Cows and Fish Report

Overview of Riparian Health in Alberta

A Review of Cows and Fish Data from 1997-2006

Cows and Fish

Alberta Riparian Habitat Management Society Report No. 035

Overview of Riparian Health in Alberta

A Review of Sites from 1997-2006

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In addition to financial support, we must recognise the commitment and support provided by the Cows and Fish Members and Supporters. This support has been key to refining and introducing an innovative, creative and community-based riparian management tool to landowners, producers and communities across the province and Canada.

Data summarised in this report were collected at the request of local groups, landowners and land managers. We would like to express our sincere appreciation for the interest of these individuals and groups, and their commitment to understanding and managing riparian health. Our success in delivering riparian health assessments and inventories at the local community and watershed scale is made possible by the proactive efforts of local communities, stewardship or producer groups, and Agricultural Service Boards and their representatives.

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Thanks to all past and present members of the Cows and Fish team whose efforts, dedication and critical thinking have made better tools and continue to improve how our program works with communities. In addition, our appreciation to Lorne Fitch and Barry Adams, for their early vision to implement and commit to a science-based view of riparian health, delivered within a community-led approach.

About Cows and Fish

Riparian areas are those areas along rivers, streams, lakes, wetlands, springs, and ponds that are strongly influenced by water and are recognized by water-loving vegetation and "wet" soils. Cows and Fish is striving to foster a better understanding of how riparian areas function and how improvements in management strategies in riparian areas can enhance landscape health and productivity for the benefit of livestock producers, other riparian landowners, their communities and all who use and value these landscapes.

Cows and Fish Supporters and Members: Producers and community groups, Alberta Beef Producers, Trout Unlimited Canada, Canadian Cattlemen's Association, Alberta Agriculture and Rural Development, Alberta Sustainable Resource Development, Alberta Environment, Fisheries and Oceans Canada, Prairie Farm Rehabilitation Administration of Agriculture and Agri-food Canada, Alberta Conservation Association

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EXECUTIVE SUMMARY

As part of a provincial initiative to assess baseline conditions of aquatic ecosystem health in Alberta, Cows and Fish was asked by Alberta Environment to synthesize existing Cows and Fish riparian health data in order to provide an overview of riparian health in Alberta. This synthesis fulfils part of the commitment to Albertans made by the Government of Alberta, under the province's *Water for Life* Strategy, to report on the status of aquatic health in the province. Using data collected primarily in partnership with local communities, watershed groups and agencies between 1997 and 2006, this report summarises Cows and Fish riparian health data by major river basin (watershed) and by waterbody type.

Riparian areas, those areas characterised by hydrophytic vegetation and wet soils, are located adjacent to, and are influenced by, waterbodies or elevated water tables. These areas are important for water quality, quantity and aquatic ecosystems and to society as a whole because they perform ecological functions such as trapping sediment from overland flow and flood waters, dissipating and storing water and energy, and filtering water and contaminants. In addition, riparian areas build and maintain banks and shores, generate relatively high levels of primary productivity, and provide habitat for both fish and wildlife.

Determining how well riparian areas are performing these ecological functions involves evaluating their health. Riparian health is measured through field examination of a riparian site, including collecting data for numerous physical and vegetative parameters. These parameters are then used to derive a riparian health assessment score. The riparian health assessment parameters examined provide an indication of the extent to which riparian functions are intact or have been impaired. Collectively, these parameters are indicators of overall health or lack of health of a riparian site.

In total, 1,490 riparian sites are included in this analysis; these sites cover approximately 1,380 km of riparian area assessed or inventoried and are associated with streams, rivers, lakes, wetlands, springs, and seeps in Alberta. Data are presented from the Athabasca, Beaver, North Saskatchewan, South Saskatchewan, and Milk River basins; no data are available from the Peace/Slave or Hay River basins. Provincially, just under one quarter of all sites examined are rated as healthy (22%), about half (51%) of sites rate healthy but with problems and slightly more than one quarter (27%) are unhealthy.

Based on this analysis, the ability of riparian areas in Alberta to perform ecological functions is considerably impaired on over one quarter of sites, and impaired to some degree on an additional half of sites examined. With less than one quarter of riparian areas in Alberta functioning fully, many riparian areas are not providing the ecological goods and services that come from healthy riparian areas. The loss of ecological functions means many riparian areas are doing little to improve and support aquatic health in Alberta; however, many of these functions can be regained with changes to land use and management. Improvements in riparian health will rely upon application and support of restorative, practical and sustainable management choices at local, regional and provincial scales.

For healthy sites, it is important to identify their current status and maintain their level of health, including promoting the management practices and land uses that resulted in healthy riparian areas. Broad scale planning initiatives as well as site specific work should focus on keeping existing, functioning sites healthy and aim to prevent further loss of function in healthy but with problems sites and unhealthy sites. Both strategic initiatives and local land use and management should focus on increasing the health of riparian areas that are not currently rated as healthy.

Based on this provincial synthesis of data, some vegetation related riparian health parameters are commonly impacted across most or all basins and waterbody types. Invasive plants are both widespread and relatively abundant in riparian areas. Control and eradication through a diversity of management techniques is required to reduce further impact and spread in riparian areas. Similarly, disturbance-caused undesirable herbaceous plants are also widespread and very abundant. Eradication of these disturbance-caused plants is unlikely, but management choices and land use that minimise disturbance levels and promote native, deep-rooted species should reduce their expansion and provide improvements to riparian health. Utilisation of woody plants, mostly due to wildlife and livestock, is negatively affecting the health rating and, over the long-term, if it continues at high levels, will likely reduce the cover and vigour of the tree and shrub community.

Alterations to the physical, structural aspect of riparian areas, including banks, shores, and floodplains, are of concern for some waterbody types and in some basins. Although more variable than the vegetative alterations highlighted, these modifications to soil profile and shape of bank or shore areas are of concern because they result in compacted soils, increased potential for erosion, and reduced infiltration potential. Management actions that minimize structural alterations, including avoiding using riparian areas when soils are saturated and most compactable, will improve these physical aspects of the riparian site. Ensuring that timing and intensity of use is sustainable will benefit both vegetative and physical aspects of riparian areas.

Numerous aspects of riparian health varied between waterbody types and basins. In part, this variability resulted from differences in sample size between basins and different waterbody types. These differences may warrant some targeted awareness and management application specific to waterbody type and geographic location. Overall, this variability in many parameters suggests the potential exists for improved health in areas where parameters are currently rated lower than in other basins or waterbody types. This variability also emphasizes the need for specific management approaches to be applied to individual sites with an understanding of the underlying functions and potential of riparian areas.

Of the sites included in this report, where land use data was recorded, 77% of sites had native pasture/rangeland grazing; consequently this land use was often the primary cause of alterations. Recreation was the next most frequently occurring land use, and it was often an important cause of alterations. A diversity of land uses, including development, roads, tame pasture, and other uncategorised land uses were less frequent but widespread.

Geographic gaps exist in the data, particularly in the northern and less settled regions of the province. In addition, there is limited representation of wetlands, and to a lesser degree, lakes. There are also very few sites sampled in springs and seeps. Continued examination of a diversity of land uses and waterbody types will provide value in representing the diversity of riparian health in Alberta. Additional resources will be required to continue to establish baseline data in new areas and re-examine existing data for trend and site monitoring to further contribute to the understanding of aquatic and riparian health in Alberta.

The ability to improve riparian health at the local, regional, or provincial level relies upon the active participation and involvement of landowners, land and resource managers and users, as well as local and regional groups, since the application of management choices, and impact to riparian health, will be implemented at these diverse scales. Planning for improvements to riparian health will thus need to consider how such participation and involvement can be generated. We suggest that local community-based initiatives are a realistic and proven mechanism for such implementation to occur. Continued support for these initiatives is required to improve the health of riparian areas in Alberta.

Further efforts are required to ensure that riparian health benchmark data is used to assist in the education and capacity building of landowners, land and resource manager, and communities, to better understand and manage their riparian areas. Maintaining existing health and promoting improvements to riparian health are realistic, but achieving such changes will require use of a structured approach, such as that already used by Cows and Fish. Commitment for the long-term implementation of such an approach will ensure success in awareness, building local capacity and teams, creating new and innovative tools to apply management, facilitating community based action and monitoring.

Riparian areas are fundamentally important to humans, fish, wildlife, and overall aquatic and terrestrial landscape health – conservation and management efforts must focus on improving the functional integrity of these systems. Improvements to ecosystem functions must not rely upon the collection of monitoring data that catalogues the level of function, but rather monitoring should be used within the context of a larger approach to improve the health of riparian and other ecosystems. Current loss of riparian health and continued pressures in these areas will only increase the likelihood of further losses to function unless collective efforts are made to reduce those impacts to riparian landscapes. These losses are likely to continue to a level that is irreversible and has significant negative consequences unless there is a concerted province-wide effort. We must strengthen and expand individual and group initiatives, while aligning broad planning, land use and management strategies to ensure that losses to riparian area function do not increase, but instead begin to achieve a net improvement. The approach to achieve that improvement must include education and capacity building to help landowners, managers and users to apply sustainable management.

1.0 BACKGROUND AND RATIONALE

Cows and Fish (Alberta Riparian Habitat Management Society) has been collecting baseline information on riparian health in Alberta since 1997, through work with landowners, rural municipalities, watershed and community groups, and resource agencies. In 2003, the government of Alberta released *Water for Life: Alberta's Strategy for Sustainability*, a strategy that identified protection of water through a provincial strategy that outlines three main goals for water management in Alberta: 1) safe, secure drinking water; 2) healthy aquatic ecosystems; and 3) reliable quality water supplies for a sustainable economy. The achievement of all of three of these goals is intricately linked to the maintenance of healthy, ecologically functioning riparian areas. Cows and Fish was asked to assemble and synthesize our existing riparian health assessment and inventory data for lakes, rivers, streams and wetlands, to provide an overview of riparian area health in Alberta.

Riparian areas, those areas of hydrophytic vegetation and wet soils adjacent to and influenced by waterbodies, are important for water quality, quantity and aquatic ecosystems because they perform ecological functions like trapping sediment from overland flow and flood waters, dissipating and storing water and energy, and filtering water and contaminants. In addition, riparian areas build and maintain banks and shores, generate considerable primary productivity, and provide habitat for both fish and wildlife.

Working with Dr. Paul Hansen and William (Bill) Thompson (formerly of University of Montana's Riparian and Wetland Research Program), currently of Ecological Solutions Group LLC, Cows and Fish began using the lotic (flowing waterbodies) form of the Wetland Health Assessment in Alberta in 1997, and moved to include the more detailed lentic (non-flowing waterbodies) and lotic Wetland Inventory methods in 1998. The intent of the methods is to determine if a riparian site is performing certain ecological functions (e.g. sediment trapping, water filtration, biological diversity and primary production) through the examination of parameters that provide indirect evidence of these ecological functions. Field methods involve visually examining both vegetative and physical features of a riparian site, and determining riparian health by assessing the extent to which a site displays these features. Healthier riparian areas should perform more ecological functions better than less healthy ones, and the health assessment methods are a means to indicate the extent to which these functions are occurring. Previous work commissioned by Cows and Fish indicates that healthier riparian areas have more tall and dense trees and shrubs, that healthier riparian areas support more breeding birds and that breeding birds diversity and abundance are influenced by the presence of denser and more diverse vegetation (Palliser Environmental Services Ltd. 2008; Saunders and Hurly 2000a; Saunders and Hurly 2000b).

In order to assess the availability of baseline ecological monitoring for riparian areas and to evaluate the current state of these habitats, Alberta Environment requested Cows and Fish generate a provincial riparian health overview of existing Cows and Fish data collected from 1997 to 2006, as one of several provincial reviews related to the healthy aquatic ecosystem goal of *Water for Life*. Other researchers, outside of this project, have assessed, or are assessing, stream flow and hydrology, fish and non-fish biota, as well as water quality and use such as North/South Consultants (2007) and Alberta Environment (2007).

Additional information regarding other sources of riparian observations or riparian health data collected by organizations other than Alberta Riparian Habitat Management Society (ARHMS-Cows and Fish) is presented in Cows and Fish Report No. 31, completed by Palliser Environmental Services Ltd. (Riemersma and Andrews 2007). Within Riemersma and Andrews (2007), approximately 1,030 sites have been examined using riparian health assessment (i.e. Cows and Fish methodology); other methods of evaluation were included for approximately 120 sites. Most projects included in Riemersma and Andrews (2007) are based on one or a few sites, and seldom included extensive sampling of a watershed or waterbody. Data identified in Riemersma and Andrews (2007) have not been included in this riparian health overview report for a number of reasons, including: incomplete or no assessment of health made or possible; individual site data not available (or inaccessible due to confidentiality or data ownership limitations); diverse methodologies; uncertainty of data collection methods; and a need to maintain consistent management of ARHMS data.

The riparian health overview in this report involved assembling and synthesizing data collected by Cows and Fish for Alberta lakes, wetlands, rivers, streams, springs and seeps. This report provides an overview of riparian health based on the overall health status (rating) of each site: healthy; healthy but with problems; or unhealthy. Section 3.0 of this report provides the first phase of a broad provincial riparian health status overview by major river basin and by waterbody type. A more in depth examination of individual riparian health parameters by major river basin and waterbody type follows in Section 4.0. Final sections of the report identify gaps in existing data and provide direction on where efforts should be focused to maintain and improve riparian health.

Measuring riparian health using a standard set of parameters establishes an important baseline to compare to in the future and help track whether riparian areas are: being maintained, improving or declining. This overview of existing Cows and Fish riparian health data will contribute significantly to defining the current status of aquatic ecosystem health in Alberta, establish a necessary baseline for monitoring riparian areas in the province and major river basins, identify gaps in current riparian health, focus attention on riparian health issues and suggest the actions needed to improve riparian health provincially.

2.0 METHODS

Riparian health is determined by field examination of a riparian site, involving the collection of numerous physical and vegetative parameters, and then deriving a riparian health assessment score (or rating) from the collected data. This rating is expressed as a percentage, as well as a health category (healthy, healthy but with problems, or unhealthy) (Table 1). The riparian health assessment parameters are intended to provide an indication of the extent to which riparian functions have been impaired. In a general sense, examined together, they are indicators of health or lack of health.

Table 1. Riparian health categories, percent scoring range, and level of impairment to riparian function.

Riparian Health Category	**Health Assessment Scoring Range**	**Impact to Riparian Function**
Healthy	*80-100%*	Little to no impairment to any riparian functions
Healthy, but with problems	*60-79%*	Some impairment to riparian functions due to human or natural causes
Unhealthy	*<60%*	Severe impairment to riparian functions due to human or natural causes

Two formats of data collection are included in this report: assessment (survey) and inventory. The assessment or survey method has a limited number of questions (parameters) that are scored relative to standardized scoring (refer to Appendices O, P, Q, R, U and V for field forms and methods) and contribute to the health rating. These questions are answered in the field, except for a few specific items, such as proportion of watershed dammed or proportion of natural flow removed, where applicable. In contrast, the inventory method involves collection of a larger number of questions that describe the site (refer to Appendices M, N, S and T for field forms and methods), some of which are later analyzed (derived) in the office to generate a riparian health assessment, consisting of the same parameters as the survey format. A database using formulas and scripts specifically designed to utilise the inventory data derives the health score and category. See Data Analysis for additional details.

