native, *poisonous*	0.12	0.5%	83.3%
heart-leaved Alexanders (Zizia aptera)	native	0.04	0.5%	50.0%

APPENDIX F: BAYMAR CREEK RIPARIAN PLANT INVENTORY

Life Form	Plant Status[1]	Area by Species (ha)	Percent Canopy Cover[2] (Avg)	Constancy[3]
TREES				
white spruce (Picea glauca)	native	1.05	16.7%	100.00%
balsam poplar (Populus balsamifera)	native	0.57	9.4%	**66.67%**
aspen (Populus tremuloides)	native	0.002	0.5%	33.33%
SHRUBS				
flat-leaved willow (Salix planifolia)	native	1.11	19.0%	66.67%
beaked willow (Salix bebbiana)	native	0.56	8.8%	100.00%
false mountain willow (Salix pseudomonticola)	native	0.19	3.0%	100.00%
firm leaf willow (Salix pseudomyrsinites syn. Salix myrtillifolia var. cordata)	native	0.17	2.9%	66.67%
red-osier dogwood (Cornus stolonifera)	native	0.05	10.0%	33.33%
twinflower (Linnaea borealis)	native	0.05	10.0%	33.33%
Drummond's willow (Salix drummondiana)	native	0.05	10.0%	33.33%
bog birch (Betula glandulosa)	native	0.04	0.6%	66.67%
northern gooseberry (Ribes oxyacanthoides)	native	0.03	0.5%	100.00%
common wild rose (Rosa woodsii)	native	0.03	0.5%	100.00%
shrubby cinquefoil (Potentilla fruticosa)	native	0.03	10.0%	33.33%
bunchberry (Cornus canadensis)	native	0.03	0.5%	66.67%
wild red raspberry (Rubus idaeus)	native	0.03	0.5%	66.67%
Canada buffaloberry (Shepherdia canadensis)	native	0.03	0.5%	66.67%
dwarf raspberry (Rubus arcticus)	native	0.03	0.5%	33.33%
basket willow (Salix petiolaris)	native	0.03	0.5%	33.33%
dewberry (Rubus pubescens)	native	0.004	0.5%	66.67%
ground juniper (Juniperus communis)	native	0.002	0.5%	33.33%
twining honeysuckle (Lonicera dioica)	native	0.002	0.5%	33.33%
wild red currant (Ribes triste)	native	0.002	0.5%	33.33%
dusky willow (Salix melanopsis)	native	0.002	0.5%	33.33%
snowberry (Symphoricarpos albus)	native	0.002	0.5%	33.33%
smooth willow (Salix glauca)	native	0.002	0.5%	33.33%
GRASSES AND GRASS-LIKES				
bluejoint (Calamagrostis canadensis)	native	1.66	30.0%	33.33%
water sedge (Carex aquatilis)	native	0.64	11.0%	66.67%
wire rush (Juncus balticus)	native	0.64	11.0%	66.67%
tufted hair grass (Deschampsia cespitosa)	native	0.58	9.3%	100.00%
fowl bluegrass (Poa palustris)	native	0.55	9.3%	66.67%
small bottle sedge (Carex utriculata)	native	0.55	9.5%	66.67%
Kentucky bluegrass (Poa pratensis)	*disturbance*, introduced	0.23	3.9%	66.67%
awned sedge (Carex atherodes)	native	0.17	3.0%	33.33%
timothy (Phleum pratense)	*disturbance*, introduced	0.03	0.5%	100.00%
northern wheat grass (Agropyron dasystachyum)	native	0.03	0.5%	33.33%
northern awnless brome (Bromus inermis ssp pumpellianus)	native	0.03	0.5%	33.33%

small-winged sedge (Carex microptera)	native	0.03	0.5%	33.33%
orchard grass (Dactylis glomerata)	introduced	0.03	0.5%	33.33%
foothills rough fescue (Festuca campestris)	native	0.03	0.5%	33.33%
sweet grass (Hierochloe odorata)	native	0.03	0.5%	33.33%
reed canary grass (Phalaris arundinacea)	native	0.03	0.5%	33.33%
smooth brome (Bromus inermis)	*disturbance*, introduced	0.01	3.0%	33.33%
brome grass (Bromus spp.)	unknown, not unique	0.002	0.5%	33.33%
Norway sedge (Carex norvegica)	native	0.002	0.5%	33.33%
sedge (Carex spp.)	native	0.002	0.5%	33.33%
hairy wild rye (Elymus innovatus)	native	0.002	0.5%	33.33%
woolly sedge (Carex lanuginosa)	native	0.002	0.5%	33.33%
Raymond's sedge (Carex raymondii)	native	0.002	0.5%	33.33%
rush-like sedge (Carex scirpoidea)	native	0.002	0.5%	33.33%
Rocky Mountain fescue (Festuca saximontana)	native	0.002	0.5%	33.33%
FORBS				
arrow-leaved coltsfoot (Petasites sagittatus)	native	0.55	10.0%	33.33%
common horsetail (Equisetum arvense)	native, *poisonous*	0.22	3.5%	100.00%
tall lungwort (Mertensia paniculata)	native	0.18	2.9%	100.00%
yellow avens (Geum aleppicum)	native	0.17	3.0%	66.67%
Canada thistle (Cirsium arvense)	**invasive**, introduced	0.17	2.7%	100.00%
common dandelion (Taraxacum officinale)	*disturbance*, introduced	0.17	2.7%	100.00%
common fireweed (Epilobium angustifolium)	native	0.17	2.9%	66.67%
variegated horsetail (Equisetum variegatum)	native	0.05	10.0%	33.33%
bishop's-cap (Mitella nuda)	native	0.05	10.0%	33.33%
graceful cinquefoil (Potentilla gracilis)	native	0.04	0.6%	66.67%
common yarrow (Achillea millefolium)	native	0.03	0.5%	100.00%
wild strawberry (Fragaria virginiana)	*disturbance*, native	0.03	0.5%	100.00%
northern bedstraw (Galium boreale)	native	0.03	0.5%	100.00%
star-flowered Solomon's-seal (Smilacina stellata)	native	0.03	0.5%	100.00%
veiny meadow rue (Thalictrum venulosum)	native	0.03	0.5%	100.00%
wild vetch (Vicia americana)	native	0.03	0.5%	100.00%
wild white geranium (Geranium richardsonii)	native	0.03	0.5%	66.67%
cream-colored vetchling (Lathyrus ochroleucus)	native	0.03	0.5%	66.67%
smooth aster (Aster laevis)	native	0.03	0.5%	66.67%
field mouse-ear chickweed (Cerastium arvense)	*disturbance*, native	0.03	0.5%	66.67%
saline shooting star (Dodecatheon pulchellum)	native	0.03	0.5%	66.67%
curled dock (Rumex crispus)	introduced	0.03	0.5%	66.67%
hairy rock cress (Arabis hirsuta)	native	0.03	0.5%	33.33%
water-hemlock (Cicuta maculata)	native, *poisonous*	0.03	0.5%	33.33%
three-flowered avens (Geum triflorum)	native	0.03	0.5%	33.33%
northern hedysarum (Hedysarum boreale)	native	0.03	0.5%	33.33%
cow parsnip (Heracleum lanatum)	native	0.03	0.5%	33.33%
wild mint (Mentha arvensis)	native	0.03	0.5%	33.33%
vine-leaved coltsfoot (Petasites vitifolius)	native	0.03	0.5%	33.33%
perennial sow-thistle (Sonchus arvensis)	**invasive**, introduced	0.03	0.5%	33.33%
alsike clover (Trifolium hybridum)	*disturbance*, introduced	0.03	0.5%	33.33%
common nettle (Urtica dioica)	native	0.03	0.5%	33.33%
early blue violet (Viola adunca)	native	0.03	0.5%	66.67%
Macoun's buttercup (Ranunculus macounii)	native	0.004	0.5%	66.67%
senecio (Senecio spp.)	unknown, not unique	0.004	0.5%	66.67%
long-stalked chickweed (Stellaria longipes)	native	0.004	0.5%	66.67%

white clover (Trifolium repens)	*disturbance*, introduced	0.004	0.5%	33.33%
red and white baneberry (Actaea rubra)	native, *poisonous*	0.002	0.5%	33.33%
blue columbine (Aquilegia brevistyla)	native	0.002	0.5%	33.33%
aster (Aster spp.)	unknown, not unique	0.002	0.5%	33.33%
tall larkspur (Delphinium glaucum)	native, *poisonous*	0.002	0.5%	33.33%
broad-leaved fireweed (Epilobium latifolium)	native	0.002	0.5%	33.33%
sweet-scented bedstraw (Galium triflorum)	native	0.002	0.5%	33.33%
large-leaved yellow avens (Geum macrophyllum)	native	0.002	0.5%	33.33%
yellow hedysarum (Hedysarum sulphurescens)	native	0.002	0.5%	33.33%
fringed loosestrife (Lysimachia ciliata)	native	0.002	0.5%	33.33%
one-flowered wintergreen (Moneses uniflora)	native	0.002	0.5%	33.33%
one-sided wintergreen (Orthilia secunda)	native	0.002	0.5%	33.33%
palmate-leaved coltsfoot (Petasites palmatus)	native	0.002	0.5%	33.33%
common pink wintergreen (Pyrola asarifolia)	native	0.002	0.5%	33.33%
western dock (Rumex occidentalis)	native	0.002	0.5%	33.33%
balsam groundsel (Senecio pauperculus)	native	0.002	0.5%	33.33%
goldenrod (Solidago spp.)	native	0.002	0.5%	33.33%
clasping-leaved twisted-stalk (Streptopus amplexifolius)	native	0.002	0.5%	33.33%
western Canada violet (Viola canadensis)	native	0.002	0.5%	33.33%
many-flowered yarrow (Achillea sibirica)	native	0.002	0.5%	33.33%
showy everlasting (Antennaria pulcherrima)	*disturbance*, native	0.002	0.5%	33.33%
western willow aster (Aster hesperius)	native	0.002	0.5%	33.33%
milk vetch (Astragalus eucosmus)	native	0.002	0.5%	33.33%
Drummond's thistle (Cirsium drummondii)	native	0.002	0.5%	33.33%
common scouring-rush (Equisetum hyemale)	native	0.002	0.5%	33.33%
alpine bistort (Polygonum viviparum)	native	0.002	0.5%	33.33%
silverweed (Potentilla anserina)	*disturbance*, native	0.002	0.5%	33.33%
red clover (Trifolium pratense)	*disturbance*, introduced	0.002	0.5%	33.33%
violet (Viola spp.)	native	0.002	0.5%	33.33%

APPENDIX G: JAMIESON CREEK RIPARIAN PLANT INVENTORY

Life Form	Plant Status[1]	Area by Species (ha)	Percent Canopy Cover[2] (Avg)	Constancy[3]
TREES				
white spruce (Picea glauca)	native	3.91	20.90%	100.00%
balsam poplar (Populus balsamifera)	native	1.05	6.22%	66.67%
aspen (Populus tremuloides)	native	0.34	2.01%	66.67%
SHRUBS				
beaked willow (Salix bebbiana)	native	3.43	18.31%	100.00%
flat-leaved willow (Salix planifolia)	native	1.40	7.48%	100.00%
false mountain willow (Salix pseudomonticola)	native	1.40	7.48%	100.00%
shrubby cinquefoil (Potentilla fruticosa)	native	0.72	4.28%	66.67%
firm leaf willow (Salix pseudomyrsinites syn. Salix myrtillifolia var. cordata)	native	0.26	1.41%	100.00%
basket willow (Salix petiolaris)	native	0.25	1.49%	66.67%
northern gooseberry (Ribes oxyacanthoides)	native	0.09	0.50%	100.00%
twining honeysuckle (Lonicera dioica)	native	0.06	0.50%	66.67%
common wild rose (Rosa woodsii)	native	0.06	0.50%	66.67%
wild red raspberry (Rubus idaeus)	native	0.06	0.50%	66.67%
dwarf raspberry (Rubus arcticus)	native	0.04	0.50%	66.67%
bog birch (Betula glandulosa)	native	0.03	0.50%	33.33%
hoary willow (Salix candida)	native	0.03	0.50%	33.33%
shining willow (Salix lucida)	native	0.03	0.50%	33.33%
willow (Salix spp.)	native	0.01	0.50%	33.33%
GRASSES AND GRASS-LIKES				
water sedge (Carex aquatilis)	native	4.76	28.12%	66.67%
bluejoint (Calamagrostis canadensis)	native	2.79	14.89%	100.00%
awned sedge (Carex atherodes)	native	2.58	21.49%	66.67%
Kentucky bluegrass (Poa pratensis)	*disturbance*, introduced	2.43	12.99%	100.00%
wire rush (Juncus balticus)	native	1.70	9.09%	100.00%
quack grass (Agropyron repens)	*disturbance*, introduced	1.06	5.68%	100.00%
small bottle sedge (Carex utriculata)	native	0.98	5.78%	66.67%
smooth brome (Bromus inermis)	*disturbance*, introduced	0.48	4.04%	66.67%
tufted hair grass (Deschampsia cespitosa)	native	0.25	1.49%	66.67%
fowl bluegrass (Poa palustris)	native	0.20	3.00%	33.33%
Sartwell's sedge (Carex sartwellii)	native	0.09	0.50%	100.00%
timothy (Phleum pratense)	*disturbance*, introduced	0.08	0.50%	66.67%
Norway sedge (Carex norvegica)	native	0.06	0.50%	66.67%
Raymond's sedge (Carex raymondii)	native	0.06	0.50%	66.67%
orchard grass (Dactylis glomerata)	introduced	0.06	0.50%	66.67%
slender wheat grass (Agropyron trachycaulum)	native	0.05	0.50%	33.33%
graceful sedge (Carex praegracilis)	native	0.05	0.50%	33.33%
bluebunch fescue (Festuca idahoensis)	native	0.03	0.50%	33.33%
red fescue (Festuca rubra)	native or introduced	0.03	0.50%	33.33%
sweet grass (Hierochloe odorata)	native	0.03	0.50%	33.33%
wheat grass (Agropyron spp.)	native	0.01	0.50%	33.33%

alpine foxtail (Alopecurus occidentalis)	native	0.01	0.50%	33.33%
sedge (Carex spp.)	native	0.01	0.50%	33.33%
meadow fescue (Festuca pratensis)	introduced	0.01	0.50%	33.33%
FORBS				
arrow-leaved coltsfoot (Petasites sagittatus)	native	0.73	3.92%	100.00%
tall lungwort (Mertensia paniculata)	native	0.48	4.04%	66.67%
common horsetail (Equisetum arvense)	native, *poisonous*	0.39	2.10%	100.00%
yellow avens (Geum aleppicum)	native	0.35	1.86%	100.00%
white clover (Trifolium repens)	*disturbance*, introduced	0.31	3.00%	33.33%
field mouse-ear chickweed (Cerastium arvense)	*disturbance*, native	0.21	2.48%	66.67%
curled dock (Rumex crispus)	introduced	0.20	3.00%	33.33%
cow parsnip (Heracleum lanatum)	native	0.10	0.87%	66.67%
common yarrow (Achillea millefolium)	native	0.09	0.50%	100.00%
water-hemlock (Cicuta maculata)	native, *poisonous*	0.09	0.50%	100.00%
Canada thistle (Cirsium arvense)	**invasive**, introduced	0.09	0.50%	100.00%
wormseed mustard (Erysimum cheiranthoides)	*disturbance*, introduced	0.09	0.50%	100.00%
wild mint (Mentha arvensis)	native	0.09	0.50%	100.00%
star-flowered Solomon's-seal (Smilacina stellata)	native	0.09	0.50%	100.00%
common dandelion (Taraxacum officinale)	*disturbance*, introduced	0.09	0.50%	100.00%
veiny meadow rue (Thalictrum venulosum)	native	0.09	0.50%	100.00%
wild vetch (Vicia americana)	native	0.09	0.50%	100.00%
western willow aster (Aster hesperius)	native	0.08	0.50%	66.67%
saline shooting star (Dodecatheon pulchellum)	native	0.08	0.50%	66.67%
northern green bog orchid (Habenaria hyperborea)	native	0.08	0.50%	66.67%
silverweed (Potentilla anserina)	*disturbance*, native	0.08	0.50%	66.67%
early blue violet (Viola adunca)	native	0.08	0.50%	66.67%
heart-leaved Alexanders (Zizia aptera)	native	0.08	0.50%	66.67%
red and white baneberry (Actaea rubra)	native, *poisonous*	0.06	0.50%	66.67%
Canada anemone (Anemone canadensis)	native	0.06	0.50%	66.67%
common fireweed (Epilobium angustifolium)	native	0.06	0.50%	66.67%
northern bedstraw (Galium boreale)	native	0.06	0.50%	66.67%
long-stalked chickweed (Stellaria longipes)	native	0.06	0.50%	66.67%
common nettle (Urtica dioica)	native	0.06	0.50%	66.67%
large-leaved yellow avens (Geum macrophyllum)	native	0.05	3.00%	33.33%
purple avens (Geum rivale)	native	0.05	3.00%	33.33%
milk vetch (Astragalus eucosmus)	native	0.05	0.50%	33.33%
wild strawberry (Fragaria virginiana)	*disturbance*, native	0.05	0.50%	33.33%
bluebur (Lappula squarrosa)	*disturbance*, introduced	0.05	0.50%	33.33%
late yellow locoweed (Oxytropis monticola)	native, *poisonous*	0.05	0.50%	33.33%
alpine bistort (Polygonum viviparum)	native	0.05	0.50%	33.33%
celery-leaved buttercup (Ranunculus sceleratus)	native	0.05	0.50%	33.33%
common blue-eyed grass (Sisyrinchium montanum)	native	0.05	0.50%	33.33%
perennial sow-thistle (Sonchus arvensis)	**invasive**, introduced	0.05	0.50%	33.33%
long-leaved chickweed (Stellaria longifolia)	native	0.05	0.50%	33.33%
alsike clover (Trifolium hybridum)	*disturbance*, introduced	0.05	0.50%	33.33%
white camas (Zigadenus elegans)	native, *poisonous*	0.05	0.50%	33.33%
three-flowered avens (Geum triflorum)	native	0.03	0.50%	33.33%
elephant's-head (Pedicularis groenlandica)	native	0.03	0.50%	33.33%
graceful cinquefoil (Potentilla gracilis)		0.03	0.50%	33.33%
balsam groundsel (Senecio pauperculus)	native	0.03	0.50%	33.33%
wild sarsaparilla (Aralia nudicaulis)	native	0.01	0.50%	33.33%

smooth aster (Aster laevis)	native	0.01	0.50%	33.33%
wild white geranium (Geranium richardsonii)	native	0.01	0.50%	33.33%
cream-colored vetchling (Lathyrus ochroleucus)	native	0.01	0.50%	33.33%
fringed loosestrife (Lysimachia ciliata)	native	0.01	0.50%	33.33%
pale persicaria (Polygonum lapathifolium)	native	0.01	0.50%	33.33%
sheep sorrel (Rumex acetosella)	introduced	0.01	0.50%	33.33%
western dock (Rumex occidentalis)	native	0.01	0.50%	33.33%
marsh skullcap (Scutellaria galericulata)	native	0.01	0.50%	33.33%
Canada goldenrod (Solidago canadensis)	native	0.01	0.50%	33.33%
marsh hedge-nettle (Stachys palustris)	native	0.01	0.50%	33.33%
stinkweed (Thlaspi arvense)	*disturbance*, introduced	0.01	0.50%	33.33%
western Canada violet (Viola canadensis)	native	0.01	0.50%	33.33%

APPENDIX H: ROBINSON CREEK RIPARIAN PLANT INVENTORY

Category	Species Common Name *(Scientific Name)*	Plant Status[1]	% Canopy Cover[2] ROB1	ROB2
Trees	aspen *(Populus tremuloides)*	native	NO	0.5
	balsam poplar *(Populus balsamifera)*	native	0.5	0.5
	white spruce *(Picea glauca)*	native	3.0	90
Shrubs	basket willow *(Salix petiolaris)*	native	0.5	NO
	beaked willow *(Salix bebbiana)*	native	0.5	NO
	bog birch *(Betula glandulosa)*	native	3.0	NO
	buckbrush/snowberry *(Symphoricarpos occidentalis)*	native	NO	0.5
	Canada buffaloberry *(Shepherdia canadensis)*	native	NO	0.5
	common wild rose *(Rosa woodsii)*	native	0.5	NO
	dwarf raspberry *(Rubus arcticus)*	native	0.5	NO
	false mountain willow *(Salix pseudomonticola)*	native	0.5	0.5
	firm leaf willow *(Salix pseudomyrsinites)*	native	3.0	NO
	flat-leaved willow *(Salix planifolia)*	native	10.0	0.5
	ground juniper *(Juniperus communis)*	native	NO	0.5
	northern gooseberry *(Ribes oxyacanthoides)*	native	0.5	3.0
	prickly rose *(Rosa acicularis)*	native	NO	10.0
	Saskatoon *(Amelanchier alnifolia)*	native	NO	0.5
	shrubby cinquefoil *(Potentilla fruticosa)*	native	0.5	NO
	smooth willow *(Salix glauca)*	native	3.0	0.5
	wild red raspberry *(Rubus idaeus)*	native	NO	3.0
	yellow willow *(Salix lutea)*	native	0.5	NO
Grasses (and Grass-like species)	bluejoint *(Calamagrostis canadensis)*	native	3.0	3.0
	common tall manna grass *(Glyceria grandis)*	native	0.5	NO
	creeping meadow foxtail *(Alopecurus arundinaceus)*	*introduced*	0.5	NO
	fowl bluegrass *(Poa palustris)*	native	3.0	NO
	fringed brome *(Bromus ciliatus)*	native	0.5	NO
	hairy wild rye *(Elymus innovatus)*	native	NO	10.0
	Kentucky bluegrass *(Poa pratensis)*	*disturbance, introduced*	0.5	0.5
	quack grass *(Agropyron repens)*	*disturbance, introduced*	0.5	0.5
	Raymond's sedge *(Carex raymondii)*	native	0.5	0.5
	short-awned sedge *(Carex microglochin)*	native	0.5	NO
	small bottle sedge *(Carex utriculata)*	native	60.0	3.0
	smooth brome *(Bromus inermis)*	*disturbance, introduced*	0.5	10.0
	timothy *(Phleum pratense)*	*disturbance, introduced*	0.5	0.5
	tufted hair grass *(Deschampsia cespitosa)*	native	3.0	10.0
	water sedge *(Carex aquatilis)*	native	20.0	NO
	wire rush *(Juncus balticus)*	native	3.0	NO