In the resulting health assessment, from either a survey or inventory, the individual parameters have scores (or ratings), resulting in the site receiving an overall score or rating based on the total score from all health parameters examined. A combination of surveys and inventories are included in this report (Table 2).

Table 2. Provincial summary of riparian health data collection methods in Alberta 1997-2006.

	Large River Health Survey	Lotic Health Survey	Lotic Inventory	Lentic Health Survey	Lentic Inventory	Total
Number of Sites	309	72	939	25	145	1490

Both inventory and survey methods involve identifying plants that are found within riparian areas, however, documentation of plant species is much more detailed in the inventory method. A list of plant species we have identified in Alberta's riparian areas is included in Appendix J. Our primary resource for plant species naming is *Flora of Alberta* by E.H. Moss (1994). Other common field guides for Alberta are used for naming non-vascular plants and a wider variety of ornamental (introduced) species. The provincial plant list in Appendix J is based on 1,393 sites with inventory data; the total area of these sites is 10,271 ha. At each site, there is potential for overlap of individual species' canopy cover. Consequently, the total area by species may not equal the total area assessed.

Plant species data were collected and categorised according to plant status. Plant status includes identifying whether a species was native, introduced, or poisonous. In addition, plants that factor into specific riparian health parameters are categorised as disturbance-caused undesirable herbaceous (referred to as 'disturbance' in Appendix J) or invasive species. Several of these plant status categories are not mutually exclusive; however a plant cannot be both native and introduced, nor can it be both invasive and disturbance-caused. Plant status is designated by Cows and Fish in association with Alberta Sustainable Resource Development Rangeland Management Branch, the *Alberta Weed Control Act and Regulations* (Alberta Government, 2006), and *Flora of Alberta* (E. H. Moss, 1994). Where details are included for numbers of species within a lifeform (eg. trees, shrubs, graminoids, forbs), plants that were not identified to species but shared a genus with another identified plant were considered not unique and therefore not counted in the total number.

2.1 Data Limitations

2.1.1 Data Acquisition

The data included in this report have been collected primarily by working at the request of local groups, organization and agencies, with voluntary landowner and land manager participation. Because data included in this report were collected to assist with baseline monitoring and management information for individual landowners or land managers and local groups at their request, its collection at the broad level was neither random nor stratified provincially, although many projects areas were stratified at the local level.

Because the vast majority of data collected was done so at the request of individuals and groups, there are a number of potential data bias concerns that might arise from this situation. First, there might be a perception that only those individuals interested and with healthy riparian areas would participate, but if this were the case, the data might be expected to show only or mostly

healthy riparian sites, which it does not. Secondly, there may be a perception that only those interested or with riparian health issues participate.
If this potential bias existed, then it might be seen by having virtually all unhealthy riparian sites, which did not occur. This concern is addressed in many local project areas through a stratification process. Although participation of landowners/land managers is completely voluntary, we aim, wherever possible, to collect representative samples within a local project area. This means that landowners or land managers can be, and often are, included that were not initially involved or interested when the group's request was made to us.

Riparian sites (polygons) are irregular in shape and size; however, a number of general considerations are observed in delineating site boundaries. The area included in a riparian assessment or inventory is based on a combination of ecological, management and logistical considerations. Riparian boundaries are determined using vegetative features (e.g. dominance of facultative and obligate hydrophytic plants), hydrologic and channel features (e.g. staining or flood debris lines, flood prone areas), historical information (e.g. area frequently inundated in regular high water events), and by exclusion of the aquatic, open water zone. Sites are selected to ensure that only one land management type or approach and one landowner are included within a site. Site length is determined by these criteria, as well as the need to provide a representative sample, useful in terms of relevance to management and monitoring goals. For lotic systems, wherever possible, similar amounts of inside and outside bends are included in the sampled area, preferably including at least two meander cycles. For small lentic systems, the entire riparian area surrounding the waterbody may be included.

2.1.2 Geographic Distribution

Data collection has been primarily where extensive or long-term recreational, agricultural or residential land use and land settlement have occurred, including both public and private lands. Riparian extension and awareness programs with local communities began in 1992 in southern Alberta. Such work was limited in central or northern parts of the province until 1999, and continues to be minimal in the far north, due to limited human habitation and staff resources. As a result, southern and central areas of the province are more heavily represented in the provincial data included in this report. While some of the major provincial river basins have comparatively high sample rates, at least in some regions within them, there is poor or no representation from other basins (Table 3). In particular, no data exists for the Peace/Slave Rivers Basin or the Hay River Basin up to and including 2006 data. Comparison of riparian health data collection methods used for the major basins is presented in Appendix C-Table 2. Comparison of sampling effort by year within each basin is presented in Appendix D-Table 2.

Overall site lengths assessed and included in this report, by basin, are presented in Table 3. Lengths were recorded for all sites completed in the Athabasca River Basin and the Beaver River Basin. For the Milk River Basin, length is based on 94% of sites, North Saskatchewan River Basin – 95% of sites, and the South Saskatchewan River Basin – 99% of sites. Average site length is slightly less than 1 km.

Table 3. Riparian health sites for major river basins in Alberta 1997-2006.

Major Basin	Number of Sites	Percent of Total Sites	Length (km)
Athabasca River Watershed	110	7%	65
Beaver River Watershed	20	1%	15
North Saskatchewan River Watershed	253	17%	185
South Saskatchewan River Watershed	912	61%	936
Milk River Watershed	195	13%	178
Provincial Total	1490	100%*	1379

Note: No sites have been completed in the Hay River and Peace/Slave River Basins
*Rounding may result in a total that is less than 100%

2.1.3 Waterbody Type

For the purposes of this report, waterbodies were categorized into four waterbody types: lakes and wetlands; springs and seeps; large rivers; and streams and small rivers. The majority of the data included in this report involve riparian sites from streams and rivers (lotic or flowing), with fewer of the sites represented involving lakes and wetlands (lentic or non-flowing) waterbodies (Table 4). Very few sites were sampled that represent springs or seeps (and these may be lotic or lentic). With such limited sample size in this waterbody type, the overview of riparian health for those sites should not be considered to represent springs and seeps across Alberta.

Cursory examination of hydrographic information indicates that the actual number of streams and rivers in Alberta outweighs the numbers of lakes, particularly in the more settled regions of the province, but there are very extensive numbers of wetlands in the province. This prevalence of wetlands is not reflected in the proportion of data collected and thus presented. Most of the data collection occurred as a result of community or stewardship groups formed around local stream or river watersheds, resulting in the higher proportion of lotic, flowing water riparian sites being included in the report.

Table 4. Riparian sites by waterbody type in Alberta 1997-2006.

Waterbody Type	Number of Systems	Number of Sites	Percent of total sites	Length (km)*
Streams and Small Rivers	164	904	61%	738
Large Rivers	21	402	27%	565
Lakes and Wetlands	55	168	11%	72
Seeps and Springs	12	16	1%	6
Provincial Total	252	1490	100%	1379**

*Total length of riparian areas in this provincial data set is based on 98% of sites. Lengths for the other 2% of sites cannot be calculated due to missing data, or there is insufficient accuracy in older global positioning system data.
**Rounding may actually result in a total value that is greater than the total to one decimal place.

Due to inherent differences between flowing and non-flowing waterbodies, there are different parameters of riparian health that are measured on these waterbody types (see Section 2.4 Table 8). Thus, there are separate data collection methods for lotic and lentic systems. Refer to Appendices M, N, O and P for details on lotic methods and Appendices S, T, U and V for details on lentic methods. In addition, due to the increased likelihood of hydrologic alterations (eg. damming, diversions, flow management) on large rivers, there is also a large river assessment (survey) that can be used for large lotic systems. Refer to Appendices Q and R for details. For the purposes of this report, where data for those hydrologic parameters was available, the large river health survey was used. Three quarters (75%) of the data for large rivers is presented as such. Where data for those hydrologic parameters was unavailable for large rivers, data collected using the other lotic inventory or assessment methodology, which is appropriate for all lotic system types, are included. This approach represents one quarter (25%) of the large river data. Comparison of riparian health data collection methods used for waterbody types is presented in Appendix C-Table 1. Comparison of sampling effort by year for each waterbody type is presented in Appendix D-Table 1.

2.1.4 Land Use

Beginning in 2001, the land use(s) of each site was recorded. More than one land use category could be recorded for a site. Where the category 'No Land Use' was recorded, this indicates no anthropogenic land use was visible nor indicated by the landowner/land manager (i.e. land was idle or undisturbed by current or recent use). Of the 1,490 sites included in this report, 1,023 have land use data available (69% of sites) (Tables 5 and 6). Refer to Appendix H for additional details. Because only a subset of sites have land use data, the riparian health results for the entire data set cannot be directly linked to land use data.

Table 5. Land use data for major river basins in Alberta 1997-2006.

Major River Basin	Number of Sites with Land Use Data	Percent of Total Sites
Athabasca River Watershed	107	97%
Beaver River Watershed	19	95%
North Saskatchewan River Watershed	233	92%
South Saskatchewan River Watershed	571	63%
Milk River Watershed	93	48%
Provincial Total	1023	69%

Table 6. Land use data by waterbody type in Alberta 1997-2006.

Waterbody Type	Number of Sites with Land Use Data	Percent of Total Sites
Streams and Small Rivers	595	66%
Large Rivers	265	66%
Lakes and Wetlands	150	89%
Springs and Seeps	13	81%
Provincial Total	1023	69%

2.2 Data Related Decisions

Riparian health inventory and assessment has been an evolving process over the past 10 years as understanding of riparian areas in Alberta and elsewhere has evolved. Working with our Montana colleagues' experiences of over 3,000 sites and incorporating our own experiences with over 1,500 sites, this evolution and critical review has ensured the methodology continues to be widely applicable and reflective of impacts to the health of riparian areas in Alberta. The most recent methodology (2006, for this report) reflects this evolution and is the most appropriate method to date for collecting data and evaluating riparian health in Alberta. The health for all sites from 1997-2006 included in this report is reported using the 2006 methodologies. Some parameters during these 10 years were collected using methods that are slightly different from 2006 methodology, but overall health is still the end product of the analysis. Details for other years' methods can be obtained by contacting Cows and Fish.

Where possible, the riparian health scores which have been derived from riparian health inventory data are used to portray health since the inventory is a more detailed way of collecting data. Where riparian health data were collected as a health survey (assessment) and no inventory was done, those sites are analyzed and reported using the health assessment scores. Where site data needed for an assessment question were missing or incomplete, these sites were removed from this provincial summary. As mentioned in Section 2.1.3, for large river sites, approximately three quarters (75%) are presented based on the large river health survey method. The remaining large river sites (25%) are presented based on lotic inventory or lotic survey methods because complete large river health survey data was not collected (Appendix C-Table 1).

Monitoring of riparian health is recommended approximately five years after the first evaluation is done. Some individuals and communities have recently (in the past couple of years) had Cows and Fish monitor sites that were inventoried or assessed several years ago. For these sites, the most recent data are included, ensuring each site is included only once.

2.3 Data Analysis

Analysis of riparian health inventory data is done using a computer database specifically designed for that purpose. Using the FileMaker Pro Database software, members of the Ecological Solutions Group LCC, developed the Cows and Fish riparian health database structure and format. The database is designed to take detailed inventory data and compile (or derive) it into the key questions (parameters) that determine riparian health. Riparian health information collected using the health survey protocols is also housed in the database.

Derived riparian health scores are based on data collected using the inventory method. The categories that make up the scoring system are the same as in the health survey. The essential difference between inventory and survey (assessment) is that the computer generates the score by deriving it from the inventory data, rather than the observer determining the score in the assessment. For example, to determine the derived score for preferred tree and shrub regeneration, the computer does a calculation based on the total canopy cover for preferred species of both trees and shrubs and the proportion of those species that were entered as the seedling and sapling age class. In the survey (assessment), the evaluator uses his/her observations of the same aspects but it is a visual determination, not a calculated one.

Within the detailed examination of riparian health parameters for a basin or waterbody type (Section 4.0 and discussion within Section 6.0), the individual site scores for each parameter within that subset of data are averaged. This parameter average is achieved by taking all scores for a particular parameter from individual sites within that subset of data, summing them and dividing by the total possible score for that parameter. The individual site scores are recorded as whole numbers, but this averaging process can result in parameter average scores that are not whole numbers, and thus, they may fall between the accepted categorical scores which are defined in Appendices P, R and V.

In order to describe the average parameter scores, equivalent percent was used to relate results to a health category (healthy, healthy but with problems, unhealthy). As a result, parameters that had an average score of 80% or higher are described as healthy; parameters that scored 60-79% are described as healthy but with problems and; those that scored less than 60% are described as unhealthy (Table 7). Because each parameter score has specific criteria associated with it (e.g. A score of 6 out of 6 for vegetative cover means more than 95% is vegetated), those average ratings that fell between standard health scores were assigned descriptive criteria based on the minimum criteria met by that score (refer to Appendix K).

Table 7. Riparian health parameter rating system.

Health Category	Unhealthy	Healthy but with Problems	Healthy
Percent Range	0% - 60%	60% - 79%	80% - 100%
Maximum Possible Score	**Average Actual Score Range**		
3	0- 1.7	1.8 - 2.3	2.4 - 3
6	0 - 3.5	3.6 - 4.7	4.8 - 6
9	0 - 5.3	5.4 - 7.1	7.2 - 9
12	0 - 7.1	7.2 -9.5	9.6 - 12

2.4 Description of Riparian Health Parameters

Most of the parameters (factors) rated in these evaluations are based on ocular estimations. Such estimation may be difficult on large, heavily wooded 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 parameter breakout groupings and point weighting in the evaluation are somewhat subjective and are not grounded in quantitative science so much as based on the collective experience of an array of riparian scientists, range professionals, and land managers.

Each parameter is rated according to conditions observed on the site. The evaluator estimates the scoring category for each parameter and enters that value on the score sheet. Not all of the same parameters are assessed for all waterbodies because lakes and wetlands, streams and small rivers and large rivers are somewhat different in their nature. Table 8 portrays the parameters that can be assessed and which waterbodies and data collection methods they are applicable to. The function of the riparian area is the same but some of the factors that influence these waterbodies are unique to that system's health. Note that detailed descriptions of the methods are included in Appendices M-V and are the most up to date versions (2006) relevant to the data in this report. Riparian health methodology has been evolving over time so significant changes to methods are highlighted in the discussion below or within detailed results discussions where applicable.

Table 8. Riparian health parameters relative to waterbody type.