Forbs (broad leaf plants)	alsike clover *(Trifolium hybridum)*	*disturbance, introduced*	0.5	0.5
	arrow-leaved coltsfoot *(Petasites sagittatus)*	native	0.5	NO
	Canada goldenrod *(Solidago canadensis)*	native	0.5	0.5
	Canada thistle *(Cirsium arvense)*	***invasive**, introduced*	0.5	0.5
	cleavers *(Galium aparine)*	***invasive**, introduced*	NO	0.5
	common dandelion *(Taraxacum officinale)*	*disturbance, introduced*	0.5	0.5
	common fireweed *(Epilobium angustifolium)*	native	0.5	10.0
	common horsetail *(Equisetum arvense)*	native, *poisonous*	0.5	30.0
	common nettle *(Urtica dioica)*	native	0.5	0.5
	common scouring-rush *(Equisetum hyemale)*	native	NO	0.5
	common yarrow *(Achillea millefolium)*	native	0.5	0.5
	cow parsnip *(Heracleum lanatum)*	native	0.5	NO
	cream-colored vetchling *(Lathyrus ochroleucus)*	native	NO	0.5
	curled dock *(Rumex crispus)*	*introduced*	0.5	NO
	flixweed; tansy mustard *(Descurainia sophia)*	*disturbance, introduced*	0.5	NO
	graceful cinquefoil *(Potentilla gracilis)*	native	0.5	NO
	harebell *(Campanula rotundifolia)*	native	NO	0.5
	heart-leaved Alexanders *(Zizia aptera)*	native	0.5	NO
	hemp-nettle *(Galeopsis tetrahit)*	*disturbance, introduced*	0.5	0.5
	Lindley's aster *(Aster ciliolatus)*	native	NO	0.5
	marsh yellow cress *(Rorippa palustris)*	native	NO	0.5
	northern bedstraw *(Galium boreale)*	native	0.5	0.5
	northern willowherb *(Epilobium ciliatum)*	native	NO	0.5
	palmate-leaved coltsfoot *(Petasites palmatus)*	native	0.5	NO
	perennial sow-thistle *(Sonchus arvensis)*	***invasive**, introduced*	0.5	0.5
	rough cinquefoil *(Potentilla norvegica)*	*disturbance*, native	NO	0.5
	showy everlasting *(Antennaria pulcherrima)*	*disturbance*, native	0.5	0.5
	silverweed *(Potentilla anserina)*	*disturbance*, native	0.5	0.5
	smooth aster *(Aster laevis)*	native	0.5	NO
	star-flowered Solomon's-seal *(Smilacina stellata)*	native	NO	0.5
	stinkweed *(Thlaspi arvense)*	*disturbance, introduced*	0.5	NO
	tall larkspur *(Delphinium glaucum)*	native, *poisonous*	0.5	0.5
	tall lungwort *(Mertensia paniculata)*	native	0.5	3.0
	veiny meadow rue *(Thalictrum venulosum)*	native	0.5	0.5
	vine-leaved coltsfoot *(Petasites vitifolius)*	native	NO	0.5
	water smartweed *(Polygonum coccineum)*	native	0.5	NO
	western willow aster *(Aster hesperius)*	native	0.5	0.5
	wild mint *(Mentha arvensis)*	native	0.5	0.5
	wild strawberry *(Fragaria virginiana)*	*disturbance*, native	0.5	0.5
	wild vetch *(Vicia americana)*	native	0.5	0.5
	wintergreen *(Pyrola spp.)*	*unknown*	0.5	NO
	yellow avens *(Geum aleppicum)*	native	0.5	0.5

NO = Not Observed

APPENDIX I: LESUEUR CREEK WETLANDS RIPARIAN PLANT INVENTORY

SITE: LEW1			
Life Form	**Plant Status[1]**	**Area by Species (ha)**	**Percent Canopy Cover[2] (Avg)**
TREES			
white spruce (Picea glauca)	native	0.22	10.0%
balsam poplar (Populus balsamifera)	native	0.01	0.5%
aspen (Populus tremuloides)	native	0.01	0.5%
SHRUBS			
firm leaf willow (Salix pseudomyrsinites syn. Salix myrtillifolia var. cordata)	native	0.87	40.0%
flat-leaved willow (Salix planifolia)	native	0.43	20.0%
smooth willow (Salix glauca)	native	0.22	10.0%
bog birch (Betula glandulosa)	native	0.07	3.0%
hoary willow (Salix candida)	native	0.07	3.0%
shrubby cinquefoil (Potentilla fruticosa)	native	0.01	0.5%
common wild rose (Rosa woodsii)	native	0.01	0.5%
dwarf raspberry (Rubus arcticus)	native	0.01	0.5%
pussy willow (Salix discolor)	native	0.01	0.5%
GRASSES AND GRASS-LIKES			
water sedge (Carex aquatilis)	native	1.74	80.0%
small bottle sedge (Carex utriculata)	native	0.07	3.0%
wire rush (Juncus balticus)	native	0.07	3.0%
northern reed grass (Calamagrostis inexpansa)	native	0.01	0.5%
hair-like sedge (Carex capillaris)	native	0.01	0.5%
tufted hair grass (Deschampsia cespitosa)	native	0.01	0.5%
Richardson's fescue (Festuca rubra ssp. arctica)	native	0.01	0.5%
Kentucky bluegrass (Poa pratensis)	*disturbance*, introduced	0.01	0.5%
FORBS			
common yarrow (Achillea millefolium)	native	0.01	0.5%
many-flowered yarrow (Achillea sibirica)	native	0.01	0.5%
small wood anemone (Anemone parviflora)	native	0.01	0.5%
showy everlasting (Antennaria pulcherrima)	*disturbance*, native	0.01	0.5%
smooth aster (Aster laevis)	native	0.01	0.5%
saline shooting star (Dodecatheon pulchellum)	native	0.01	0.5%
common fireweed (Epilobium angustifolium)	native	0.01	0.5%
common horsetail (Equisetum arvense)	native, *poisonous*	0.01	0.5%
wild strawberry (Fragaria virginiana)	*disturbance*, native	0.01	0.5%
northern bedstraw (Galium boreale)	native	0.01	0.5%
bog orchid (Habenaria spp.)	native	0.01	0.5%
cream-colored vetchling (Lathyrus ochroleucus)	native	0.01	0.5%
western wood lily (Lilium philadelphicum)	native	0.01	0.5%
elephant's-head (Pedicularis groenlandica)	native	0.01	0.5%
palmate-leaved coltsfoot (Petasites palmatus)	native	0.01	0.5%

alpine bistort (Polygonum viviparum)	native	0.01	0.5%
star-flowered Solomon's-seal (Smilacina stellata)	native	0.01	0.5%
long-stalked chickweed (Stellaria longipes)	native	0.01	0.5%
wild vetch (Vicia americana)	native	0.01	0.5%

SITE: LSX1			
Life Form	**Plant Status[1]**	**Area by Species (ha)**	**Percent Canopy Cover[2] (Avg)**
TREES			
white spruce (Picea glauca)	native	0.33	80.0%
lodgepole pine (Pinus contorta)	native	0.002	0.5%
SHRUBS			
firm leaf willow (Salix pseudomyrsinites syn. Salix myrtillifolia var. cordata)	native	0.08	20.0%
common bearberry (Arctostaphylos uva-ursi)	native	0.04	10.0%
water birch (Betula occidentalis)	native	0.04	10.0%
ground juniper (Juniperus communis)	native	0.04	10.0%
smooth willow (Salix glauca)	native	0.04	10.0%
creeping juniper (Juniperus horizontalis)	native	0.01	3.0%
shrubby cinquefoil (Potentilla fruticosa)	native	0.01	3.0%
Canada buffaloberry (Shepherdia canadensis)	native	0.01	3.0%
common wild rose (Rosa woodsii)	native	0.002	0.5%
dwarf raspberry (Rubus arcticus)	native	0.002	0.5%
hoary willow (Salix candida)	native	0.002	0.5%
Drummond's willow (Salix drummondiana)	native	0.002	0.5%
Farr's willow (Salix farriae)	native	0.002	0.5%
false mountain willow (Salix pseudomonticola)	native	0.002	0.5%
GRASSES AND GRASS-LIKES			
wire rush (Juncus balticus)	native	0.12	30.0%
water sedge (Carex aquatilis)	native	0.04	10.0%
hairy wild rye (Elymus innovatus)	native	0.04	10.0%
hair-like sedge (Carex capillaris)	native	0.01	3.0%
rush-like sedge (Carex scirpoidea)	native	0.01	3.0%
small bottle sedge (Carex utriculata)	native	0.01	3.0%
northern awnless brome (Bromus inermis ssp pumpellianus)	native	0.002	0.5%
northern reed grass (Calamagrostis inexpansa)	native	0.002	0.5%
golden sedge (Carex aurea)	native	0.002	0.5%
bristle-leaved sedge (Carex eburnea)	native	0.002	0.5%
sheathed sedge (Carex vaginata)	native	0.002	0.5%
tufted hair grass (Deschampsia cespitosa)	native	0.002	0.5%
Richardson’s fescue (Festuca rubra ssp. arctica)	native	0.002	0.5%
fowl manna grass (Glyceria striata)	native	0.002	0.5%
timothy (Phleum pratense)	*disturbance*, introduced	0.002	0.5%
alpine bluegrass (Poa alpina)	native	0.002	0.5%
fowl bluegrass (Poa palustris)	native	0.002	0.5%
Kentucky bluegrass (Poa pratensis)	*disturbance*, introduced	0.002	0.5%

FORBS			
smooth aster (Aster laevis)	native	0.012	3.0%
common horsetail (Equisetum arvense)	native, *poisonous*	0.012	3.0%
northern hedysarum (Hedysarum boreale)	native	0.012	3.0%
balsam groundsel (Senecio pauperculus)	native	0.012	3.0%
common yarrow (Achillea millefolium)	native	0.002	0.5%
sweet-flowered androsace (Androsace chamaejasme)	native	0.002	0.5%
cut-leaved anemone (Anemone multifida)	native	0.002	0.5%
small wood anemone (Anemone parviflora)	native	0.002	0.5%
showy everlasting (Antennaria pulcherrima)	*disturbance*, native	0.002	0.5%
blue columbine (Aquilegia brevistyla)	native	0.002	0.5%
broad-leaved arnica (Arnica latifolia)	native	0.002	0.5%
Canada thistle (Cirsium arvense)	**invasive**, introduced	0.002	0.5%
pale coralroot (Corallorhiza trifida)	native	0.002	0.5%
yellow lady's-slipper (Cypripedium calceolus)	native	0.002	0.5%
sparrow's-egg lady's-slipper (Cypripedium passerinum)	native	0.002	0.5%
saline shooting star (Dodecatheon pulchellum)	native	0.002	0.5%
common fireweed (Epilobium angustifolium)	native	0.002	0.5%
wild strawberry (Fragaria virginiana)	*disturbance*, native	0.002	0.5%
northern bedstraw (Galium boreale)	native	0.002	0.5%
yellow avens (Geum aleppicum)	native	0.002	0.5%
northern green bog orchid (Habenaria hyperborea)	native	0.002	0.5%
bracted bog orchid (Habenaria viridis)	native	0.002	0.5%
alpine hedysarum (Hedysarum alpinum)	native	0.002	0.5%
yellow hedysarum (Hedysarum sulphurescens)	native	0.002	0.5%
western wood lily (Lilium philadelphicum)	native	0.002	0.5%
fringed loosestrife (Lysimachia ciliata)	native	0.002	0.5%
tall lungwort (Mertensia paniculata)	native	0.002	0.5%
round-leaved orchid (Orchis rotundifolia)	native	0.002	0.5%
elephant's-head (Pedicularis groenlandica)	native	0.002	0.5%
palmate-leaved coltsfoot (Petasites palmatus)	native	0.002	0.5%
arrow-leaved coltsfoot (Petasites sagittatus)	native	0.002	0.5%
common butterwort (Pinguicula vulgaris)	native	0.002	0.5%
common plantain (Plantago major)	*disturbance*, introduced	0.002	0.5%
alpine bistort (Polygonum viviparum)	native	0.002	0.5%
common pink wintergreen (Pyrola asarifolia)	native	0.002	0.5%
entire-leaved groundsel (Senecio integerrimus)	native	0.002	0.5%
star-flowered Solomon's-seal (Smilacina stellata)	native	0.002	0.5%
low goldenrod (Solidago missouriensis)	native	0.002	0.5%
mountain goldenrod (Solidago spathulata)	native	0.002	0.5%
long-stalked chickweed (Stellaria longipes)	native	0.002	0.5%
common dandelion (Taraxacum officinale)	*disturbance*, introduced	0.002	0.5%
sticky false asphodel (Tofieldia glutinosa)	native	0.002	0.5%
western Canada violet (Viola canadensis)	native	0.002	0.5%
white camas (Zigadenus elegans)	native, *poisonous*	0.002	0.5%