Riparian Health Parameter Assessed		**Waterbody Type**		
		Lakes and Wetlands, Springs and Seeps (lentic)	**Streams and Small Rivers, Large Rivers, Springs and Seeps (lotic)**	**Large River**
Vegetative	vegetative cover	✓	✓	
	cottonwood and poplar regeneration			✓
	regeneration of other tree species			✓
	preferred shrub regeneration			✓
	preferred tree/shrub regeneration	✓	✓	
	preferred tree/shrub utilisation	✓	✓	✓
	dead/decadent woody material		✓	✓
	total canopy cover of woody plants			✓
	invasive plants	✓	✓	✓
	disturbance plants	✓	✓	✓
	presence of native graminoids			✓
	exotic undesirable woody species			✓
	human-caused alterations to vegetation	✓		
Physical	root mass protection		✓	✓
	human-caused alterations to banks		✓	✓
	human-caused bare ground	✓	✓	✓
	human-caused alterations to rest of site		✓	
	human-caused alterations to the physical site	✓		
	floodplain accessibility			✓
	channel incisement		✓	
Hydrologic	artificial water level change	✓		
	dewatering of the river system			✓
	control of flood peak/timing by upstream dams			✓

The following describes the parameters that are used in determining the health of riparian areas in Alberta.

It should be noted that within a waterbody type, it may be difficult to assess some parameters. For example, on severely disturbed sites, woody vegetation potential can be difficult to determine. On such sites, clues to potential may be sought on nearby sites with similar landscape position and are rated comparatively to them. Some sites may not have the potential to grow woody species. Sites without potential for woody species are not rated on parameters concerning regeneration and utilisation of trees and shrubs. The same approach applies if a site does not have a defined channel or bank. Sites without this feature are not rated on parameters concerning incisement, bank alterations or bank root mass protection.

Vegetative Cover

Vegetation cover helps to stabilize banks, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, and reduce the rate of evaporation (Platts et al, 1987). For this parameter the fraction of the polygon covered by plant growth is estimated as canopy cover provided by all standing, rooted plants (live or dead).

Cottonwood and Poplar Regeneration

This parameter examines the proportion of cottonwoods (*Populus* spp. excludes *P. tremuloides*) that are seedlings or saplings within a site based on canopy cover. This parameter is assessed differently on either side of the Red Deer River valley. For areas south of and including the Red Deer River valley, asexual regeneration from root sprouts is not considered regeneration; in this southern area of the province, only reproduction from seed is considered regeneration. This is because these trees are primarily riverine species that pioneer on recent alluvium from seed, and root sprouts do not generally maintain populations. In areas north of the Red Deer River valley, any mode of reproduction for this group of trees is considered regeneration, because in the Parkland and Boreal Natural Regions poplar populations are not as dependent on seed deposited on riverine alluvium.

Regeneration of other Tree Species

This parameter assesses the amount of younger age classes for non-cottonwood trees within a site based on canopy cover. 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 the dynamics of the system (e.g. 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.

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 a population along the river over the long term. As in tree regeneration, the proportion of canopy cover provided by seedlings and saplings within the site is assessed.

NOTE: For sites with riparian health surveys (assessments without an inventory) completed prior to 2000, this parameter was examined somewhat differently. The concept of preferred woody plant species was not considered, but rather all woody plants were included when examining this parameter. This means that sites with many plants that we now exclude from consideration, but with few young preferred plants, could score higher than sites with surveys completed in or later than 2001. Sites with inventory data are not affected.

Preferred Tree and Shrub Establishment and/or Regeneration

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. A waterbody's ecological stability and, therefore health, is dependent on the presence of enough tree and/ or shrub regeneration to maintain those life forms along the waterbody over the long term. Preferred tree and shrub communities are ones that are the best indicators of riparian health on a site and often decline most rapidly under high pressure and disturbance. This parameter is assessed based on the proportion of preferred trees and shrub canopy cover that are seedlings and saplings

NOTE: In 1998, this parameter was examined somewhat differently. At that time woody plant establishment and regeneration was measured based on presence and absence of age classes of late-seral/climax woody species including cottonwoods. The concept of proportion of canopy cover that is seedlings and saplings was not considered nor was the concept of preferred woody plant species. Therefore, for riparian health surveys (assessments without an inventory) completed in 1998, the interpretation of the rating for this parameter on a given site may be different than those in following years.

In 1999, this parameter evolved to measure health of woody species based on proportion of canopy cover provided by seedlings and saplings. All woody plants were included when examining this parameter. The concept of preferred woody plant species was still not considered. This means that sites from with survey data collected in 1999 that had many plants we now exclude from consideration, but with few young preferred plants, could score higher than those sites with surveys completed in or later than 2001. Sites with inventory data are not affected.

In addition the criteria for determining age classes of trees and shrubs has been modified over time, as highlighted in the content below.

From 1998 methods: *Age classes of shrubs are based on relative height and stem size by species. Shrubs are in three age classes: seedling/sapling, mature, and dead/decadent. Generally, those plants with stems up to one inch (2.5 cm) thick and/or no more than half as tall as the tallest individuals of that species on the site are considered seedling/saplings. Mature plants have stems thicker than one inch (2.5 cm) or those having reproductive structures. Dead/decadent criteria are same as for trees.*

From 1998 to 2005 methods: *Age classes of trees are based on species and size as follows (dbh is diameter at breast height):*

Age Class	*Conifers and Cottonwoods*	*Other Broadleaf Species*
Seedling	*<4.5 ft tall or <1.0 in dbh*	*<3.0 ft tall*
Sapling	*≥4.5 ft tall & 1.0 in to <5 in dbh*	*≥3.0 ft tall & <3.0 in dbh*
Pole	*≥5.0 in to <9 in dbh*	*≥6.0 ft tall & ≥3.0 to <5.0 in dbh*
Mature	*≥9.0 in dbh*	*≥5.0 in dbh*

From 2006 methods: *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.*

Preferred Trees and Shrubs Utilisation

Utilisation describes removal of woody material by wildlife or livestock (i.e. browsing), beaver, and humans. Excessive browsing and other kinds of utilisation can eliminate these important plants from the community and result in their replacement by undesirable invaders. With excessive utilisation, the plant loses vigour, is prevented from flowering, or is killed. Utilisation in small amounts is normal and not a health concern, but concern increases with greater intensity of use. The types of utilisation are not separated by cause or kind. General inferences regarding kind of use may be made based on other factors within the riparian health evaluation and discussions with landowners or land managers.

NOTE: For riparian health surveys (assessments without an inventory) completed prior to 2001, this parameter was examined somewhat differently. The concept of preferred woody plant species was not considered, but rather all woody plants were included when examining this parameter. This means that sites with many of the plants we now exclude from consideration could score higher than those sites with surveys completed in or later than 2001. Sites with inventory data are not affected.

Dead and Decadent Woody Material

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, stress from over grazing, climatic impacts, disease and insect damage of a site, if severe enough, may change the site vegetation potential from riparian species to upland species. In all these cases, a high percentage of dead and decadent woody material reflects degraded vegetative health, which can lead to reduced streambank integrity, channel incisement, and excessive lateral cutting, besides reducing production and other wildlife values. The term decadent refers to woody plants with 30% or more dead wood in the upper canopy.

NOTE: This parameter was added to the lotic health assessment in 1998.

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 North American 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 parameters dealing with woody plants, this parameter focuses on how much of the total site is covered by woody plants.

Invasive Plant Species (Weeds)

Invasive plants (weeds) are alien species whose introduction does or is likely to cause economic or environmental harm. This parameter 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. This parameter evaluates the total percentage of the site area that is covered by the combined canopy of all plant species designated as invasive.

Our primary resource for designation of invasive plants is *Invasive Weed and Disturbance-caused Plant List* (Cows and Fish, 2007) which is related to the *Alberta Weed Control Act and Regulations* (Alberta Government, 2006). Invasive plant species are generally those designated as noxious or restricted by the *Alberta Weed Control Act and Regulations.* In some cases, a species designated as a nuisance species by the *Alberta Weed Control Act and Regulations* is categorized as invasive if it tends to be particularly aggressive in riparian areas.

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 the fraction of the site area on which weeds had a well established population of individuals (i.e., the area infested). As of 2005, common caragana (*Caragana arborescens*) was added to the invasive species list; where it was found prior to 2005, it does not affect the riparian health score.

Disturbance-Caused Undesirable Herbaceous Species (Disturbance Plants)

A large cover of disturbance-caused undesirable herbaceous species, native or introduced, indicates displacement of the potential natural community 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 or adds undesirable ones. Invasive species considered in the previous parameter are not included in this parameter.

Our primary resource for designation of disturbance plants is *Invasive Weed and Disturbance-caused Plant List* (Cows and Fish, 2007). The categorisation of a plant as disturbance-caused for riparian health purposes is based on the experience of Cows and Fish staff and other agencies working in riparian areas (e.g. Alberta Sustainable Resource Development Public Lands Division, Ecological Solutions Ltd. (Montana)). Disturbance-caused plants include most nuisance weeds (designated by the *Alberta Weed Control Act and Regulations* (Alberta Government, 2006)) as well as many non-regulated species that increase in riparian areas under some disturbance.

Presence of Native Graminoids
Certain riparian functions (i.e., primary forage production, wildlife habitat, and maintenance of natural biodiversity) are best served by native species that evolved with the ecosystem. Native graminoids are very often reduced or eliminated from a site as the result of long term disturbance. Therefore, one measure of the health of a riparian site is the amount of cover by these species (as a group) remaining.

Exotic Undesirable Woody Species
The degree to which the vegetative community consists of exotic undesirable woody species in most cases reflects the degradation of many riparian functions since they displace more sensitive and valuable species. Although these species may contribute to some riparian functions to varying degrees, they are less effective than desirable woody species. This parameter evaluates the percent of the total woody species canopy cover is composed of exotic undesirable woody species.

NOTE: As of 2004, common caragana (*Caragana arborescens*) was added to the exotic undesirable woody species list; where it was found prior to 2004, it does not affect the riparian health score.

Human-Caused Alterations to Site Vegetation
Alteration of the vegetation is meant to include all changes to the plant community composition or structure within the polygon caused by human actions (e.g., logging, mining, roads, construction, or development) or by agents of human management (e.g., livestock). The intention here is to assess long term, or permanent, vegetation changes, not 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 changes that diminish or disrupt the natural wetland function of the vegetation.

NOTE: This parameter was added to the lentic assessment in 2001.

Root Mass Protection
Streamside vegetation stabilizes the soil to the extent that it provides deep, binding roots. All tree and shrub species provide such roots. The vegetation along rivers performs the primary physical functions of stabilizing the soil with a deep and binding root mass, and filtering sediment from overland flow. All tree and shrub species are considered to have deep, binding root masses. Invasive and disturbance-caused plants do not have this quality. Although certain herbaceous species (e.g. sedges) may provide protection on smaller streams, their value along rivers is limited.

Human-Caused Alterations to Banks
Altered stream or river banks are those having impaired structural integrity (strength or stability) usually due to human causes. These banks are more susceptible to cracking and/or slumping. Impaired structure can mobilize channel and bank materials, cause loss of fishery and wildlife habitat, lower the water table, etc. Bank alteration can result from such causes as livestock or wildlife hoof shear, concentrated trampling, vehicle or all terrain vehicle tracks, residential development, road construction, farming, railroad construction, water diversion weirs, boat ramps, rip-rap, levees and fill. The basic criterion is any disturbance to bank structure that increases erosion potential or changes the bank profile shape.

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

Human-Caused Physical Alteration to the Rest of the Site
Apart from the streambank, the remainder of the riparian area is naturally formed to perform riparian functions that may be disrupted by a variety of human-caused disturbances. The purpose of this question is to evaluate physical change to the soil, topography, and hydrology as it affects the ability of the natural system to function normally. These changes include those to the soil surface that impede water infiltration (i.e., impervious covers, compacted paths, trails, etc.), physical alterations for the purpose of hydrologic changes (i.e., draining, ditching, berm creation, etc.) or for any other purpose (tillage, landscaping, etc).

NOTE: prior to 2005, this parameter was assessed only for pugging, hummocking, and in some cases, rutting. This may mean that other kinds of alterations were not accounted for, if present, and sites could score higher than if all physical alterations were included.

Human-Caused Alterations to the Physical Site
The purpose of this question is to assess physical change to the soil, shoreline integrity, and hydrology as it affects the ability of a natural lentic system to function normally. Changes in shore and bank contour and any change in soil structure will alter infiltration of water, increase soil compaction, and cause increased sediment contribution 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 to the physical characteristics of a site.

NOTE: This parameter was added to the lentic assessment in 2001.

Floodplain Accessibility
Many of the most important functions of a riparian ecosystem on a river will 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. This parameter evaluates the fraction of the historic 100 year floodplain that remains unrestricted by such embankments. This can usually be determined by comparing the area within the embankments to the area within the 100 year floodplain.

Stream Channel Incisement (Vertical Stability)
An incised stream channel has experienced vertical downcutting of its bed. Incisement can lower the water table enough to change vegetation site potential. It can also increase stream energy by reducing sinuosity, reduce water retention/storage, and increase erosion. A stream becomes critically incised when downcutting lowers the channel bed so that the two-year flood event cannot overflow the banks

Degree of Artificial Withdrawal or Raising of Water Level (Water Level Change)
Although water levels naturally fluctuate on a seasonal basis in most systems, many wetland systems are affected by human-caused (artificial) additions or withdrawals. These artificial changes of water level rarely follow a temporal regime that maintains healthy native wetland plant communities. The result is often a barren band of shore exposed or inundated for much of each growing season. This causes shore material to destabilize, and often provides sites for weeds to invade. Such conditions are extremely detrimental to healthy riparian function.

Not all lentic wetlands evaluated with this data collection method will have surface water potential, but any wetland may have its water table degraded by draining, pumping, or diverting its surface or subsurface supply.

NOTE: This parameter assessed only water level reduction (i.e. withdrawals) until 2004.

Dewatering of the River System
Proper functioning of any riparian ecosystem depends, by definition, upon the system's supply of water. The degree to which this "lifeblood" is artificially removed from the system is directly reflected in a reduction of riparian functions (i.e. wetland plant community maintenance, channel bank stability, wildlife habitat, overall system primary production, etc.). Dewatering of the system can be estimated by determining the proportion of the average river discharge which is removed 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 implementation of diversions. This question only deals with irrigation or similar withdrawals from a section of river. The details on determination of level of dewatering are included in Appendix L.

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 energy generation, agricultural and industrial purposes and to mitigate the damages caused by the natural flooding to human development on the floodplain. The effects of these dams are generally negative to 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. The details on determination of control of flood peak and timing by upstream dams are provided in Appendix L.

3.0 STATUS OF RIPARIAN HEALTH IN ALBERTA

3.1 Provincial Riparian Health Overview

Included in this report is the riparian health rating from 1,490 riparian sites and over 1,380 km of Alberta's waterbodies, collected between 1997 and 2006. The riparian health category (healthy, healthy but with problems, unhealthy) for the majority of sites was derived from a riparian and wetland inventory of physical and vegetative characteristics appropriate to the waterbody type. Provincially, the majority of streams and rivers were examined using lotic inventory methods. Fewer streams and rivers were examined using health assessment methods. Similarly, on non-flowing waterbodies, the majority of data collection occurred using lentic inventory methods (Section 2.0 Table 2).

Details regarding the plant species found are presented in Appendix J. Based on 1,393 inventories, the species covering the greatest area were brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*), balsam poplar (*Populus balsamifera*), and buckbrush/snowberry (*Symphoricarpus occidentalis*). The most commonly occurring plant was Canada thistle (*Cirsium arvense*) followed by Kentucky bluegrass.