APPENDIX J: BENCHLANDS WETLAND RIPARIAN PLANT INVENTORY

Life Form	Plant Status[1]	Area by Species (ha)	Percent Canopy Cover[2] (Avg)
TREES			
white spruce (Picea glauca)	native	0.10	40.0%
balsam poplar (Populus balsamifera)	native	0.01	3.0%
SHRUBS			
silverberry (Elaeagnus commutata)	native	0.05	20.0%
common bearberry (Arctostaphylos uva-ursi)	native	0.01	3.0%
sandbar willow (Salix exigua)	native	0.01	3.0%
yellow willow (Salix lutea)	native	0.01	3.0%
basket willow (Salix petiolaris)	native	0.01	3.0%
flat-leaved willow (Salix planifolia)	native	0.01	3.0%
false mountain willow (Salix pseudomonticola)	native	0.01	3.0%
yellow mountain avens (Dryas drummondii)	native	0.001	0.5%
ground juniper (Juniperus communis)	native	0.001	0.5%
shrubby cinquefoil (Potentilla fruticosa)	native	0.001	0.5%
common wild rose (Rosa woodsii)	native	0.001	0.5%
beaked willow (Salix bebbiana)	native	0.001	0.5%
hoary willow (Salix candida)	native	0.001	0.5%
firm leaf willow (Salix pseudomyrsinites syn. Salix myrtillifolia var. cordata)	native	0.001	0.5%
Canada buffaloberry (Shepherdia canadensis)	native	0.001	0.5%
buckbrush/snowberry (Symphoricarpos occidentalis)	native	0.001	0.5%
GRASSES AND GRASS-LIKES			
wire rush (Juncus balticus)	native	0.08	30.0%
Kentucky bluegrass (Poa pratensis)	*disturbance*, introduced	0.05	20.0%
smooth brome (Bromus inermis)	*disturbance*, introduced	0.03	10.0%
small bottle sedge (Carex utriculata)	native	0.03	10.0%
water sedge (Carex aquatilis)	native	0.01	3.0%
red fescue (Festuca rubra)	native or introduced	0.01	3.0%
crested wheat grass (Agropyron pectiniforme)	*disturbance*, introduced	0.001	0.5%
northern reed grass (Calamagrostis inexpansa)	native	0.001	0.5%
narrow reed grass (Calamagrostis stricta)	native	0.001	0.5%
golden sedge (Carex aurea)	native	0.001	0.5%
hair-like sedge (Carex capillaris)	native	0.001	0.5%
rush-like sedge (Carex scirpoidea)	native	0.001	0.5%
sedge (Carex spp.)	native	0.001	0.5%
tufted hair grass (Deschampsia cespitosa)	native	0.001	0.5%
hairy wild rye (Elymus innovatus)	native	0.001	0.5%
Richardson's fescue (Festuca rubra ssp. arctica)	native	0.001	0.5%
fowl manna grass (Glyceria striata)	native	0.001	0.5%
timothy (Phleum pratense)	*disturbance*, introduced	0.001	0.5%
fowl bluegrass (Poa palustris)	native	0.001	0.5%

FORBS			
common horsetail (Equisetum arvense)	native, *poisonous*	0.03	10.0%
swamp horsetail (Equisetum fluviatile)	native	0.03	10.0%
smooth aster (Aster laevis)	native	0.01	3.0%
early yellow locoweed (Oxytropis sericea)	native, *poisonous*	0.01	3.0%
Canada goldenrod (Solidago canadensis)	native	0.01	3.0%
mountain goldenrod (Solidago spathulata)	native	0.01	3.0%
perennial sow-thistle (Sonchus arvensis)	**invasive**, introduced	0.01	3.0%
common dandelion (Taraxacum officinale)	*disturbance*, introduced	0.01	3.0%
white clover (Trifolium repens)	*disturbance*, introduced	0.01	3.0%
common yarrow (Achillea millefolium)	native	0.001	0.5%
small wood anemone (Anemone parviflora)	native	0.001	0.5%
small-leaved everlasting (Antennaria parvifolia)	*disturbance*, native	0.001	0.5%
showy everlasting (Antennaria pulcherrima)	*disturbance*, native	0.001	0.5%
plains wormwood (Artemisia campestris)	native	0.001	0.5%
pasture sagewort (Artemisia frigida)	native	0.001	0.5%
aster (Aster spp.)	unknown, not unique	0.001	0.5%
garden bluebell (Campanula rapunculoides)	**invasive**, introduced	0.001	0.5%
Canada thistle (Cirsium arvense)	**invasive**, introduced	0.001	0.5%
sparrow's-egg lady's-slipper (Cypripedium passerinum)	native	0.001	0.5%
mountain shooting star (Dodecatheon conjugens)	native	0.001	0.5%
broad-leaved fireweed (Epilobium latifolium)	native	0.001	0.5%
variegated horsetail (Equisetum variegatum)	native	0.001	0.5%
wild strawberry (Fragaria virginiana)	*disturbance*, native	0.001	0.5%
yellow avens (Geum aleppicum)	native	0.001	0.5%
northern green bog orchid (Habenaria hyperborea)	native	0.001	0.5%
alpine hedysarum (Hedysarum alpinum)	native	0.001	0.5%
northern hedysarum (Hedysarum boreale)	native	0.001	0.5%
narrow-leaved hawkweed (Hieracium umbellatum)	native	0.001	0.5%
bluebur (Lappula squarrosa)	*disturbance*, introduced	0.001	0.5%
yellow sweet-clover (Melilotus officinalis)	*disturbance*, introduced	0.001	0.5%
round-leaved orchid (Orchis rotundifolia)	native	0.001	0.5%
reflexed locoweed (Oxytropis deflexa)	native, *poisonous*	0.001	0.5%
late yellow locoweed (Oxytropis monticola)	native, *poisonous*	0.001	0.5%
elephant's-head (Pedicularis groenlandica)	native	0.001	0.5%
alpine bistort (Polygonum viviparum)	native	0.001	0.5%
common pink wintergreen (Pyrola asarifolia)	native	0.001	0.5%
few-flowered ragwort (Senecio pauciflorus)	native	0.001	0.5%
star-flowered Solomon's-seal (Smilacina stellata)	native	0.001	0.5%
sticky false asphodel (Tofieldia glutinosa)	native	0.001	0.5%
common goat's-beard (Tragopogon dubius)	introduced	0.001	0.5%
red clover (Trifolium pratense)	*disturbance*, introduced	0.001	0.5%
wild vetch (Vicia americana)	native	0.001	0.5%

APPENDIX K

FACTORS FOR ASSESSING LARGE RIVER FLOODPLAIN HEALTH

FACTORS FOR ASSESSING LARGE RIVER FLOODPLAIN HEALTH

Some factors on the evaluation will not apply on all sites. For example, sites without potential for woody species are not rated on factors concerning trees and shrubs. Vegetative site potential can be determined by using a key to site type (e.g., Thompson and Hansen 2001, 2002, 2003, or another appropriate publication). On severely disturbed sites, vegetation potential can be difficult to determine. On such sites, clues to potential may be sought on nearby sites with similar landscape position.

Most of the factors rated in this evaluation are based on ocular estimations. Such estimation may be difficult on large, brushy sites where visibility is limited, but extreme precision is not necessary. While the rating categories are broad, evaluators do need to calibrate their eye with practice. It is important to remember that a health rating is not an absolute value. The factor breakout groupings and point weighting in the evaluation are somewhat subjective and are not grounded in quantitative science so much as in the collective experience of an array of riparian scientists, range professionals, and land managers.

The evaluator must keep in mind that this assessment form is designed to account for most sites and conditions in the applicable region. However, rarely will all the questions seem exactly to fit the circumstances on a given site. Therefore, try to answer each question with a literal reading. If necessary, explain anomalies in the comment section. Each factor below will be rated according to conditions observed on the site. The evaluator will estimate the scoring category and enter that value on the score sheet.

1. Cottonwood and Balsam Poplar Regeneration. This item is assessed differently on either side of the Red Deer River valley. For areas south of and including the Red Deer River valley, do not count asexual regeneration from root sprouts. In this southern area of the province, count only reproduction from seed. This is because these trees are primarily riverine species that pioneer on recent alluvium from seed, and root sprouts do not serve well to maintain populations. In areas north of the Red Deer River valley (and some areas farther south in higher precipitation zones, such as the foothills west of Highway 2) count any mode of reproduction for this group of trees, because in these cooler/moister zones cottonwoods and balsam poplar populations are not dependent on seed deposited on riverine alluvium. (***NOTE:*** In this item do not include the species *Populus tremuloides* (aspen), which is included in the next item below.

Reproduction success can be determined by estimating the established seedling and sapling cover expressed as percentage of the overall cover of the species on the site. (***Note:*** For this item, include plants taller than 30 cm (1 ft) in height, but less than 12.5 cm (5 in) in dbh [diameter at breast height: 1.35 m (4.5 ft)]). If no potential for cottonwood or balsam poplar exists on the polygon (such as when it is on the outside of a long meander curve where depositional material is not expected, or there are no such trees on similar site positions nearby) replace both Actual Score and Possible Score with NA. Count plants installed by human planting, if these are successfully established. To be successfully established the new plants need to have at least one complete growing season on the site. Most newly established plants do not survive the first growing season. ***NOTE:*** *Use judgement and caution in counting occasional seedlings in precarious positions where they have little potential for survival due to natural physical jeopardy (e.g., at water's edge along outside curve).*

Scoring:

6 = More than 15% of the cottonwood and/or balsam poplar cover is established seedlings and/or saplings.
4 = 5% to 15% of the cottonwood and/or balsam poplar cover is established seedlings and/or saplings.
2 = Up to 5% of the cottonwood and/or balsam poplar cover is established seedlings and/or saplings.
0 = None of the cottonwood and/or balsam poplar cover is established seedlings or saplings.

2. Regeneration of Other Native Tree Species. As succession progresses on a riparian site, the pioneer trees and shrub communities are replaced by later seral communities (if river dynamics allow enough time). If the site is not de-watered or otherwise disturbed, this progression is often to communities dominated by other native tree species. Depending upon dynamics of the system (how fast the channel migrates laterally), the potential may exist for equilibrium at different locations along the river between younger (those dominated by young trees and willows) communities and older communities with aging cottonwoods/poplars and later seral species such as *Populus tremuloides* (aspen), *Picea glauca* (white spruce), *Acer negundo* (Manitoba maple), and *Fraxinus pennsylvanica* (green ash). ***Note:*** Seedlings and saplings of these species include individuals which are less than 7.5 cm (3 in) in dbh. In situations where all plant communities are in an early successional stage and where no later successional species are yet expected (such as a young point bar or a newly formed island), replace both Actual Score and Possible Score with NA.