Overall provincial riparian health is based on inclusion of riparian areas associated with large rivers, streams and small rivers, lakes and wetlands and seeps or springs, involving 252 different waterbodies (Section 2.1.3 Table 4). Data collection locations are identified in Figure 1. Less than one quarter of sites examined between 1997 and 2006 are healthy, approximately half are rated as healthy but with problems, and slightly more than one quarter are unhealthy (Figure 2). A small selection of photographs representing sites in each of the riparian health categories is presented in Appendix I.

While site locations are spread across many regions of the province, the provincial overview is most influenced by sampling in the South Saskatchewan River Basin, with 61% of all sites located in that basin (Section 2.1.2 Table 3).

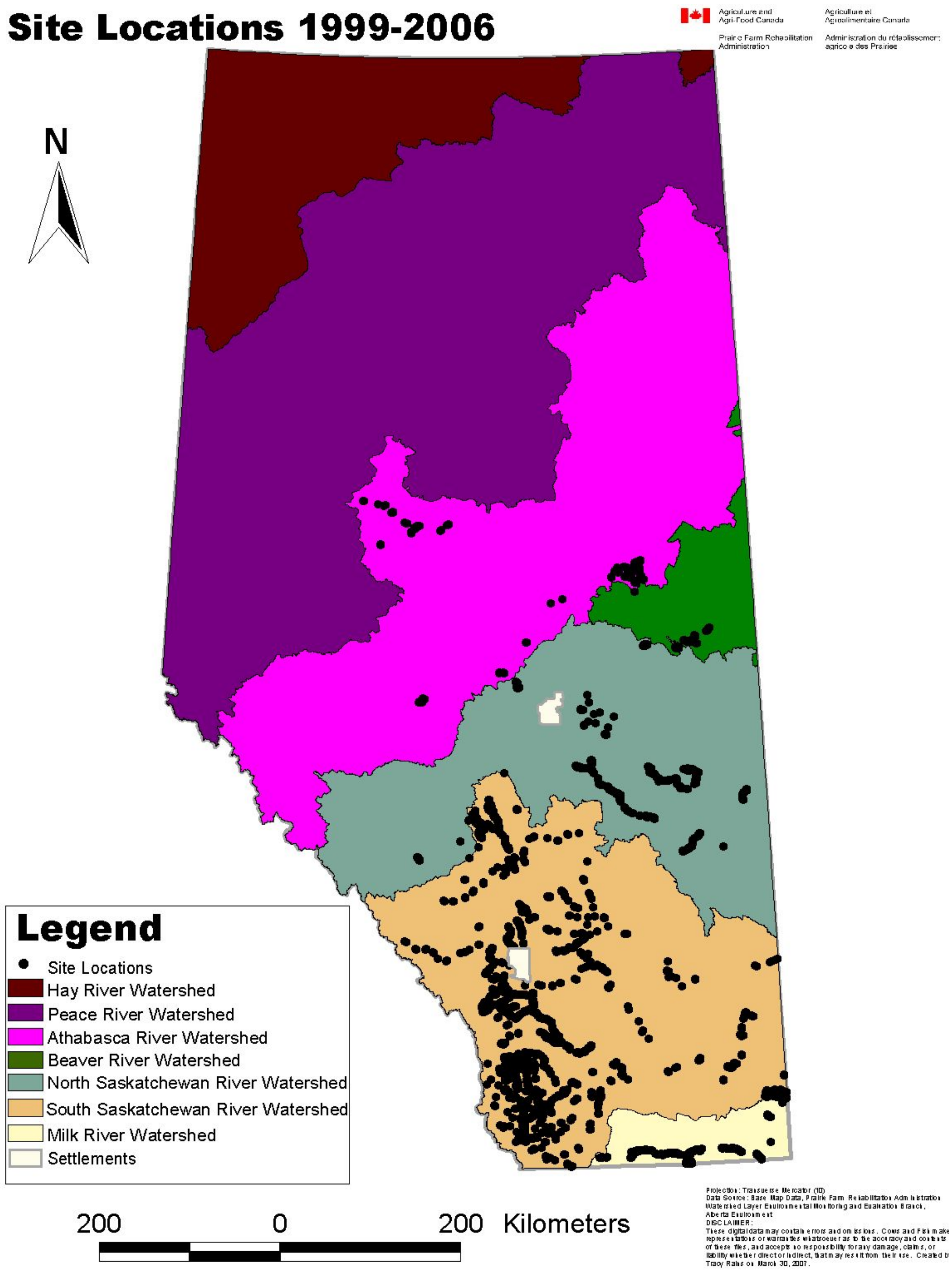


Figure 1. Distribution of riparian health sites in Alberta, 1999-2006. Sites examined prior to 1999 are not shown.

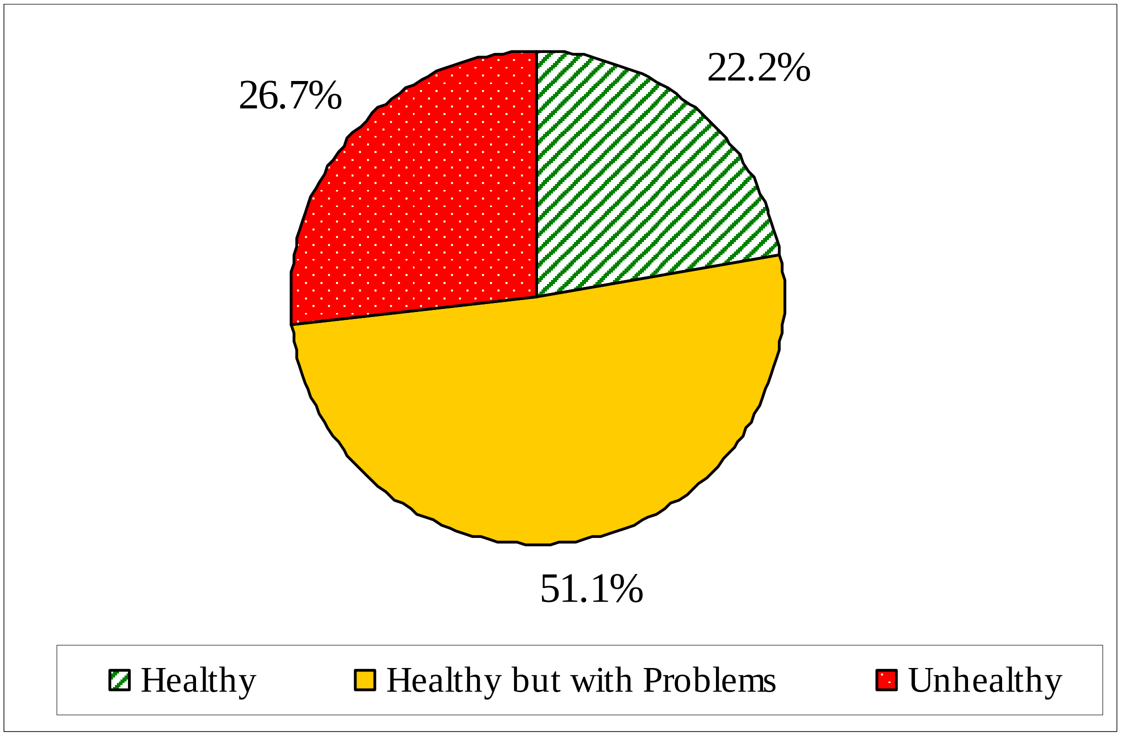


Figure 2. Provincial summary of riparian health in Alberta 1997-2006 (n=1490 sites).

3.1.1 Provincial Riparian Health Overview by Waterbody Type

Riparian health data has been collected for a wide variety of streams (intermittent, ephemeral, perennial), rivers, lakes, wetlands and seeps or springs. The data summarized do not include any riparian areas associated with bogs or fens. Nearly two thirds of sites were categorized as streams and small rivers; 18% of these sites rate as healthy (Figure 3). Of large river sites, 27% are healthy (Figure 4). Slightly more than a quarter of lake and wetland sites are healthy (29%; Figure 5). Very few springs and seeps were examined, but of these, 31% are healthy (Figure 6). The waterbody type with the greatest proportion of healthy sites is seeps and springs category (Figures 3-6), although sample size (n=16) is much smaller than other types, so the comparison between waterbody types is not appropriate. Because of the very limited sample size of springs and seeps, the riparian health overview for that waterbody type provides limited provincial perspective. A comparative table of provincial riparian health by waterbody type can be referred to in Appendix A.

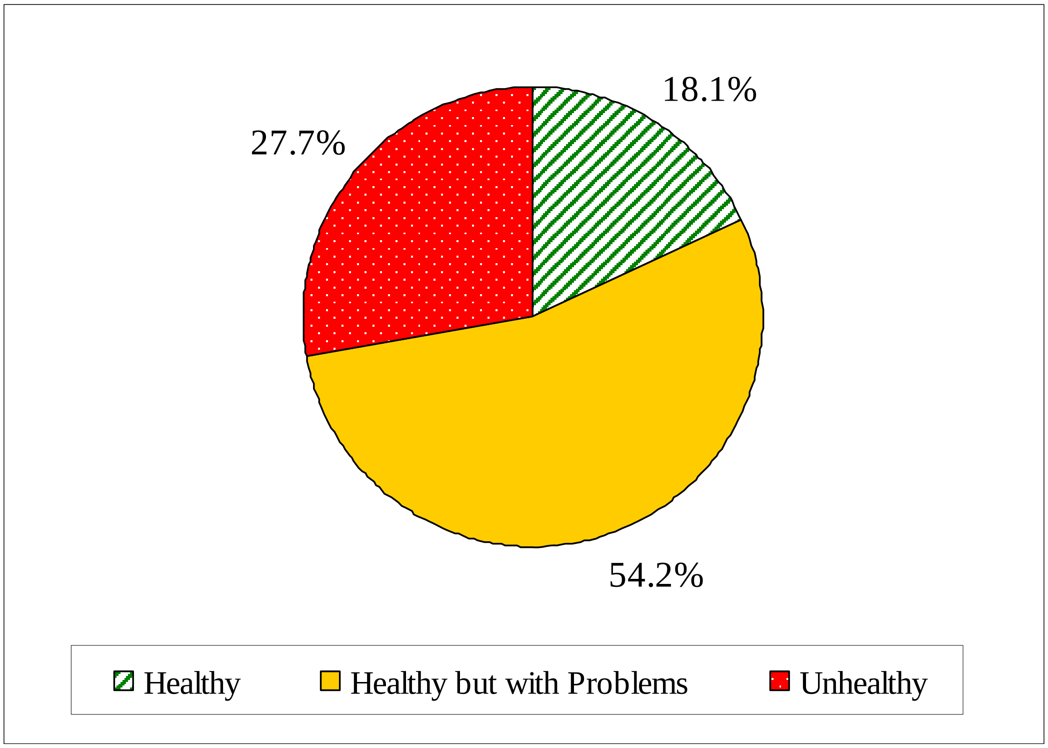


Figure 3. Summary of riparian health for stream and small river sites (n=904) in Alberta, 1997-2006.

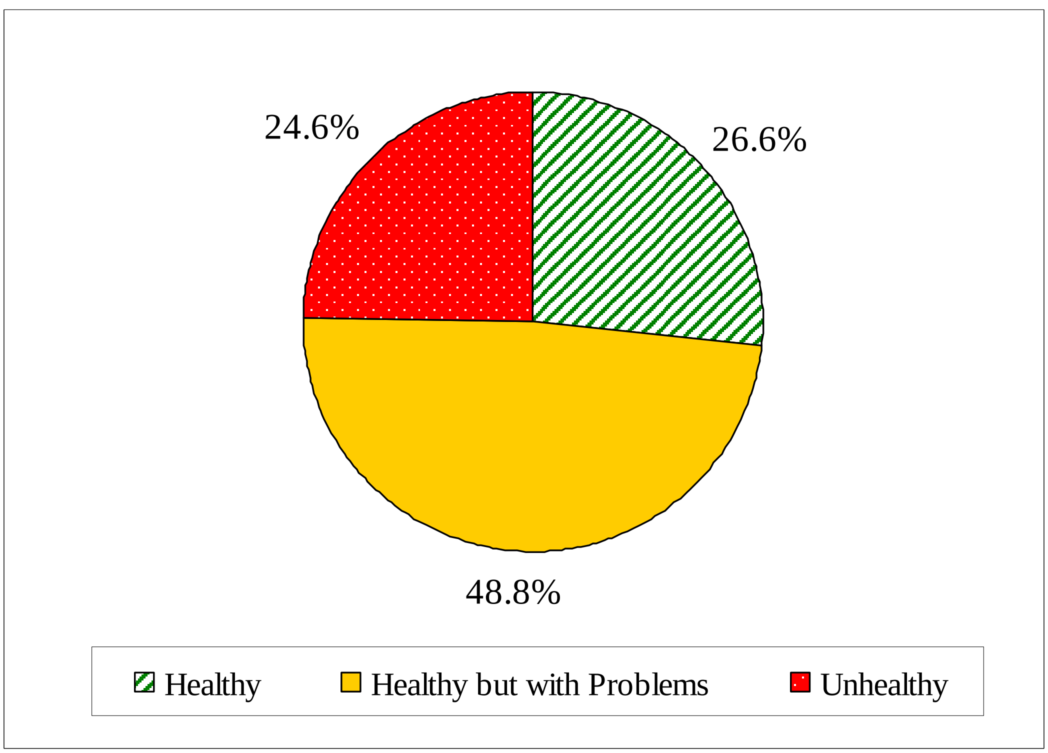


Figure 4. Summary of riparian health for large river sites (n=402) in Alberta, 1997-2006.

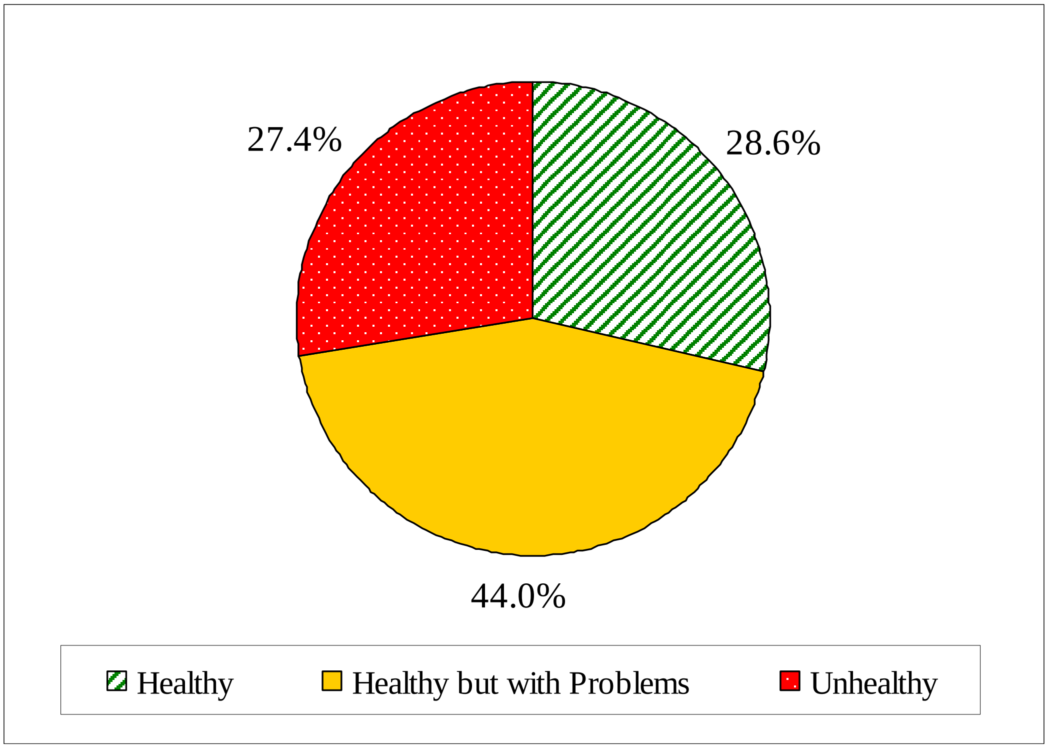


Figure 5. Summary of riparian health for lake and wetland sites (n=168) in Alberta, 1997-2006.

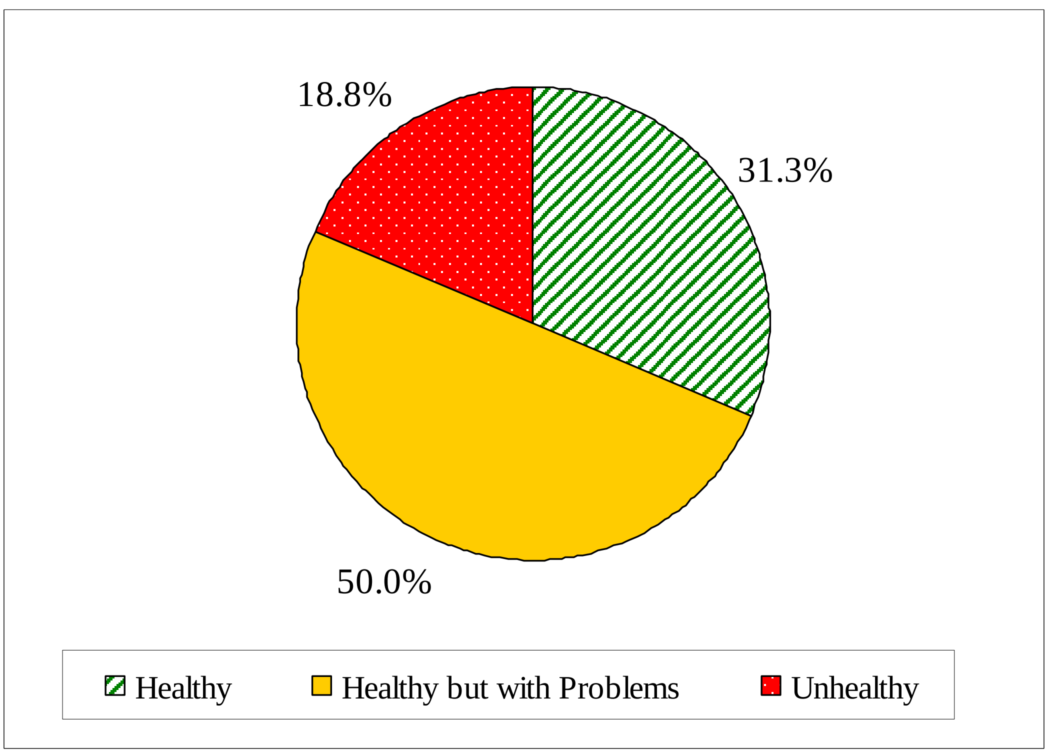


Figure 6. Summary of riparian health for seep and spring sites (n=16) in Alberta, 1997-2006.

3.2 Riparian Health Overview by Major River Basin

Riparian health data were summarized for each of the seven major river basins within the province as requested and delineated by Alberta Environment: the Hay River, Peace/Slave Rivers, Beaver River, Athabasca River, North Saskatchewan River, South Saskatchewan River and Milk River (Figure 7). The majority of sites examined and included in this report are from the three southern most basins, with the South Saskatchewan River Basin representing 61% of the sites. The northern basins have more limited representation, with no sites completed in the Hay River or Peace/Slave River Basins (Section 2.1.2 Table 3). Examination of the data at a minor basin or sub-basin level is beyond the scope of this report.

The summaries below are provided for each of the main major river basins within the province, to provide details on health rating and sample size by basin. Refer to Appendix B for a summary table of riparian health by major river basin in Alberta.

3.2.1 Hay River Basin

No riparian health data, collected and housed as described in Section 2.0, exists for the Hay River Basin.

3.2.2 Peace/Slave Rivers Basin

No riparian health data, collected and housed as described in Section 2.0, exists for the Peace/Slave Rivers Basin.

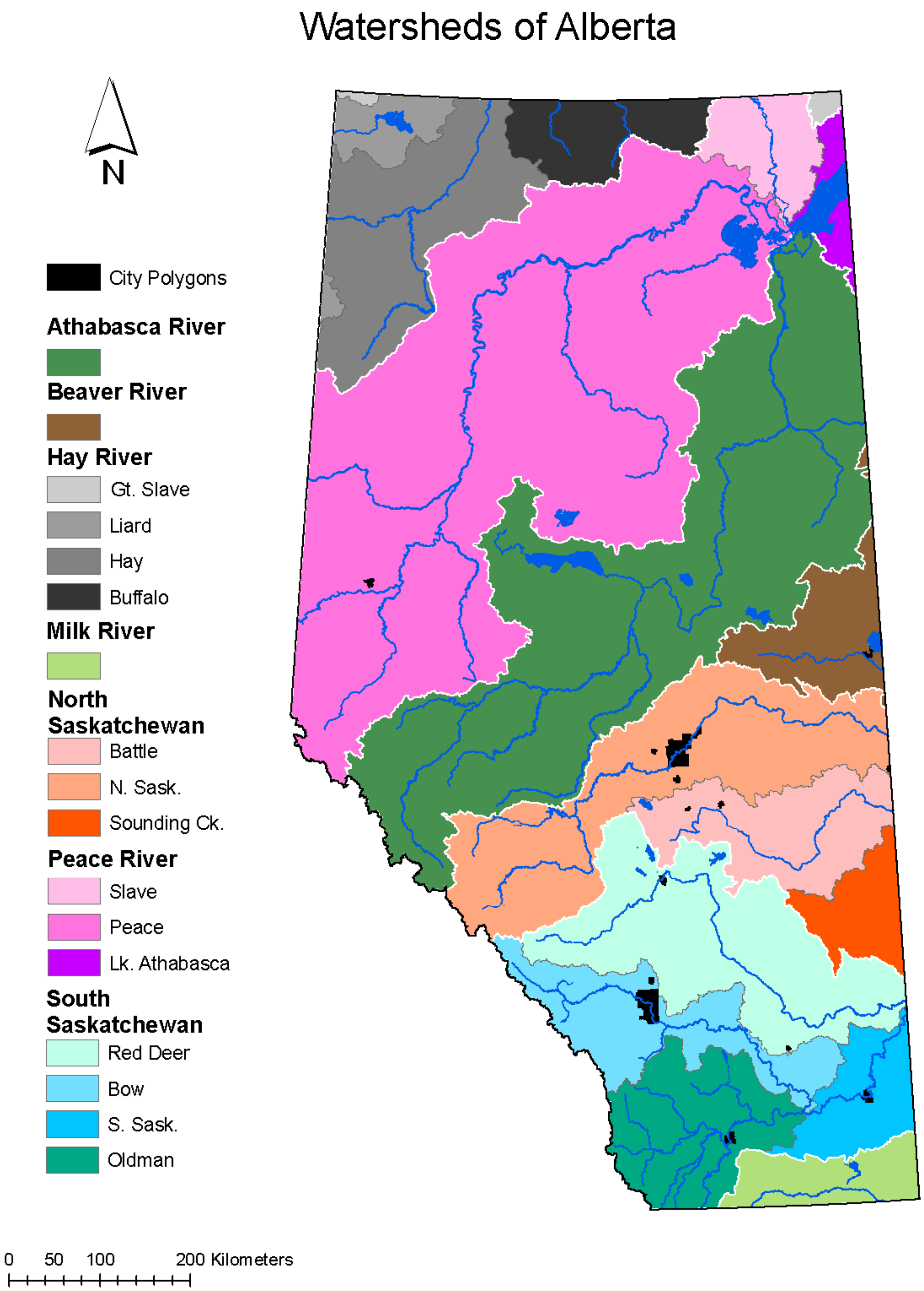


Figure 7. Map of Alberta illustrating major river basins and sub-basins. Map provided by Alberta Environment (2006).

3.2.3 Athabasca River Basin

Data in the Athabasca River basin includes sites from areas of the watershed that are both upstream and downstream of the town of Athabasca. The majority of sites are in middle portion of the watershed (Figure 1). Just over one third of sites assessed in the Athabasca River basin are healthy (Figure 8). More than one half of data was collected at lakes or wetlands, with approximately a quarter of sites on streams/small rivers and the remainder on large rivers (Appendix E).

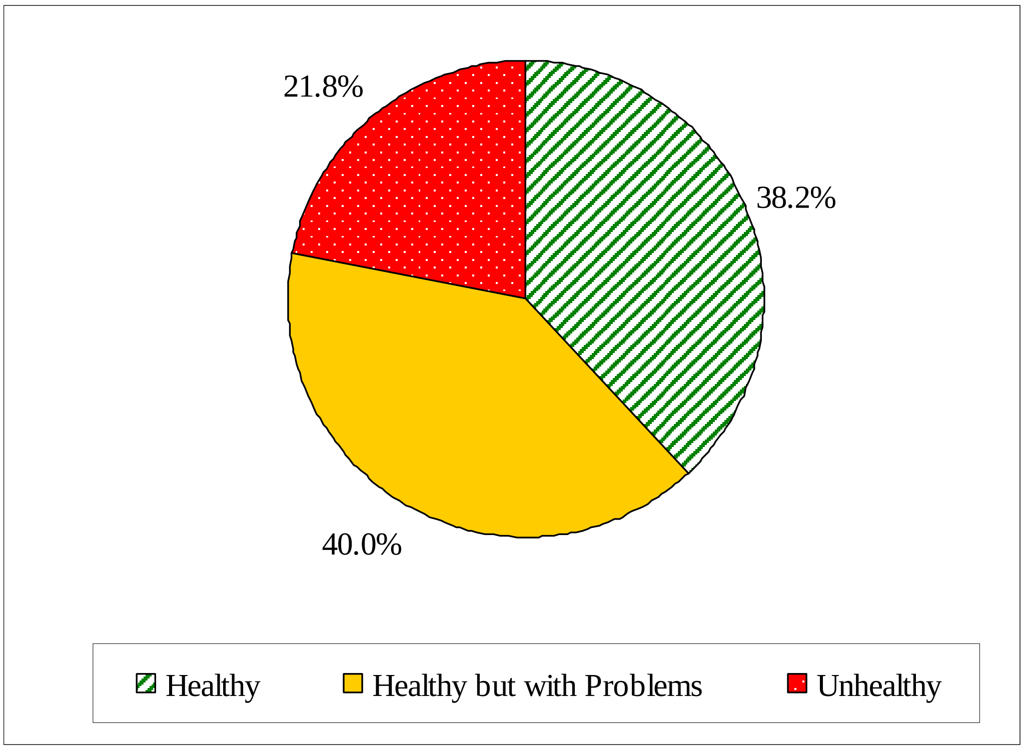


Figure 8. Summary of riparian health for Athabasca River basin (n=110) in Alberta, 1997-2006.

3.2.4 Beaver River Basin

Data in this section were collected from areas that drain into the Beaver River, also referred to by some sources as the Churchill River basin. Due to the small sample size (n=20), limited broad scale conclusions regarding riparian health in the Beaver River basin can be made. Sites were mostly located near the southern boundary of the basin (Figure 1). Sixty percent of sites sampled in the Beaver River basin are healthy (Figure 9). Almost three quarters of all sites were streams and small rivers (Appendix E).

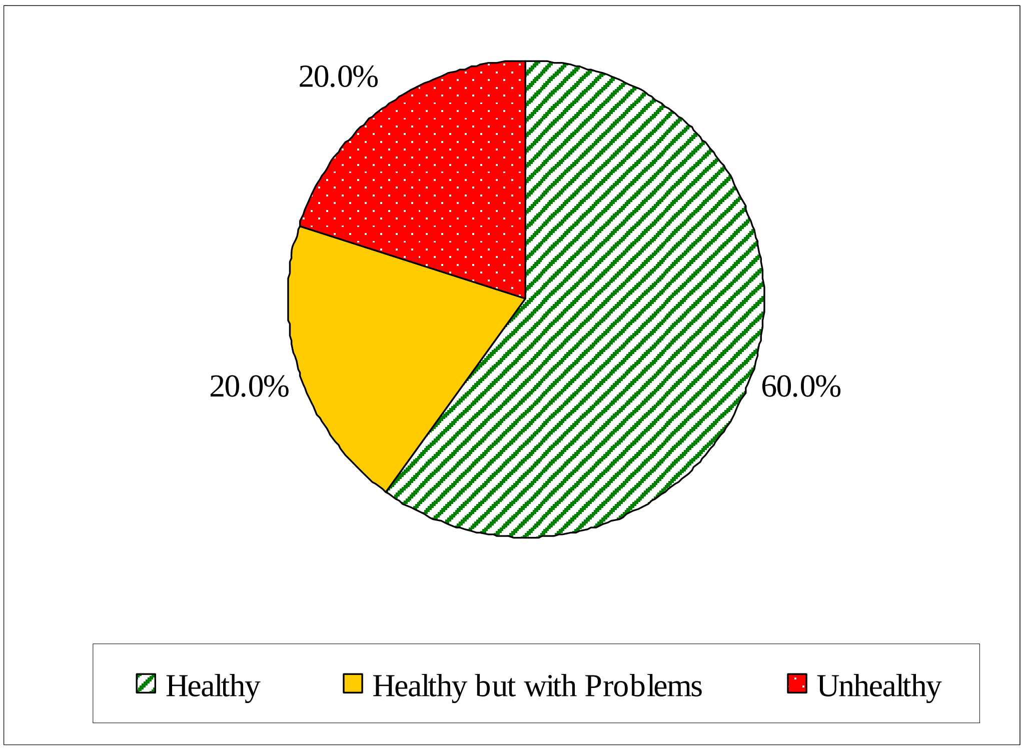


Figure 9. Summary of riparian health for Beaver River basin (n=20) in Alberta, 1997-2006.

3.2.5 North Saskatchewan River Basin

Data in the North Saskatchewan River basin includes areas of the watershed both upstream and downstream of Edmonton, and on a variety of systems in these reaches. No sites were sampled on the North Saskatchewan River. The majority of sites are located in the eastern half (downstream portion) of the basin, with many in both the Battle River and North Saskatchewan basins (Figure 1). Nineteen percent of sites rate as healthy (Figure 10), with approximately 40% of sites categorised as streams and small rivers (Appendix E). Between one third and one quarter of sites were large rivers; a similar number were lakes and wetlands.