The health of a population can be based on current regeneration success without having to determine the exact potential distribution between cottonwoods/poplars and the other tree species on a site. This regeneration success can be determined from the seedling and sapling canopy cover expressed as a percentage of the overall cover of the group of tree species on the site other than cottonwoods/poplars. Count plants installed by human planting, if these are successfully established. To be successfully established the new plants need to have at least one complete growing season on the site. Most newly established plants do not survive the first growing season.

Scoring:

3 = More than 5% of the other (non-cottonwood/balsam poplar) tree cover is seedlings and/or saplings.
2 = 1% to 5% of the other (non-cottonwood/balsam poplar) tree cover is seedlings and/or saplings.
1 = Less than 1% of the other (non-cottonwood/balsam poplar) tree cover is seedlings and/or saplings.
0 = Seedlings and saplings of trees species other than cottonwoods/balsam poplars or absent.

3. Regeneration of Preferred Shrub Species. Another indicator of a river system's ecological stability and, therefore, health is the presence of enough shrub regeneration to maintain the lifeform population along the river over the long term. Ecological stability is used in the broad sense that over the reach as a whole there is an equilibrium of community composition and structure.

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [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* species (caragana), *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [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 (e.g., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon 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* (buckbrush/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 buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/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 1.8 m (6.0 ft), seedlings and saplings are those individuals less than 1.8 m (6.0 ft) tall. For species normally not exceeding 1.8 m (6.0 ft), seedlings and saplings are those individuals less than 0.45 m (1.5 ft) tall or which lack reproductive structures and the relative stature to suggest maturity. Count plants installed by human planting, if these are successfully established. Establishment success can be assumed for plants surviving at least one full year after planting. (***Note:*** Evaluators should take care also not to confuse short stature resulting from heavy browsing with that due to young plants.)

Scoring: (*If the site has no potential for 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 shrubs, then enter NC and explain in the comment field below.*)

6 = More than 5% of the preferred shrub species cover is seedlings and/or saplings.
4 = 1% to 5% of the preferred shrub species cover is seedlings and/or saplings.
2 = Less than 1% of the preferred shrub species cover is seedlings and/or saplings.
0 = None of the preferred shrub species cover is seedlings or saplings.

4. Standing Decadent and Dead Woody Material. 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 (de-watering) due to either human or natural causes. De-watering 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 vegetation 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. The observer is to ignore (not count) decadence in poplars or cottonwoods which are decadent ***due to old age*** (rough and furrowed bark extends substantially up into the crowns of the trees) (species: *Populus deltoides* [plains cottonwood], *P. angustifolia* [narrow-leaf cottonwood], and *P. balsamifera* [balsam poplar]), because cottonwoods/poplars are early seral species and naturally die off in the absence of disturbance to yield the site to later seral species. The observer is to consider (count) decadence in these species if apparently caused by de-watering, browse stress, climatic influences, or parasitic infestation (insects/disease). The observer should comment on conflicting or confounding indicators, and/or if the cause of decadence is simply unknown (*but not due to old age*).

Scoring:

3 = Less than 5% of the total canopy cover of woody species is decadent and/or dead.
2 = 5% to 25% of the total canopy cover of woody species is decadent and/or dead.
1 = 25% to 50% of the total canopy cover of woody species is decadent and/or dead.
0 = More than 50% of the total canopy cover of woody species is decadent and/or dead.

5a. Browse Utilization of Available 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, or all woody plants have already been removed.*) Livestock and/or wildlife browse many riparian woody species. Excessive browsing can eliminate these important plants from the community and result in their replacement by undesirable invaders. With excessive browsing, the plant loses vigour, is prevented from flowering, or is killed. Utilization in small amounts is normal and not a health concern, but concern increases with greater browse intensity.

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [salt cedar]) are excluded from the evaluation of utilization. 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* species (caragana), *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [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 (e.g., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon 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* (buckbrush/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 buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

Consider as available all tree and shrub plants to which animals may gain access and that they can reach. For tree species, this means mostly just seedling and sapling age classes. 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, because this would not accurately reflect actual use when more browsing can occur later in the season. Browsing of second year or older material affects the overall health of the plant and continual high use will affect the ability of the plant to maintain itself on the site. Determine percentage by comparing the number of leaders browsed or utilised 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. Do not count utilization on dead plants, unless it is clear that death resulted from over-grazing. ***Note:*** If a shrub is entirely mushroom/umbrella shaped by long term heavy browse or rubbing, count utilization of it as heavy.

Scoring: (*Consider all shrubs within animal reach and seedlings and saplings of tree species. If the site has no woody vegetation [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.*)
3 = None (0% to 5% of available second year and older leaders of preferred species are browsed).
2 = Light (5% to 25% of available second year and older leaders of preferred species are browsed).
1 = Moderate (25% to 50% of available second year and older leaders of preferred species are browsed).
0 = Heavy (More than 50% of available second year and older leaders of preferred species are browsed).

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.

Removal of woody vegetation may occur at once (a logging operation), or it may be cumulative over time (annual firewood cutting or beaver activity). Give credit for re-growth. Consider how much the removal of a tree many years ago may have now been mitigated with young replacements.

Four non-native species or genera are excluded from consideration here because these are aggressive, undesirable exotic plants that should be removed. They are *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus cathartica* (European/common buckthorne), and *Tamarix* species (salt cedar).

Determine the extent to which woody vegetation (trees and shrubs) is lacking due to being physically removed in the recent past (i.e., cut, mowed, trimmed, logged, cut by beaver, or otherwise cut from their growing position). When you have determined how much was removed, then compare that to the amount remaining uncut/re-grown, and choose a "best fit estimate" from the categories below. (***NOTE:*** In general, the more recent the removal, the more entirely it is fully counted; and conversely, the older the removal, the more likely it is to be mitigated by re-growth.)

This question is really looking at volume (three dimensions) and not canopy cover (two dimensions). For example, if an old growth spruce tree is removed, a number of new seedlings/saplings may become established and could soon achieve the same canopy cover as the old tree had. However, the value of the old tree to wildlife and overall habitat values is far less than that of the seedling/saplings. It will take a very long time before the seedlings/saplings can grow to replace all the habitat values that were provided by the tall old tree. On the other hand, shrubs, such as willows, grow faster and may replace the volume of removed plants in a much shorter time.

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. Total Canopy Cover of Woody Species. Woody species play a critical role in riverbank integrity. Natural riverbanks are protected by large bank rock (e.g., boulders and cobbles) and by woody vegetation. On floodplains comprised primarily of fine textured materials—which are typical of many western rivers—riverbanks are protected only by the woody vegetation. In these cases, it is critically important to manage for healthy woody vegetation. Woody vegetation also traps sediment, helps to reduce velocity of flood waters, protects the soil from extreme temperatures, and provides wildlife habitat. ***Note:*** Unlike other items dealing with woody plants, this item focuses on how much of the total polygon is covered by woody plants.

Scoring:
3 = More than 50% of the total area is occupied by all woody species.
2 = 25% to 50% of the total area is occupied by all woody species.
1 = 5% to 25% of the total area is occupied by all woody species.
0 = Less than 5% of the total area is occupied by all woody species.

7. Invasive Plant Species (Weeds). Invasive plants (weeds) are alien species 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]). Space is provided on the form for recording weed species counted. Include both woody and herbaceous invasive species. ***Leave no listed species field blank, however;*** enter "0" to indicate absence of a value. (A blank field means the observer forgot to collect the data; a value means the observer looked.)

The site's health rating on this item combines two factors: weed density/distribution class and total canopy cover. A perfect score of 6 out of 6 points can only be achieved if the site is weed free. A score of 4 out of the 6 points means the weed problem is just beginning (i.e., very few weeds and small total canopy cover (less than 1%). A moderate weed problem gets 2 out of 6 points. It has a moderately dense weed plant distribution (a class between 4 and 7) and moderate total weed canopy cover (between 1% and 15%). A site scores 0 points if the density/distribution is in class 8 or higher, or if the total weed canopy cover is 15% or more.

7a. Total Canopy Cover of Invasive Plant Species (Weeds). The evaluator 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: 6 = No invasive plant species (weeds) on the site. **4 =** Invasive plants present with total canopy cover less than 1% of the polygon area. **2 =** Invasive plants present with total canopy cover between 1% and 15% of the polygon area. **0 =** Invasive plants present with total canopy cover more than 15% of the polygon area.

7b. Density Distribution of Invasive Plant Species (Weeds). The evaluator 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 realising that the real situation may be only roughly approximated at best by any of these diagrams. Choose the category that most closely matches the view of the polygon.

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.

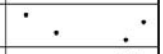
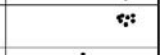
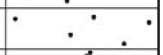
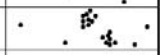
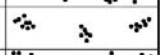
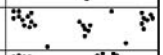
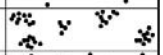
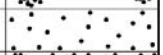
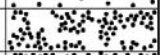
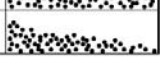
CLASS	DESCRIPTION OF ABUNDANCE	DISTRIBUTION PATTERN
0	No invasive plants on the polygon	
1	Rare occurrence	
2	A few sporadically occurring individual plants	
3	A single patch	
4	A single patch plus a few sporadically occurring plants	
5	Several sporadically occurring plants	
6	A single patch plus several 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 K1. Weed density distribution class guidelines

NOTE: Prior to the 2001 season, the health score for weed infestation was assessed from a single numerical value that does not represent weed canopy cover, but instead represents the fraction of the polygon area on which weeds had a well established population of individuals (i.e., the area infested).

8. 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 any additional species included.

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

Scoring: 3 = Less than 5% of the reach covered by undesirable herbaceous species. **2** = 5% to 25% of the reach covered by undesirable herbaceous species. **1** = 25% to 50% of the reach covered by undesirable herbaceous species. **0** = More than 50% of the reach covered by undesirable herbaceous species.

9. Riverbank Root Mass Protection. Vegetation along river banks performs the primary physical functions of stabilising the soil with a binding root mass and of filtering sediments from overland flow. Few studies have documented depth and extent of root systems of plant species found in wetlands, however flow energies commonly experienced by rivers are effectively resisted only by the deep and extensive roots provided by tree and shrub species. Natural rivers typically move dynamically across their valley bottom. The vegetation roots serve to slow this lateral movement to a rate that allows normal floodplain ecosystem function, such as development of mid and later seral vegetation communities for habitat values. For this reason there needs to be good root mass protection well back from the immediate toe of the current bank position.

In situations where you are assessing a high, cut bank (usually on an outside bend), the top may be upland, but the bottom is riparian. Do not assess the area that is non-riparian. In cases of tall, nearly vertical cut banks, assess the bottom portion that comes in contact with floodwaters. Omit from consideration those areas where the bank is comprised of bedrock, since these neither provide binding root mass, nor erode at a rate that is normally a concern. In assessing root mass protection along a river, consider a band that extends back approximately 15 m (50 ft) from the bank top. (This is a "rule of thumb" for guidance that requires only estimated measurements.) The bank top is that point where the upper bank levels off to the relatively flat surface of a floodplain or terrace. This question is most critically assessed along straight reaches and outside curves, therefore do not get too concerned with trying to find the exact location of the bank top along inside curve point bar positions. ***Note:*** *Riprap does not substitute for, act as, nor preclude the need for deep, binding root mass.*

Scoring:

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

10. Human-Caused Bare Ground. Bare ground is soil not covered by plants, litter or duff, downed wood, or rocks larger than 6 cm (2.5 in). Hardened, impervious surfaces (e.g., asphalt, concrete, etc.) are not bare ground—these do not erode nor allow weeds sites to invade. 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.