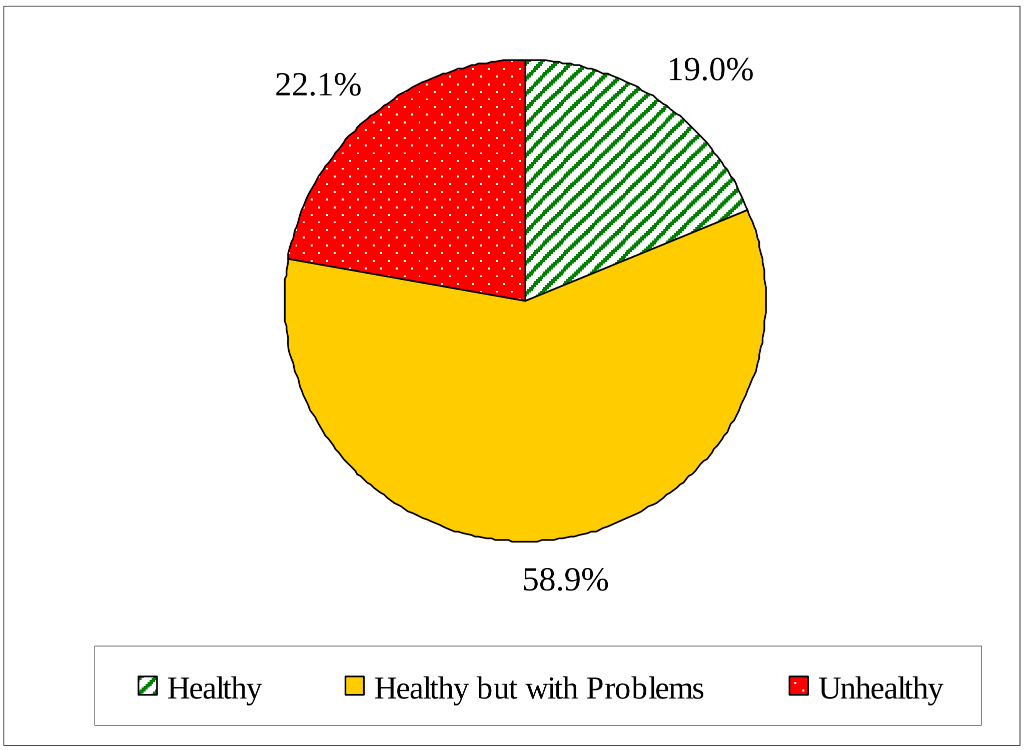


Figure 10. Summary of riparian health for North Saskatchewan River basin (n=253) in Alberta, 1997-2006.

3.2.6 South Saskatchewan River Basin

Within the South Saskatchewan River basin, data were collected from within each of the main sub-basins: Bow River, Red Deer River, Oldman River and South Saskatchewan River as well as Swift Current Creek (within Alberta) (Figure 1). Approximately 61% of all sites included in this provincial riparian health overview are located in the South Saskatchewan River basin (Section 2.1.2 Table 3). Twenty percent of sites rate as healthy (Figure 11) in the South Saskatchewan River basin, with approximately two thirds of sites being streams and small rivers. Approximately 20% of sites examined were large rivers, with a much smaller number of lakes and wetlands (Appendix E).

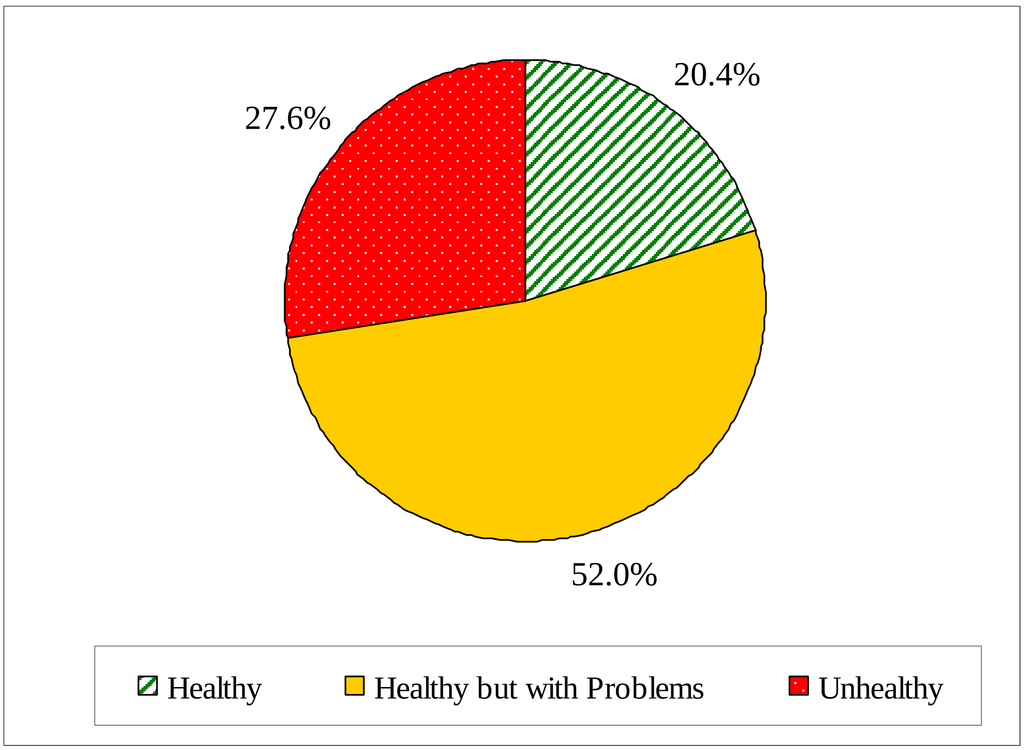


Figure 11. Summary of riparian health for South Saskatchewan River basin (n=912) in Alberta, 1997-2006.

3.2.7 Milk River Basin

Data in this section were collected from two large sub-basins, including the Milk River and the Lodge Creek watersheds, which comprise portions of the larger Missouri River basin, referred to here as the Milk River basin. Sites are located along almost the entire length of the watershed, with numerous sites also concentrated in the Cypress Hills area (Figure 1). Approximately half of sites are large rivers (Appendix E), with slightly fewer streams and small rivers. A limited number of lake or wetland sites were examined. Within the Milk River basin, 22% of sites rate as healthy (Figure 12).

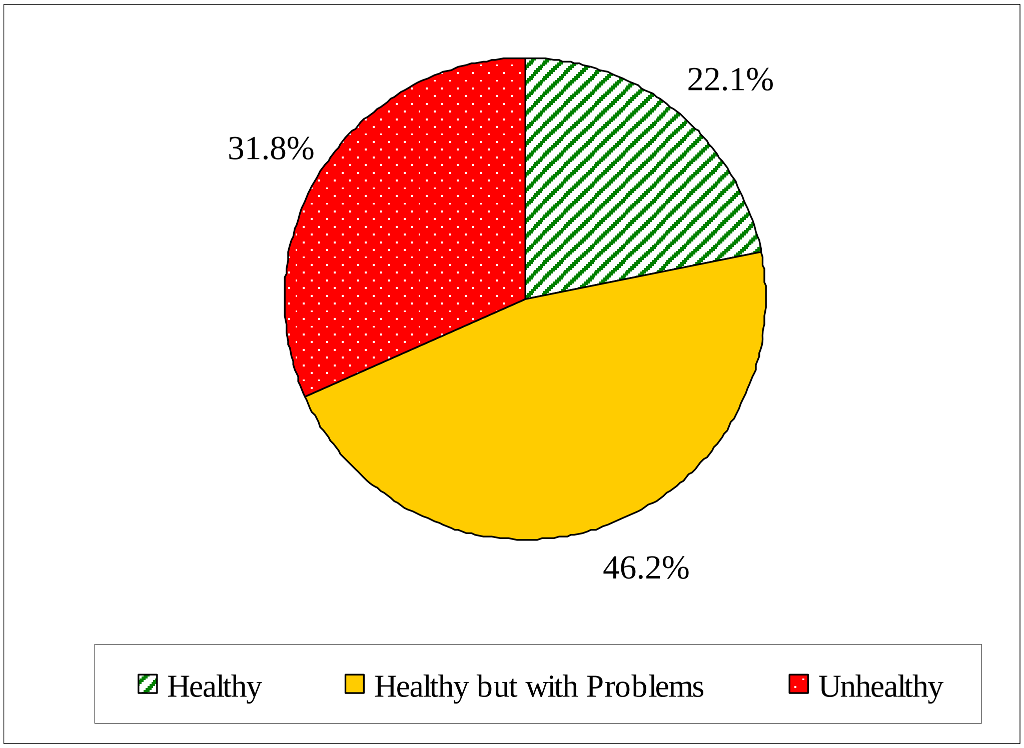


Figure 12. Summary of riparian health for Milk River basin (n=195) in Alberta, 1997-2006.

4.0 DETAILED EXAMINATION OF RIPARIAN HEALTH PARAMETERS IN ALBERTA

Riparian areas are complex, dynamic systems that have a variety of attributes or parameters that can be used to measure or indicate their health, ability to function ecologically or condition. The riparian health parameters that comprise the health assessment are individually important to understand particular details about a riparian site. When considered together, these parameters collectively provide a more complete picture of a site's characteristics at a particular point in time. If all of the parameters or attributes are intact, we infer that the riparian area is functioning properly or is healthy. Not all aspects or parameters are specifically related to all ecological functions, but rather the complement of parameters, when considered together, can be valuable in understanding the ability of the site to perform all ecological functions.

Riparian areas perform a diverse suite of ecological functions, such as filtering and trapping sediment, bank building and erosion reduction (eg. Beeson and Doyle, 1995; Daniels and Gilliam 1996; O'Neill and Gordon, 1994; Woodwards and Wui, 2001). It may be difficult to generally observe changes in overall riparian health, especially if it happens over a long period of time; detailed examination of specific aspects of a riparian area allows us to capture these changes.

Components of the riparian health assessment (survey) and inventory are intended to relate to ecological functions directly or indirectly, and research in Alberta has shown a relationship between riparian health data and other ecological measures. Recent research examined the linkages related to biodiversity (via breeding birds) and riparian health data (Palliser Environmental Services Ltd. 2008). That research found that canopy cover of trees and shrubs and the presence of shrubs greater than 1.6 m (6 feet) were potential indicators within the riparian health methodology that could be used for breeding bird abundance and diversity (these are parameters recorded in the riparian health inventory). In addition, the overall health categories were linked to biodiversity measures. There were significantly more confirmed breeding birds using healthy riparian sites than unhealthy sites, and significantly more birds used healthy riparian areas compared to riparian areas rated as unhealthy or healthy but with problems (Palliser Environmental Services Ltd. 2008).

In general terms, riparian areas are healthy when they are performing a suite of ecological functions, and generally, they may maintain a healthy state under light human use. When some of the elements of a riparian site are impacted or altered more heavily by either natural or human disturbances, riparian areas are healthy but with problems with only some of the parameters functioning properly. As the rate and intensity of disturbance increases, riparian areas can reach a point where they fail to perform their functions properly and become unhealthy.

4.1 Riparian Health Parameters by Waterbody Type

4.1.1 Streams and Small Rivers

Of riparian areas associated with streams and small rivers, 904 sites were sampled. There are 11 riparian health parameters used in assessing the health of streams and small rivers (Section 2.4 Table 8). Of these 11 riparian health parameters related to streams and small rivers, three are healthy or functioning properly, four are healthy but with problems or functioning at risk, and four are unhealthy or non-functioning (Figure 13). The majority of stream and small river sites were sampled within the South Saskatchewan River basin (Appendix E). Because we have sampled a small proportion of sites in the province, the discussion of riparian health parameters is limited to the sites we have sampled and may not be applicable to the entire province.

4.1.1.1 Vegetation Parameters

On streams and small river riparian areas, there are six parameters related to vegetation. The overall rating of each parameter is based on the number of applicable sites. Detailed discussion about each parameter is based on sites with inventory data that can support that discussion.

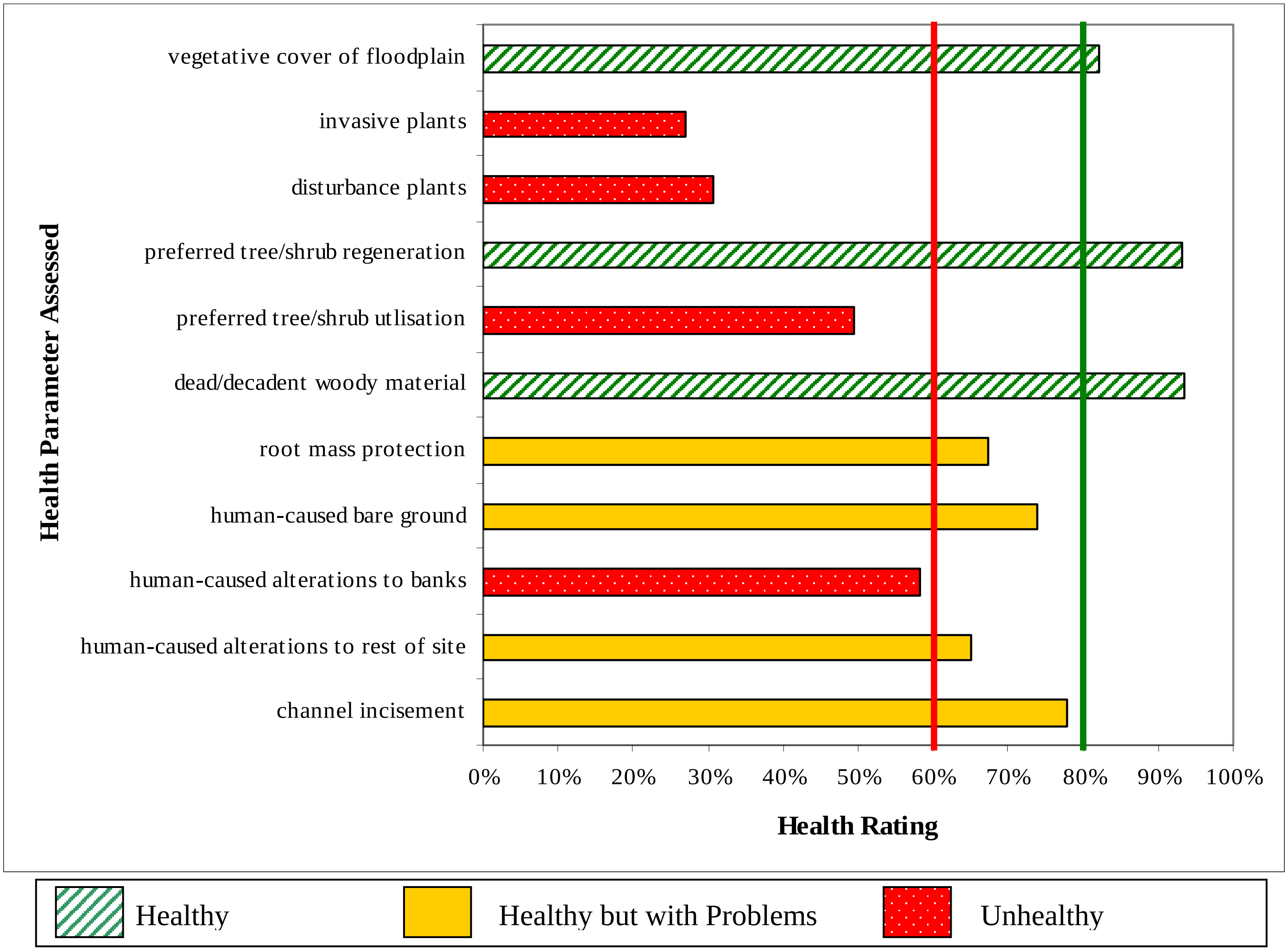


Figure 13. Evaluation of riparian health parameters for streams and small rivers (n=904) in Alberta. Note: sample size may vary by parameter; see text for sample size specific to each parameter.