River channels that go dry during the growing season can create problems for polygon delineation. On most rivers, the area of the channel bottom is excluded from the polygon. (***Note:*** *The whole channel width extends from right bankfull stage to left bankfull stage; however we need to include the lower banks in all polygons, therefore consider for exclusion ONLY the relatively flat and lowest area of the channel—the "bottom."*) This allows data to be collected on the riparian area while excluding the aquatic zone, or open water, of the river. The aquatic zone is the area covered by water and lacking persistent emergent vegetation. Persistent emergent vegetation consists of perennial wetland species that normally remain standing at least until the beginning of next growing season, e.g., *Typha* species (cattails), *Scirpus* species (bulrushes), *Carex* species, and other perennial graminoids.

In many systems, large portions of the channel bottom may become exposed due to seasonal irrigation use, hydroelectric generation, and natural seasonal changes such as are found in many prairie ecosystems. In these cases, especially along prairie rivers, the channel bottom may have varying amounts of herbaceous vegetation, and the channel area is ***included*** in the polygon as area to be inventoried. Typically, these are the "pooled channel" river type that has scour pools scattered along the length, interspersed with reaches of grass, bulrush, or sedge-covered channel bottom. If over half (>50%) the channel bottom area has a canopy cover of persistent vegetation cover (perennial species), taken over the entire length of the polygon as a whole, then the entire channel qualifies for inclusion within the inventoried polygon area. If you are in doubt whether to include the channel bottom in the polygon, then leave it out, but be sure to indicate this in the comment section. This is important so that future assessments of the polygon will be looking at the same area of land.

Scoring:

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

NOTE: Questions 11 and 12 below generally must be answered in the office using maps and other data.

11. Removal or Addition of Water from/to the River System. Proper functioning of any riparian ecosystem depends, by definition, upon the system supply of water. The degree to which this "lifeblood" is artificially manipulated by removal or addition from/to the system is directly reflected in a reduction of riparian functions (e.g., wetland plant community maintenance, channel bank stability, wildlife habitat, overall system primary production). The extent of this alteration of the system can be estimated by determining the fraction of the average river flow, which is removed or added during the critical growing season each year. This determination can be based upon gauging station records as they relate to historic flow records established before construction of diversions. This question only deals with water volume changes. The question of dams controlling the timing of peak runoff is taken care of in the next question.

Scoring: 9 = Less than 10% of average river flow volume during the critical growing season is changed. **6** = 10% to 25% of average river flow volume during the critical growing season is changed. **3** = 25% to 50% of average river flow volume during the critical growing season is changed. **0 =** More than 50% of average river flow volume during the critical growing season is changed.

12. Control of Flood Peak and Timing by Upstream Dam(s). Natural riverine ecosystems adapt to, and depend upon, the volume and timing of annual peak flows, which are determined by the watershed water yield and variability of the local climate. Humans have installed dams on many rivers for agricultural and industrial purposes and to mitigate the damages caused by the natural flooding to human development on the floodplain. The dams affect the functional health of the natural system. In this context, the health of the river system relates directly to the fraction of the watershed which remains undammed. Thus, this item includes all tributaries which flow into the river upstream of the reach being assessed.

Scoring: 9 = Less than 10% of the watershed upstream of the reach is controlled by dams. **6** = 10% to 25% of the watershed upstream of the reach is controlled by dams. **3** = 25% to 50% of the watershed upstream of the reach is controlled by dams. **0** = More than 50% of the watershed upstream of the reach is controlled by dams.

13. Riverbanks Structurally Altered by Human Activity. Altered riverbanks are those having impaired structural integrity (strength or stability) due to human causes. These banks are more susceptible to cracking and/or slumping. Count as riverbank alteration such damage as livestock or wildlife hoof shear and concentrated trampling, vehicle or ATV tracks, and any other areas of human-caused disruption of bank integrity, including riprap or use of fill. The basic criterion is any disturbance to bank structure that increases erosion potential or bank profile shape change. One large exception is lateral bank cutting caused by stream flow, even if thought to result from upstream human manipulation of the flow. The intent of this item is to assess only direct, on-site mechanical or structural damage to the banks. Each bank is considered separately, so total bank length for this item is approximately twice the reach length of channel in the polygon (more if the river is braided). ***NOTE:*** Constructed riverbanks (especially those with riprap) may be stabilised at the immediate location, but are likely to disrupt normal flow dynamics and cause erosion of banks downstream. In assessing structural alteration, consider a band along the river bank approximately 4 m (13 ft) wide back from the bank toe. As with deep, binding root mass, this question is most critically assessed along straight reaches and outside curves, therefore do not get hung up trying to find the exact location of the bank top along inside curve point bar positions.

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

14. Human Physical Alteration to the Rest of the Polygon. Within the remainder of the polygon area, outside the stream bank 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 system 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:

- **Soil Compaction.** This kind of alteration includes livestock-caused hummocking and pugging, recreational trails that obviously have compacted the soil, vehicle and machine tracks and ruts in soft soil, etc.
- **Plowing/Tilling.** This is disruption of the soil surface for cultivation purposes.
- **Results of Hydrologic Change.** Include in this category any area that is physically affected by removal or addition of water for human purpose, although cause may be occurring upstream off-site. The physical effects to look for are erosion due to reduced or increased water, bared soil surface that had water cover removed, or flooded area that normally supports a drier vegetation type.
- **Human Impervious Surface.** This includes roofs, hardened surfaces like walkways and roads, boat launches, etc.
- **Topographic Change.** This is the deliberate alteration of terrain and/or drainage pattern for human purposes. It may be for aesthetic (landscaping) or other reasons, including such structures as water diversions ditches and canals.

Scoring: 6 = Less than 5% of the polygon is altered by human causes. **4 =** 5% to 15% of the polygon is altered by human causes. **2 =** 15% to 25% of the polygon is altered by human causes. **0** = More than 25% of the polygon is altered by human causes.

15. Floodplain Accessibility within the Polygon. Many of the most important functions of a riparian ecosystem depend upon the ability of the channel to access its floodplain during high flows. This access is restricted by levees and other human constructed embankments, such as roadbeds. Evaluators should determine what fraction of the historic 100 year floodplain within the polygon remains unrestricted by such embankments. This can usually be determined by comparing the area within the embankments (as shown on the latest photos or maps available).

Scoring: 6 = More than 85% of the floodplain is accessible to flood flows. **4** = 65% to 85% of the floodplain is accessible to flood flows. **2** = 35% to 65% of the floodplain is accessible to flood flows. **0** = Less than 35% of the floodplain is accessible to flood flows.

REFERENCES

Cows and Fish. 2002. Invasive Weed and Disturbance-caused Herbaceous Species List For Use in Riparian Health Assessment and Inventory in Alberta. Alberta Riparian Habitat Management Program. Lethbridge, Alberta, Canada. http://www.cowsandfish.org/pdfs/weeds.pdf

Thompson, William H. and Paul L. Hansen. 2001. Classification and management of riparian and wetland sites of the Saskatchewan Prairie Ecozone and parts of adjacent subregions. Riparian and Wetland Research Program, the University of Montana, Prepared for the Saskatchewan Wetland Conservation Corporation, Regina, Saskatchewan, Canada. 298 pp.

Thompson, William H. and Paul L. Hansen. 2002. Classification and management of riparian and wetland sites of Alberta's Grasslands Natural Region and adjacent subregions. Bitterroot Restoration, Inc., Prepared for the Alberta Riparian Habitat Management Program-Cows and Fish, Lethbridge, Alberta. 416 pp.

Thompson, William H. and Paul L. Hansen. 2003. Classification and management of riparian and wetland sites of Alberta's Parkland Natural Region and Dry Mixedwood Natural Subregion. Bitterroot Restoration, Inc. Prepared for the Alberta Riparian Habitat Management Program-Cows and Fish, Lethbridge, Alberta. 340 pp.

APPENDIX L

FACTORS FOR ASSESSING LOTIC WETLAND HEALTH OF STREAMS AND SMALL RIVERS

FACTORS FOR ASSESSING LOTIC WETLAND HEALTH (SURVEY)

Some factors on the evaluation will not apply on all sites. For example, sites without potential for woody species are not rated on factors concerning trees and shrubs. Vegetative site potential can be determined by using a key to site type (e.g., Thompson and Hansen 2001, 2002, 2003, or another appropriate publication). On severely disturbed sites, vegetation potential can be difficult to determine. On such sites, clues to potential may be sought on nearby sites with similar landscape position.

Most of the factors rated in this evaluation are based on ocular estimations. Such estimation may be difficult on large, brushy sites where visibility is limited, but extreme precision is not necessary. While the rating categories are broad, evaluators do need to calibrate their eye with practice. It is important to remember that a health rating is not an absolute value. The factor breakout groupings and point weighting in the evaluation are somewhat subjective and are not grounded in quantitative science so much as in the collective experience of an array of riparian scientists, range professionals, and land managers.

The evaluator must keep in mind that this assessment form is designed to account for most sites and conditions in the applicable region. However, rarely will all the questions seem exactly to fit the circumstances on a given site. Therefore, try to answer each question with a literal reading. If necessary, explain anomalies in the comment section. Each factor below will be rated according to conditions observed on the site. The evaluator will estimate the scoring category and enter that value on the score sheet.

1. Vegetation Cover of Floodplain and Streambanks. Vegetation cover helps to stabilise banks, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, and reduce the rate of evaporation (Platts and others 1987). On most streams the area of the channel bottom is excluded from the polygon. (***Note:*** *The whole channel width extends from right bankfull stage to left bankfull stage; however we need to include the lower banks in all polygons, therefore consider for exclusion ONLY the relatively flat and lowest area of the channel—the "bottom."*) This allows data to be collected on the riparian area while excluding the aquatic zone, or open water, of the stream. The aquatic zone is the area covered by water and lacking persistent emergent vegetation. Persistent emergent vegetation consists of perennial wetland species that normally remain standing at least until the beginning of next growing season, e.g., *Typha* species (cattails), *Scirpus* species (bulrushes), *Carex* species, and other perennial graminoids.

In many systems, large portions of the channel bottom may become exposed due to seasonal irrigation use, hydroelectric generation, and natural seasonal changes such as are found in many prairie ecosystems. In these cases, especially the prairie streams, the channel bottom may have varying amounts of herbaceous vegetation, and the channel area is ***included*** in the polygon as area to be inventoried. Typically these are the "pooled channel" stream type that has scour pools scattered along the length, interspersed with reaches of grass, bulrush, or sedge-covered channel bottom. If over half (>50%) the channel bottom area has a canopy cover of persistent vegetation cover (perennial species), taken over the entire length of the polygon as a whole, then it qualifies for inclusion within the inventoried polygon area. If the you are in doubt whether to include the channel bottom in the polygon, then leave it out, but be sure to indicate this in the comment section. This is important so that future assessments of the polygon will be looking at the same area of land.

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

2. Invasive Plant Species (Weeds). Invasive plants (weeds) are alien species 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]). Space is provided on the form for recording weed species counted. Include both woody and herbaceous invasive species. ***Leave no listed species field blank, however;***

enter "0" to indicate absence of a value. (A blank field means the observer forgot to collect the data; a value means the observer looked.)