Note riparian health categories are defined as: Healthy (80-100%) – Little or no impairment to riparian functions; Healthy but with Problems (60-79%) – Some impairment to riparian functions due to human or natural causes; and Unhealthy (<60%) – Impairment to many riparian functions due to human or natural causes.

Vegetative Cover of the Site

Overall vegetative cover is assessed for all (n=904) of the streams and small river sites. Throughout the applicable sites, vegetation cover is generally sufficient, rating healthy. This means on average, sites have over 85% of the riparian area covered by vegetation.

From the sites with inventory data (n=836), we can describe vegetation life form distribution. Graminoids are the most abundant (77% cover) followed by shrubs (40% cover) and forbs (23% cover). Trees are least abundant with only about 13% of the cover.

There was a total of 651 different plant species identified. The most abundant was Kentucky bluegrass *(Poa pratensis)* followed by smooth brome (*Bromus inermis)* and buckbrush/snowberry (*Symphoricarpos occidentalis*). The most common plant was also Kentucky bluegrass, found on 94% of sites. Canada thistle (*Cirsium arvense*) was nearly as common, found on 93% of inventoried sites. Buckbrush/snowberry and common yarrow (*Achillea millefolium*) were found on 85% of inventoried sites. Of all of the plant species observed, over three quarters (81%) of them are native. About 8% are listed as disturbance and 3% are invasive.

4.1.1.1.1 Woody Plants: Presence, Reproduction and Health

Trees and shrubs are an important characteristic of riparian health where they have the potential to grow. On stream and small river sites, all except one site have that potential. There were 21 tree and 90 shrub species identified. The most abundant woody plant was buckbrush/snowberry and then balsam poplar (*Populus balsamifera*). Buckbrush/snowberry, along with beaked willow (*Salix bebbiana*) was the most common woody plants, occurring on 85% and 76% of inventoried sites, respectively.

Preferred Tree and Shrub Establishment and Regeneration

This parameter is based on all sites with the potential for preferred trees and shrubs (refer to Methods for details), which included all but one site. Preferred tree and shrub regeneration and establishment along streams and small rivers rates healthy, meaning that on average, there is greater than 5% of these woody species in the seedling and sapling age classes.Preferred Tree and Shrub Utilisation

This parameter is based on all sites with potential for preferred tree and shrub species, and that have available material to be browsed or otherwise removed by livestock, humans or wildlife. (n=898). Half of sites (52%) had no or light utilisation. About 13% of sites had heavy browse or utilisation on preferred trees and shrubs. On average, utilisation of preferred woody plants is 25% - 50%, and thus rates unhealthy.

Dead and Decadent Standing Woody Material

This parameter was examined on sites with trees and shrubs (excluding those done in 1998) (n=855) and rates healthy on stream and small river sites. This means that on average less than 25% of the total canopy cover of woody species on these stream and small river sites is dead or decadent.

4.1.1.1.2 Non-Woody Plants: Diversity and Health

Non-woody plants include grass and grass-like (graminoid) species and broad-leaf plants (forbs). They are important aspects of diversity and health in riparian areas. On stream and small river sites, 133 graminoids and 401 forbs were identified. The most abundant and common non-woody plant is Kentucky bluegrass. Canada thistle is the second most common, while smooth brome is the second most abundant herbaceous species.

Invasive Plants

This parameter is based on all stream and small river sites (n=904). Invasive plants found and assessed, on average, have a canopy cover greater than 15% and/or a density and distribution of Class 8 or higher. That makes this parameter unhealthy on sites completed along streams and small rivers.

From the 836 stream and small river sites with inventory data, there are 22 plant species listed as invasive. Canada thistle is the most abundant and most common invasive plant followed by perennial sow thistle *(Sonchus arvensis)* and tall buttercup *(Ranunculus acris*). Canada thistle and perennial sow thistle each occupy between 1% and 3% of the area and are found on 93% and 63% of sites, respectively. Of the other invasive plants observed in the basin, each occupy less than 1% of the area and are only found on a few sites. Although the cover and abundance of these other species is minimal, they should be monitored closely, controlled, and eradicated where possible. Thirty-four of the stream and small river sites (less than 4% of sites) had no invasive plants observed.

Disturbance-Caused Undesirable Herbaceous Species (Disturbance Plants)

This parameter is common among all data collection methods and is based on nearly all stream and small river sites (n=903). The majority of sites sampled have more than 45% of their area covered by disturbance plants, on average, resulting in an unhealthy parameter rating.

Based on the 836 sites with inventory data, there were 54 disturbance plant species found on stream and small river sites. Kentucky bluegrass is the most abundant and common disturbance species, followed by smooth brome as the second most abundant.

4.1.1.2 Physical Parameters

For streams and small rivers, there are four parameters related to physical aspects of the riparian area, and they are common to each site examined. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.1.1.2.1 Banks and Floodplain: Structure and Stability

<u>Root Mass Protection</u>

This parameter is examined for most streams and small river sites (n=850); it was not collected where defined banks were absent, or where banks and near bank areas were obscured, such as by high water levels. Overall it rates healthy but with problems, which means that on average, 65% to 85% of the bank length assessed has adequate diversity of plants with deep binding roots to provide protection against erosion and lateral cutting.

<u>Human-Caused Bare Ground</u>

This parameter is examined for most stream and small river sites (n=902). On average, streams and small river sites had between 1% and 5% exposed soil due to human activities, rating this parameter healthy but with problems.

Human-caused bare ground is caused by a number of types of activities. From 830 sites with inventory data on causes, the primary activity recorded as the source of human-caused bare ground along streams and small rivers is grazing, with both greatest number of sites and most area affected by grazing. Recreational activities, construction, logging and mining each comprise a very small amount of area influenced, although recreation was the most common of these types. A variety of other non-categorised sources occurred on many sites as well.

<u>Human-Caused Structural Alterations to Banks</u>

This parameter is examined for most streams and small river sites (n=849); it was not collected where defined banks were absent, or where banks were obscured, such as by high water levels. On average, sites have between 15% and 35% the bank length structurally altered from human causes, resulting in an unhealthy rating.

Streambank alterations on 778 sites were primarily caused by grazing, as determined from those sites that had inventory data. Grazing was the most common and affected the most length. Other causes present, but affecting very few sites and very little area were mining, construction, logging, and cultivation. Recreation affected a very small area, but was recorded more often than these other causes. Other diverse and unspecified categories were also recorded as present on many sites.

Human-Caused Physical Alteration to the Rest of Site

This parameter was assessed on nearly all sites (n=902). On average, 5% to 15% of the area's soil or topography has been altered by human activities and therefore the average health rating is healthy but with problems.

Based on sites from 2005 and 2006 with causes of physical alterations (n=196), the primary source of alterations is grazing. Grazing is the most frequently occurring cause and is the cause of alterations to the greatest area. Cultivation, recreation, logging and construction each accounted for very minor amounts of altered area and occurred very infrequently. Other uncategorized types of causes occur on a few sites and contribute to a small area of alterations.

Channel Incisement

This parameter was assessed on most sites (n=854); it was not collected in some situations, including where high water levels or littoral vegetation obscured required bank or channel characteristics. Of sites examined, on average, the channel is generally showing slight incisement, in either an improving or degrading phase, with 1-2 year flows only accessing a narrow floodplain less than or slightly wider than twice bankfull width. On average, the health rating is healthy but with problems.

4.1.1.3 Riparian Health Summary

With more than half (54%) of the stream and small river sites rating healthy but with problems, less than one fifth (18%) rating as healthy, and about one quarter (28%) rating as unhealthy overall health was affected by numerous parameters. Three riparian health parameters scored healthy. Overall vegetative cover was high, meaning that the riparian area is normally well covered with plants to help reduce erosion and support filtering and trapping of sediment from overland flow or flood waters. Regeneration and establishment of preferred trees and shrubs was also good, with sufficient proportions of seedlings and saplings to maintain riparian woody plant communities. In the overall woody plant community, there was very little dead and decadent canopy, so most tree and shrub communities were not showing signs of impact in this parameter. These parameters are good signs that the cover necessary in riparian areas is present and that the tree and shrub community is generally regenerating and maintaining itself.

A number of parameters have some concerns and rated healthy but with problems. Streambank rootmass protection, human-caused bare ground, human-caused physical alterations to the rest of the site, and channel incisement all rated between 60% and 80%. Streambanks need additional deep binding roots, which are currently lacking, in order to increase rootmass protection. The lack of species with deep binding roots is influenced by some loss of woody plants and prevalence of invasive and disturbance caused species. Bare ground resulting from human activities is of concern, as it contributes negatively to water quality, fish and wildlife habitat, and overall ability of riparian areas to function. Alterations to the non-streambank portion of the riparian area are present, altering the soil profile and contributing to a reduction in water infiltration ability.

Four parameters are unhealthy, including invasive and disturbance caused plants, utilisation of preferred trees and shrubs and human-caused alterations to streambanks. The prevalence of invasive and disturbance-caused species decreases bank stability, reduces filtration and limits bank holding capacity during high water events. Utilisation of trees and shrubs has or will reduce the vigour of woody plants, and is likely a contributing factor to insufficient deep binding roots. Alterations on the streambanks reduce the ability of a site to withstand the impact of water action and may change the bank shape and soil profile, resulting in modified infiltration and habitat functions.

Land use data is only present for a portion of sites (n=595) on streams and small rivers. Note that multiple land uses may occur on a site. The most common land use is native pasture (grazing) land, being found on 88% of sites. Tame pasture, recreation, and roads are present on comparatively few sites and there was no land use on some sites; each of these categories was present on between 6% and 9% of sites (Appendix H-Table 1). Development, cropping, railroads, lawn, logging and other uncategorised land uses each were present on a very small portion of sites (i.e. less than 7% of sites).

<u>Where Efforts Could be Focused to Maintain/Improve Riparian Health</u>

Many aspects of riparian health along streams and small rivers are consistent with the other waterbody types in the province. Suggestions made in Section 6.0 are applicable here as well as the discussion to follow.

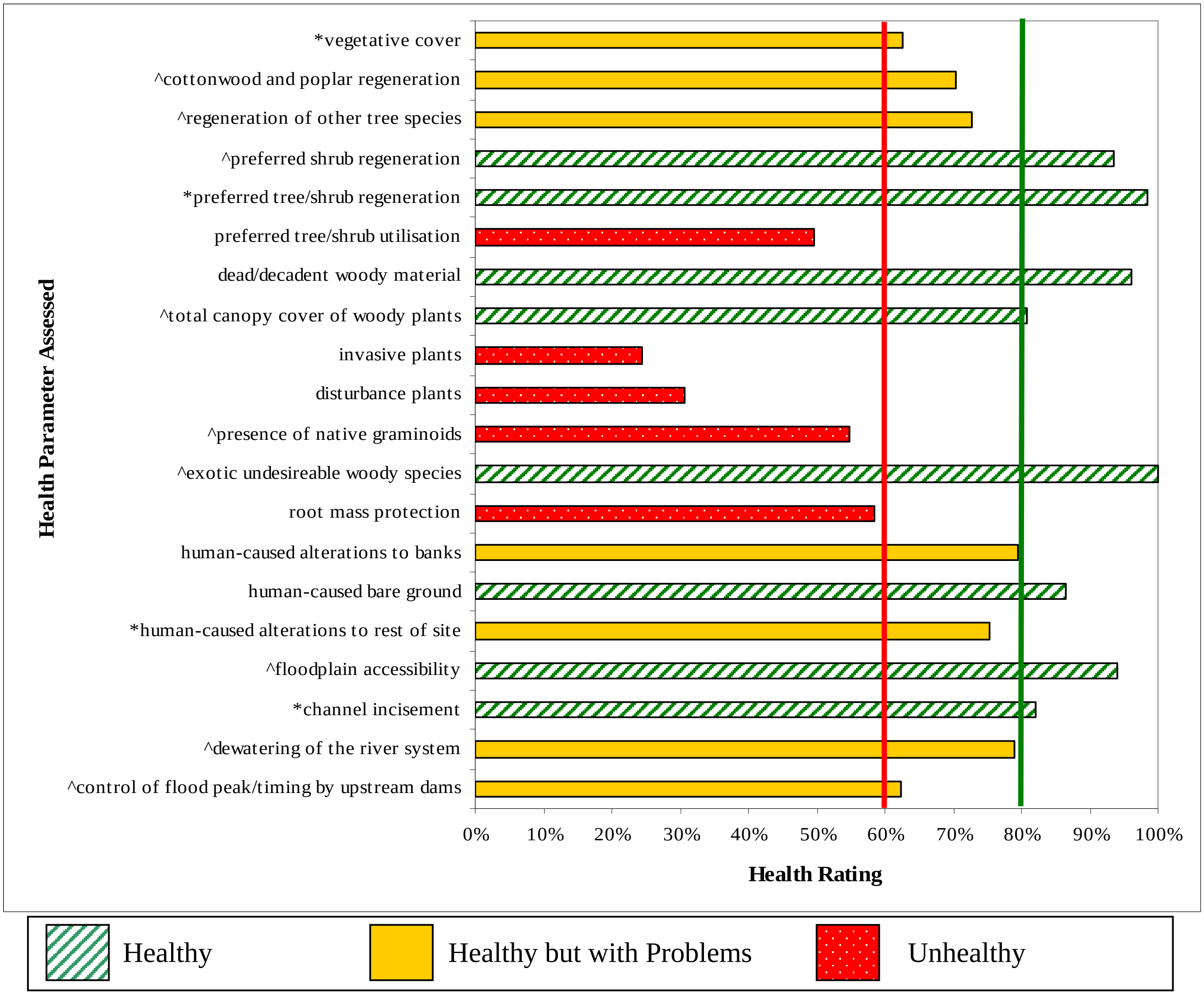
On streams and small rivers, alterations to streambanks are of concern. Reducing further impacts and allowing for recovery of existing alterations will require management of grazing timing and intensity. Management options that apply suitable livestock distribution and grazing intensity will minimise bank alterations and aid in this recovery.

4.1.2 Large Rivers

For riparian areas along large rivers, 402 sites were sampled. There are twenty riparian health parameters used in assessing the health related to large rivers (Section 2.4 Table 8), and of these twenty parameters, eight are healthy or functioning properly, seven are healthy but with problems or functioning at risk, and five are unhealthy or non-functioning (Figure 14). The majority of large river sites were sampled within the South Saskatchewan River basin (Appendix E). Because we have sampled a small proportion of sites in the province, the discussion of riparian health parameters is limited to the sites we have sampled and may not be applicable to the entire province.