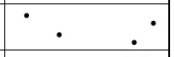
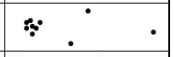
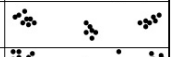
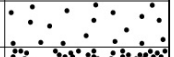
The site's health rating on this item combines two factors: weed density/distribution class and total canopy cover. A perfect score of 6 out of 6 points can only be achieved if the site is weed free. A score of 4 out of the 6 points means the weed problem is just beginning (i.e., very few weeds and small total canopy cover (less than 1%). A moderate weed problem gets 2 out of 6 points. It has a moderately dense weed plant distribution (a class between 4 and 7) and moderate total weed canopy cover (between 1% and 15%). A site scores 0 points if the density/distribution is in class 8 or higher, or if the total weed canopy cover is 15% or more.

2a. Total Canopy Cover of Invasive Plant Species (Weeds). The evaluator 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% of the polygon area. **1 =** Invasive plants present with total canopy cover between 1% and 15% of the polygon area. **0 =** Invasive plants present with total canopy cover more than 15% of the polygon area.

2b. Density/Distribution Pattern of Invasive Plant Species (Weeds). 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 realising that the real situation may be only roughly approximated at best by any of these diagrams. Choose the category that most closely matches the view of the polygon.

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.	

NOTE: Prior to the 2001 season, the health score for weed infestation was assessed from a single numerical value that does not represent weed canopy cover, but instead represents the fraction of the polygon area on which weeds had a well established population of individuals (i.e., the area infested).

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 any additional species included.

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

Scoring:
3 = Less than 5% of the site covered by disturbance-increaser undesirable herbaceous species.
2 = 5% to 25% of the site covered by disturbance-increaser undesirable herbaceous species.
1 = 25% to 50% of the site covered by disturbance-increaser undesirable herbaceous species.
0 = More than 50% of the site covered by disturbance-increaser 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 stabilisers, 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.)

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [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* species (caragana), *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [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 (e.g., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon 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* (buckbrush/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 buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/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 1.8 m (6.0 ft), seedlings and saplings are those individuals less than 1.8 m (6.0 ft) tall. For species normally not exceeding 1.8 m (6.0 ft), seedlings and saplings are those individuals less than 0.45 m (1.5 ft) 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 young plants.)

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/or saplings.
4 = 5% to 15% of the total canopy cover of preferred trees/shrubs is seedlings and/or saplings.
2 = Less than 5% of the total canopy cover of preferred tree/shrubs is seedlings and/or saplings.
0 = Preferred tree/shrub seedlings and saplings absent.

5a. Browse Utilization of Available 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, or all woody plants have already been removed.*) Livestock and/or wildlife browse many riparian woody species. Excessive browsing can eliminate these important plants from the community and result in their replacement by undesirable invaders. With excessive browsing, the plant loses vigour, is prevented from flowering, or is killed. Utilization in small amounts is normal and not a health concern, but concern increases with greater browse intensity.

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [salt cedar]) are excluded from the evaluation of utilization. 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* species (caragana), *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* species [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 (e.g., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon 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* (buckbrush/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 buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

Consider as available all tree and shrub plants to which animals may gain access and that they can reach. For tree species, this means mostly just seedling and sapling age classes. 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, because this would not accurately reflect actual use when more browsing can occur later in the season. Browsing of second year or older material affects the overall health of the plant and continual high use will affect the ability of the plant to maintain itself on the site. Determine percentage by comparing the number of leaders browsed or utilised 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. Do not count utilization on dead plants, unless it is clear that death resulted from over-grazing. ***Note:*** If a shrub is entirely mushroom/umbrella shaped by long term heavy browse or rubbing, count utilization of it as heavy.

Scoring: (*Consider all shrubs within animal reach and seedlings and saplings of tree species. If the site has no woody vegetation [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.*)
3 = None (0% to 5% of available second year and older leaders of preferred species are browsed).
2 = Light (5% to 25% of available second year and older leaders of preferred species are browsed).
1 = Moderate (25% to 50% of available second year and older leaders of preferred species are browsed).
0 = Heavy (More than 50% of available second year and older leaders of preferred species are browsed).

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.

Removal of woody vegetation may occur at once (a logging operation), or it may be cumulative over time (annual firewood cutting or beaver activity). Give credit for re-growth. Consider how much the removal of a tree many years ago may have now been mitigated with young replacements.

Four non-native species or genera are excluded from consideration here because these are aggressive, undesirable exotic plants that should be removed. They are *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus cathartica* (European/common buckthorne), and *Tamarix* species (salt cedar).

Determine the extent to which woody vegetation (trees and shrubs) is lacking due to being physically removed in the recent past (i.e., cut, mowed, trimmed, logged, cut by beaver, or otherwise cut from their growing position). When you have determined how much was removed, then compare that to the amount remaining uncut/re-grown, and choose a "best fit estimate" from the categories below. (***NOTE:*** In general, the more recent the removal, the more entirely it is fully counted; and conversely, the older the removal, the more likely it is to be mitigated by re-growth.)

This question is really looking at volume (three dimensions) and not canopy cover (two dimensions). For example, if an old growth spruce tree is removed, a number of new seedlings/saplings may become established and could soon achieve the same canopy cover as the old tree had. However, the value of the old tree to wildlife and overall habitat values is far less than that of the seedling/saplings. It will take a very long time before the seedlings/saplings can grow to replace all the habitat values that were provided by the tall old tree. On the other hand, shrubs, such as willows, grow faster and may replace the volume of removed plants in a much shorter time.

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 vegetation 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. The observer is to ignore (not count) decadence in poplars or cottonwoods which are decadent ***due to old age*** (rough and furrowed bark extends substantially up into the crowns of the trees) (species: *Populus deltoides* [plains cottonwood], *P. angustifolia* [narrow-leaf cottonwood], and *P. balsamifera* [balsam poplar]), because cottonwoods/poplars are early seral species and naturally die off in the absence of disturbance to yield the site to later seral species. The observer is to consider (count) decadence in these species if apparently caused by de-watering, browse stress, climatic influences, or parasitic infestation (insects/disease). The observer should comment on conflicting or confounding indicators, and/or if the cause of decadence is simply unknown (*but not due to old age*).

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 and/or dead.
2 = 5% to 25% of the total canopy cover of woody species is decadent and/or dead.
1 = 25% to 50% of the total canopy cover of woody species is decadent and/or dead.
0 = More than 50% of the total canopy cover of woody species is decadent and/or dead.

7. Streambank Root Mass Protection. Vegetation along streambanks performs the primary physical functions of stabilising the soil with a binding root mass and of filtering sediments from overland flow. Few studies have documented depth and extent of root systems of plant species found in wetlands. Despite this lack of documented evidence, some generalisations can be made. All tree and shrub species are considered to have deep, binding root masses. Among wetland herbaceous species, the first rule is that annual plants lack deep, binding roots. Perennial species offer a wide range of root mass qualities. Some rhizomatous species such as the deep rooted *Carex* species (sedges) are excellent bank stabilisers. Others, such as *Poa pratensis* (Kentucky bluegrass), have only shallow roots and are poor bank stabilisers. Still others, such as *Juncus balticus* (wire rush), are intermediate in their ability to stabilise banks. The size and nature of the stream will determine which herbaceous species can be effective. The evaluator should try to determine if the types of root systems present in the polygon are in fact contributing to the stability of the streambanks.

In situations where you are assessing a high, cut bank (usually on an outside bend), the top may be upland, but the bottom is riparian. Do not assess the area that is non-riparian. In cases of tall, nearly vertical cut banks, assess the bottom portion that comes in contact with floodwaters. Omit from consideration those areas where the bank is comprised of bedrock, since these neither provide binding root mass, nor erode at a perceptible rate.

Note: Riprap does not substitute for, act as, or preclude the need for deep, binding root mass.

Since the kind and amount of deep, binding roots needed to anchor a bank is dependent on size of the stream, use the following table as a general guide to determine width of a band along the banks to assess for deep, binding roots. This is a "rule of thumb" for guidance that requires only estimated measurements.

Stream Size (Bankfull Channel Width)	**Width of Band to Assess for Deep, Binding Roots**
Rivers (Larger Than 30 m [>100 ft])	15 m (50 ft)
Large Streams (Approx. 5-30 m [16-100 ft])	5 m (16 ft)
Small Streams (Up To Approx. 5 m [16 ft])	2 m (6 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 6 cm (2.5 in). Hardened, impervious surfaces (e.g., asphalt, concrete, etc.) are not bare ground—these do not erode nor allow weeds sites to invade. 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. On most streams the area of the channel bottom is excluded from the polygon. (***Note:*** *The whole channel width extends from right bankfull stage to left bankfull stage; however we need to include the lower banks in all polygons, therefore consider for exclusion ONLY the relatively flat and lowest area of the channel—the "bottom."*) This allows data to be collected on the riparian area while excluding the aquatic zone, or open water, of the stream. The aquatic zone is the area covered by water and lacking persistent emergent vegetation. Persistent emergent vegetation consists of perennial wetland species that normally remain standing at least until the beginning of next growing season, e.g., *Typha* species (cattails), *Scirpus* species (bulrushes), *Carex* species, and other perennial graminoids.

In many systems, large portions of the channel bottom may become exposed due to seasonal irrigation use, hydroelectric generation, and natural seasonal changes such as are found in many prairie ecosystems. In these cases, especially the prairie streams, the channel bottom may have varying amounts of herbaceous vegetation, and the channel area is ***included*** in the polygon as area to be inventoried. Typically, these are the "pooled channel" stream type that has scour pools scattered along the length, interspersed with reaches of grass, bulrush, or sedge-covered channel bottom. If over half (>50%) the channel bottom area has a canopy cover of persistent vegetation cover (perennial species), taken over the entire length of the polygon

as a whole, then it qualifies for inclusion within the inventoried polygon area. If you are in doubt whether to include the channel bottom in the polygon, then leave it out, but be sure to indicate this in the comment section. This is important so that future assessments of the polygon will be looking at the same area of land.

Scoring:

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

9. Streambank Structurally Altered by Human Activity. Altered streambanks are those having impaired structural integrity (strength or stability) usually due to human causes. These banks are more susceptible to cracking and/or slumping. Count as streambank alteration such damage as livestock or wildlife hoof shear and concentrated trampling, vehicle or ATV tracks, and any other areas of human-caused disruption of bank integrity, including riprap or use of fill. The basic criterion is any disturbance to bank structure that increases erosion potential or bank profile shape change. One large exception is lateral bank cutting caused by stream flow, even if thought to result from upstream human manipulation of the flow. The intent of this item is to assess only direct, on-site mechanical or structural damage to the banks. Each bank is considered separately, so total bank length for this item is approximately twice the reach length of stream channel in the polygon (more if the stream is braided). ***NOTE:*** Constructed streambanks (especially those with riprap) may be stabilised at the immediate location, but are likely to disrupt normal flow dynamics and cause erosion of banks downstream. The width of the bank to be considered is proportional to stream size. The table below gives a conceptual guideline for how wide a band along the bank to assess. ——

Stream Size (Bankfull Channel Width)	Width of Band to Assess for Bank Alteration
Rivers	(Larger Than 30 m [>100 ft]) 4 m (13 ft)
Large Streams	(Approx. 5-30 m [16-100 ft]) 2 m (6 ft)
Small Streams	(Up To Approx. 5 m [16 ft]) 1 m (3 ft)

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 stream bank 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 system 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:

- **Soil Compaction.** This kind of alteration includes livestock-caused hummocking and pugging, recreational trails that obviously have compacted the soil, vehicle and machine tracks and ruts in soft soil, etc.
- **Plowing/Tilling.** This is disruption of the soil surface for cultivation purposes. It does not include the alteration of drainage or topographic pattern, which are included in the **Topographic Change** category.
- **Hydrologic Change.** Include in this category any area that is physically affected by removal or addition of water for human purpose. The physical effects to look for are erosion due to reduced or increased water, bared soil surface that had water cover removed, or flooded area that normally supports a drier vegetation type.
- **Human Impervious Surface.** This includes roofs, hardened surfaces like walkways and roads, boat launches, etc.
- **Topographic Change.** This is the deliberate alteration of terrain and/or drainage pattern for human purposes. It may be for aesthetic (landscaping) or other reasons, including such structures as water diversions ditches and canals.

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 categorised 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 begin to 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 can begin to access a floodplain appropriate to the stream type. Active downcutting is not evident. Any old incisement is characterised by a broad floodplain inside which perennial riparian plant communities are well established. This condition is described 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**.

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 characterised 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**.

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** 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 erodible. 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.

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APPENDIX M

FACTORS FOR ASSESSING LENTIC RIPARIAN HEALTH OF LAKES AND WETLANDS

FACTORS FOR ASSESSING LENTIC (STANDING WATER) WETLAND HEALTH (SURVEY)

The riparian health score is based on 9 basic parameters pertaining to riparian health. This appendix addresses the guidelines and stipulations followed when each parameter was answered during the assessment. Keep in mind that these parameters are meant to encompass the broad range of ecological diversity that lake and wetland systems have the potential to express. The interpretations are not completely specific to any one type of stream system, yet still capture the essential factors of riparian health and function.

Many different factors must be considered when answering any one of these parameters. It is quite possible that every scenario that could be encountered when conducting assessments is not covered here. Personal judgment based on sound riparian knowledge and good visual estimations are critical tools necessary for answering these questions consistently.

This description of riparian health parameters is based on the Alberta Lentic Wetland Health (Survey) User Manual as created by Bitterroot Restoration, Inc. (2002).

LENTIC RIPARIAN HEALTH PARAMETERS

Some factors on the evaluation will not apply on all sites. For example, sites without potential for woody species are not rated on factors concerning trees and shrubs. Vegetative site potential can be determined by using a key to site type (e.g., Hansen and others 1995, Kovalchik 1987, or another appropriate publication). On severely disturbed sites, vegetation potential can be difficult to determine. On such sites, clues to potential may be sought on nearby sites with similar landscape position.

Most of the factors rated in this evaluation are based on ocular estimations. Such estimation may be difficult on large, brushy sites where visibility is limited, but extreme precision is not necessary. While the rating categories are broad, evaluators do need to calibrate their eye with practice. It is important to remember that a health rating is not an absolute value. The factor breakout groupings and point weighting in the evaluation are somewhat subjective and are not grounded in quantitative science so much as in the collective experience of an array of riparian scientists, range professionals, and land managers.

Each factor below will be rated according to conditions observed on the site. The evaluator will estimate the scoring category and enter that value on the score sheet.

1. Vegetation Cover of the Polygon. Around lentic water bodies vegetation cover helps to stabilize shorelines, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, reduce the rate of evaporation (Platts and others 1987), and contributes primary production to the ecosystem. This question focuses on how much of the entire polygon area is covered by plant growth. Item #10 below assesses the amount of human-caused bare ground. Although there is some overlap between these two items, the bare ground to be counted in item #10 is strictly limited in definition, whereas all unvegetated area not inundated by water is counted in this item. The only area within the polygon exempt from consideration here is area covered by water. Areas such as boat docks, hardened pathways, and artificial structures are counted as unvegetated along with any bare ground, human-caused or natural. The rationale is that all such unvegetated areas contribute nothing to several of the important lentic wetland functions.

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. Invasive plants (weeds) are alien species 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 Disturbancecaused Undesirable Plant List* [Cows and Fish 2002]). Some common invasive species are listed on the form, and space is allowed for recording others. ***Leave no listed species field blank, however;*** enter "0" to indicate absence of a value.

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 Pattern 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.

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 M1. Density and distribution of invasive plants.

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.

3. Disturbance-Caused 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. 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 Regeneration. (Skip this item if the site lacks potential for trees or shrubs; for example, the site is a herbaceous wet meadow or cattail 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, Hansen and others 1995). 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.)

Elaeagnus angustifolia (Russian olive) and three other shrub genera (*Symphoricarpos* spp. [buckbrush/snowberry], *Rosa* spp. [rose], and *Crataegus* spp. [hawthorn] 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) is considered an especially aggressive, undesirable exotic plant. The main reason for excluding these plants is that 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* [Saskatoon], 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* (buckbrush/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 buckbrush/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.)
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.

Elaeagnus angustifolia (Russian olive) and three other shrub genera (*Symphoricarpos* spp. [buckbrush/snowberry], *Rosa* spp. [rose], and *Crataegus* spp. [hawthorn] 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) is considered an especially aggressive, undesirable exotic plant.

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* [Saskatoon], 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* (buckbrush/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 buckbrush/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 since this may not accurately reflect actual use because significant 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. Do not include use of dead plants unless it is clear this condition was the result of over-grazing.

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.)
3 = None (0% to 5% of available second year and older leaders of preferred species are browsed).
2 = Light (5% to 25% of available second year and older leaders of preferred species are browsed).
1 = Moderate (25% to 50% of available second year and older leaders of preferred species are browsed).
0 = Heavy (More than 50% of available second year and older leaders of preferred species are browsed).

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. Human Alteration of Polygon Vegetation. Human alteration of the vegetation is meant to include all changes to the plant community composition or structure on the polygon caused by human actions (e.g., logging, mining, roads, construction, or development) or by agents of human management (e.g., livestock). It is not meant to include transitory or short-term removal of plant material that does not impact plant community composition (i.e., grazing at carefully managed levels). Of concern are the kinds of change that diminish or disrupt the natural wetland function of the vegetation. These include, but are not limited to, vegetation clearing, changing plant community composition (e.g., replacing willows with rose and buckbrush, woody species with herbaceous species, etc.), replacing native plants with tame plants, replacing deep rooted plants with shallow rooted plants, and/or replacing tall species with short species. On polygons adjacent to deep water, remember that the polygon extends out to where the water is two meters deep. (***NOTE:*** Do not count the same area twice by including it as both a vegetation and a physical alteration, unless there clearly are both kinds of alteration. Decide into which category a particular effect should go. For example: A timber harvest may clear vegetation, but not necessarily cause physical damage on one area; while on another area cause both clearing of vegetation and disruption of the soil by skidding of logs.)

Scoring:
6 = Less than 5% of polygon vegetation is altered by human activity.
4 = 5% to 15% of polygon vegetation is altered by human activity.
2 = 15% to 35% of polygon vegetation is altered by human activity.
0 = 35% or more of polygon vegetation is altered by human activity.

7. Human Alteration of Polygon Physical Site. This evaluation of human alteration of the physical site is meant to include all changes to the physical attributes of the site caused by human actions (e.g., logging, mining, housing development) or by agents of human management (e.g., livestock). The kinds of physical change that diminish or disrupt the natural wetland functions on the site include, but are not limited to, hummocking, pugging, and trails by livestock; human roads, trails, buildings, landscaping, boat launches/docks, beach clearing and building, or rip-rapping shores and banks. (***NOTE:*** Do not count the same area twice by including it as both a vegetation and a physical alteration, unless there clearly are both kinds of alteration. Decide into which category a particular effect should go. For example: A cottage owner may clear vegetation to gain a view of the lake without causing physical damage to one area; whereas, if he/she hauls in sand to enhance the beach, there is also physical alteration.)

Scoring:
12 = Less than 5% of the polygon is physically altered by human activity.
8 = 5% to 15% of the polygon is physically altered by human activity.
4 = 15% to 35% of the polygon is physically altered by human activity.
0 = 35% or more of the polygon is physically altered by human activity.

8. Human-Caused Bare Ground. Bare ground is exposed soil surface (not covered by plants, litter or duff, down wood, or rocks larger than 2.5 inches [6 cm]). Bare ground may result naturally from several processes (i.e., sedimentation, flood erosion, fire, tree fall, and exposure of lakebed by low water level), but that caused by human activity always indicates an impairment of wetland health. Exposed soil is vulnerable to erosion and is where weeds become established. Bare soil is not producing, nor providing habitat. Sediment deposits and other natural bare ground are excluded as normal and probably beyond management control. Human land uses often causing bare ground include livestock grazing, recreation, off road vehicle use, and resource extraction activities. After considering the causes of all bare ground on the site, the evaluator must estimate what percent of the site (polygon) area is human-caused bare ground.

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 = 15% or more of the site is human-caused bare ground.

9. Degree of Artificial Removal of Water. Although water levels naturally fluctuate on a seasonal basis in most systems, many wetland systems are affected by water removal for human uses. This artificial removal of water level often does not follow a temporal regime conducive to maintaining healthy native wetland plant communities. The result is often a barren band

of shore exposed for much of the growing season. This withdraws soil water from the rooting zone of established shore vegetation communities, causes shore material to destabilize, and provides sites for weeds to invade. Such conditions are extremely detrimental to the riparian vegetation, site productivity, and wildlife values.

Not all lentic wetlands evaluated with this form will have surface water potential, but any wetland may have its water table degraded by draining, pumping, or diverting its surface or subsurface supply. On such lentic wetlands as marshes and wet meadows, look for evidence of drainage ditching, pumping, and the interruption of normal surface drainage inputs by livestock watering dugouts, cross slope ditches, or dams upslope.

In this item the evaluator is asked to categorize the degree to which the system is subjected to artificially rapid or unnaturally timed fluctuations in water level. Reservoirs intended for storage of water for power generation, irrigation, and/or livestock watering typically exhibit the most severe effects, but water may be diverted or pumped from natural systems for many other reasons (domestic use, industrial use, livestock watering, etc.). This item requires the evaluator to make a subjective call by choosing as a "best fit" one of the categories of drawdown severity described below. (***Note:*** Be careful to consider the scale of the water body as it relates to the scale of water removal. Pumping a small dugout full of water for livestock might severely impact a two acre slough, but be negligible to a lake covering a section of land.)

Be sure to document the grounds for your estimate here. If there is no way to know with any reasonable degree of certainty how much water is being removed, it may be better to document the situation and to "zero out" this item (not answer it). During periods of drought lakebeds become exposed and often exhibit wide zones of almost barren shore. The evaluator must be careful not to attribute this natural phenomenon unfairly to a human cause.

Categories of Lentic Water Removal Severity

CATEGORY	DEFINITION
Not Subjected	The waterbody is not subjected to artificial drawdown.
Minor	The waterbody is subject to no more than minor artificial water level change. The shore area remains vegetated and withdrawal of water is limited or slow enough that vegetation is able to maintain growth and prevent exposed soil. A relatively narrow band affected by the water level fluctuation may support only annual plants.
Moderate	The waterbody is subject to moderate quantities, speed and/or frequency of artificial water level change. Where water is removed, it is done in a way that allows pioneer plants to vegetate at least half of the exposed area resulting from drawdown. Where water is added, some flooding may occur at levels or times not typical to the area/season.
Extreme	The waterbody is subjected to extreme changes in water level due to volume (extent), speed and/or frequency of artificial water addition or removal. Frequent or unnatural levels of flooding occur where water is added, including extensive flooding into riparian and/or upland areas; or no natural annual drawdown is allowed to occur. In extreme artificial drawdown situations, a wide band of exposed bottom remains unvegetated.

Scoring:
9 = The waterbody, or wetland, is "Not Subjected" to artificial water removal
6 = The degree of artificial water removal is "Minor"
3 = The degree of artificial water removal is "Moderate"
0 = The degree of artificial water removal is "Extreme"