4.1.2.1 Vegetation Parameters

For large river riparian areas, there are 12 parameters related to vegetation (not all applicable to all sites). The overall rating of each parameter is based on the number of applicable sites. Detailed discussion about each parameter is based on sites with inventory data that can support it.



Note: parameter is assessed for all sites unless otherwise indicated
^ large river sites with large river health only
* large river sites with lotic inventory or health survey only

Figure 14. Evaluation of riparian health parameters for large rivers (n=402) in Alberta. Note: sample size may vary by parameter; see text for sample size specific to each parameter.

Vegetative Cover of the Site

Overall vegetative cover is assessed for about one quarter (n=93) of the large river sites. The health rating for this parameter is based on both lotic health survey and derived results. Throughout the applicable sites, vegetation cover is moderate to sufficient, rating healthy but with problems. This means on average, sites have over 75-85% of the riparian area covered by vegetation.

From the sites with inventory data (n=398), we can describe vegetation life form distribution. Graminoids are the most abundant (71% cover) followed by shrubs (47% cover) and trees (28% cover). Forbs are least abundant with 23% cover.

There was a total of 531 different plant species identified. The most abundant was smooth brome, followed by balsam poplar. The most common plant was Canada thistle, found on 94% of all sites. Buckbrush/snowberry and smooth brome were nearly as common; found on 92% and 91% of inventoried sites, respectively. Of all of the plant species observed, over three quarters (80%) of them are native. About 10% are listed as disturbance and 5% are invasive.

4.1.2.1.1 Woody Plants: Presence, Reproduction and Health

Trees and shrubs are an important characteristic of riparian health where they have the potential to grow. On large river sites, all sites have the potential for at least preferred shrub species; less than 10% of sites did not have potential for preferred tree species. There were 13 tree and 78 shrub species identified. The most abundant woody plant was balsam poplar, followed by buckbrush/snowberry. Buckbrush/snowberry, along with sandbar willow (*Salix exigua*) and yellow willow (*Salix lutea*) were the most common woody plants, occurring on 92%, 89% and 81% of inventoried sites, respectively.

<u>Cottonwood and Poplar Regeneration</u>

This parameter is specific to sites assessed using large river health survey methods and where potential for cottonwoods/poplars existed (n=284). It rates healthy but with problems. Balsam poplar is the primary species found and assessed for this question and the rating means that 5-15% of the cover on these sites is established seedlings and saplings.

<u>Regeneration of Other Tree Species</u>

This parameter is specific to sites assessed using large river health survey methods and where potential for these species exists (n=237). It rates healthy but with problems. The main non-cottonwood tree species found and included in the assessment are white spruce (*Picea glauca*), Manitoba maple (*Acer negundo*) and trembling aspen (*Populus tremuloides*). The health rating means that on average, these sites have 1-5% of the other tree (non-cottonwood) cover as seedlings and saplings.

<u>Preferred Shrub Regeneration</u>

This parameter is specific to sites assessed using the large river health survey method and with potential for these preferred species (refer to Methods for details) (n=309) and rates healthy. On large river sites, the most common shrub species included in this parameter is sandbar willow. The health rating means that 1% to more than 5% of the preferred shrub cover is seedlings and saplings on average.

Preferred Tree and Shrub Establishment and Regeneration

This parameter is based on all sites with the potential for preferred trees and shrubs, and assessed using either the lotic inventory or health survey method (n= 93 sites). Preferred tree and shrub regeneration and establishment along large rivers rates healthy, meaning that overall there is greater than 5% canopy cover of these woody species in the seedling and sapling age classes.

Preferred Tree and Shrub Utilisation

This parameter is based on all sites with potential for preferred tree and shrub species, and that have available material to be browsed or otherwise removed by livestock, humans or wildlife (n=402). Average utilisation of preferred woody plants is moderate and thus rates unhealthy, with 25-50% utilisation. About half of sites (48%) had heavy or moderate utilisation. About 9% of sites show signs of no browse or utilisation on preferred trees and shrubs.

Dead and Decadent Standing Woody Material

This parameter was examined on sites with trees and shrubs (n=402) and rates healthy on large river sites. This means that less than 25% of the total canopy cover of woody species on these sites is dead or decadent.

Total Canopy Cover of Woody Plants

This parameter is specific to sites completed with large river health data collection methods (n=309) and rates healthy. The health rating means that 25% to greater than 50% of the area assessed is covered by woody plants.

Exotic Undesirable Woody Species

This parameter is specific to sites assessed with the large river health survey method (n=308) and rates healthy (less than 5% cover). Only one site had a reduced health score as a result of the presence of common caragana (*Caragana arborescens*). Slightly more than ten sites had caragana present but abundance was very low. Note that six river sites had Russian olive (*Elaeagnus angustifolia*) present, but were examined with lotic inventory methods, not large river health survey methods and therefore it does not contribute to the health of this parameter. Although the cover of exotic woody plants is minimal, these species should be eradicated to prevent further spread.

4.1.2.1.2 Non-Woody Plants: Diversity and Health

Non-woody plants include grass and grass-like (graminoid) species and broad-leaf plants (forbs). They are important aspect of diversity and health in riparian areas. On large river sites 113 graminoids and 327 forbs were identified. The most abundant non-woody plant on large river sites is smooth brome. The most common herbaceous species is Canada thistle.

Invasive Plants

This parameter is based on all large river sites (n=402). Invasive plants found and assessed in the basin, on average, have a canopy cover greater than 15% on each site and/ or a density and distribution of Class 8 or higher. That makes this parameter unhealthy.

From the 398 large river sites with inventory data, there are 24 plant species listed as invasive. Canada thistle is the most abundant and most common invasive plant. Next most common is perennial sow thistle, with butter-and-eggs (*Linaria vulgaris*) next most abundant. Canada thistle and leafy spurge *(Euphorbia esula*) each occupy greater than 1% of the area and are found on 94% and 11% of sites, respectively. Of the other invasive plants observed along large rivers, each occupy less than 1% of the area and are only found on a few sites. Although the cover and abundance of these other species is minimal, they should be monitored closely, controlled, and eradicated where possible. Only six large river sites were free of invasive plants.

Disturbance-Caused Undesirable Herbaceous Species (Disturbance Plants)

This parameter is common among all data collection methods and is based on nearly all large river sites (n=401). The majority of sites sampled have more than 45% of their area covered by disturbance plants resulting in an unhealthy parameter rating.

Based on the 398 large river sites with inventory data there were 52 disturbance plant species found. Smooth brome is the most abundant and common species, followed by Kentucky bluegrass.

Presence of Native Graminoids

This parameter is specific to sites assessed with the large river health survey method (n=309) and rates unhealthy. The health rating means that 5% - 25% of the riparian area on relevant sites along large rivers is covered by native graminoid species.

From the 398 sites with inventory data, 88 native graminoid species were identified on the large river sites with foxtail barley (*Hordeum jubatum*) being the most common.

4.1.2.2 Physical Parameters

For large rivers, there are six parameters related to physical aspects of the riparian area. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.1.2.2.1 Banks and Floodplain: Structure, Stability and Accessibility

Root Mass Protection

This parameter is examined for most large river sites (n=395); it was not collected where banks and near bank areas were obscured, such as by high water levels. Overall, root mass protection rates unhealthy, meaning that on average 35% - 65% of the river bank assessed has adequate diversity of plants with deep binding roots to provide protection against erosion and lateral cutting.

Human-Caused Structural Alterations to Banks

This parameter is examined for most large river sites (n=395); it was not collected where banks were obscured, such as by high water levels. It rates healthy but with problems among these sites, meaning that on average, more than 10-25% of the bank length is structurally altered from human causes.

Riverbank alterations on 388 sites with inventory data were primarily caused by grazing. Grazing was the most common cause of alterations and affected the most bank length. Recreation affected a small proportion of banks, but was recorded as the second most common cause of bank alterations. The only specified other cause present, but affecting very few sites and very little bank length was construction. Other diverse and unspecified categories were recorded as present on numerous sites, and those listed most often included rip rap, channelisation, bridges, and roads.

Human-Caused Bare Ground

This parameter was assessed for nearly all large river sites (n=401) and rates healthy overall. For those sites examined using the large river health survey method, on average, sites have less than 25% of exposed soil that is a result of human disturbance; for those assessed using the lotic survey or inventory methods, sites have less than 5% human-caused bare ground.

Human-caused bare ground, is affecting limited area and sites, but where present, is caused by a number of types of activities. From 393 sites with inventory data on causes, the primary activity recorded as the source of human-caused bare ground along large rivers is grazing, with both greatest number of sites and most area attributed to grazing. Recreational activities were the next most common cause of bare ground, affecting numerous sites and a modest amount of area. Construction and mining each caused bare ground on a very small amount of area and were present on very few sites. A variety of other non-categorised sources occurred on many sites as well, with roads being mentioned frequently.

Human-Caused Physical Alteration to the Rest of Site

This parameter was assessed on about one quarter of sites (n=93). Of these sites, on average, 5% to 15% of the area soil or topography has been altered by human activities and therefore the average health rating is healthy but with problems.

Only about one third of sites within this parameter have data (n=35). Based on sites from 2005 and 2006 with causes of physical alterations recorded, the primary source of alterations is grazing. Grazing is the most frequently occurring cause and is the cause of alterations to the greatest area. Recreation, logging and construction each accounted for very minor amounts of altered area as well as occurring very infrequently. Other uncategorized types of causes occur on a few sites and contribute to a small area of alterations.

Floodplain Accessibility

This parameter was assessed on nearly all sites assessed with large river health survey methods (n=308). Of these sites, on average, more than 65% of floodplain is accessible to flood waters, rating this parameter as healthy.

Channel Incisement

This parameter was assessed on sites using lotic inventory methods (n=89). On average, the channel is vertically stable and not incised or has limited incisement and 1-2 year high flows access a floodplain appropriate or slightly less than twice bankfull width. This results in a healthy average health rating.

4.1.2.3. Hydrologic Parameters

4.1.2.3.1 Damming and Dewatering

Dewatering of the River System

This parameter was assessed on approximately three quarters of all sites (n=309) which are ones assessed with the large river health survey method. Of these sites, 10%-25% of natural flows are removed on average, resulting in a rating of healthy but with problems.

Control of Flood Peak/Timing by Upstream Dams

This parameter was assessed on approximately three quarters of all sites (n=309) which are ones assessed with the large river health survey method. Of these sites, on average, 10%-50% of the watershed area upstream of the site is dammed, resulting in a rating of healthy but with problems.

4.1.2.4 Riparian Health Summary

Slightly more than one quarter (27%) of large river sites rate healthy and half (49%) rate healthy but with problems, with the remainder rated as unhealthy (24%). Numerous parameters are positively influencing riparian health. Seven riparian health parameters scored healthy. These include preferred shrub regeneration and preferred tree and shrub regeneration, dead and decadent woody material, total canopy cover of woody plants, exotic undesirable woody species, human-caused bare ground, floodplain accessibility, and channel incisement. Regeneration of shrubs and trees/shrubs combined is good, with high levels of woody plants communities, showing limited signs of dead canopy This suggests that sufficient young woody plants are present in these groups to maintain woody plant communities. The near absence of exotic woody species is positive—preventing future establishment of these species should be an important element of riparian management.

The limited amount of human-caused bare ground is excellent—this means that human activities are not generally leading to noticeable amounts of exposed soil that could contribute to erosion, loss of water quality and reduced habitat. Along the large rivers examined, high flows are generally not restricted and can access an area appropriate to the channel size—this is positive. With restrictions due to human embankments or incisement of the channel very minimal, high flows are able to access a floodplain to deposit water, material, and energy, thus contributing to the functioning of these sites.

A number of parameters have some impairment and rated healthy but with problems. Vegetative cover, cottonwood and other tree regeneration, human-caused bank alterations, alterations to the rest of the site, dewatering of the river system, and control of flood peak or timing by dams were the seven parameters in this health category. There are some concerns with regeneration of cottonwoods and other trees, which may be linked to modifications to the flow as characterized in the level of dewatering, or control of flood peak and timing by dams. Cottonwood/poplar communities are particularly susceptible to modifications in flow and timing; ensuring that further hydrologic limitations are avoided will be important, as will on-site management such as grazing timing and intensity that minimizes use of these woody plants. Alterations to the banks and rest of the riparian area are not extensive, but are of some concern as they can contribute to soil loss into the aquatic system as well as limit the ability of the floodplain to absorb and hold water.

Five parameters are unhealthy, including invasive and disturbance caused plants, utilisation of preferred trees and shrubs, presence of native graminoids, and root mass protection. The lack of deep binding roots is likely linked to the prevalence of invasive and disturbance caused species, lack of native graminoids, as well as higher levels of woody plant utilisation. These features indicate that banks may be less stable, there is less ability for filtering or buffering by plants and there is reduced bank holding capacity during high water events than if more deep-rooted species were present.

Land use data for large rivers is only present for slightly more than half of sites (n=265). Note that multiple land uses may occur on a site. The most common land use is native pasture (grazing), being recorded on 71% of sites (Appendix H-Table 1). Tame pasture, recreation, and roads are fairly common, found on between 10% and 20% of sites. No land use on was observed on nearly on quarter (23%) of sites. Development, cropping, railroads, lawn, and logging were each present on a small number of sites (no more than 5% of sites each).

<u>Where Efforts Could be Focused to Maintain/Improve Riparian Health</u>

Many aspects of riparian health along large rivers are consistent with the other waterbody types in the province. Suggestions made in Section 6.0 are applicable here as well as the discussion to follow.

Although shrub regeneration and woody plant cover is generally high, cottonwood/poplar and other tree species regeneration is somewhat limited, and may be of concern for long-term maintenance of riverine forests along rivers particularly in the southern portions of Alberta. Moderate levels of utilisation could negatively impact their reproduction in the future.

In order to promote and maintain tree and shrub communities, overall utilisation of trees and shrubs needs to be reduced.

Using a combination of weed control measures, strategies that minimise human-caused bare soil, and approaches to promote native plant vigour will help reduce disturbance and invasive species, while promoting native graminoids. Limiting further expansion of introduced grass species in riparian areas with grazing, recreation, development or other land uses will be required.

4.1.3 Lakes and Wetlands

Of riparian areas associated with lakes and wetlands, 168 sites were sampled. There are nine riparian health parameters used in assessing the riparian health of lakes and wetlands (Section 2.4 Table 8) and of these nine parameters, one is healthy or functioning properly, six are healthy but with problems or functioning at risk, and two are unhealthy or non-functioning (Figure 15). Slightly less than half of sites were located in the North Saskatchewan River basin, with more than a third located in the Athabasca River basin (Appendix E). Because we have sampled a small proportion of sites in the province, the discussion of riparian health parameters is limited to the sites we have sampled and may not be applicable to the entire province.

4.1.3.1 Vegetation Parameters

For lakes and wetlands riparian areas, there are six parameters related to vegetation (not all applicable to all sites). The overall rating of each parameter is based on the number of applicable sites. Detailed discussion about each parameter is based on sites with inventory data that can support it.

<u>Vegetative Cover of the Site</u>

Overall vegetative cover is assessed for all lakes and wetlands sites (n=168). Throughout the applicable sites vegetation cover is moderate to sufficient, rating healthy but with problems. This means on average, sites have 85% - 95% of the area covered by vegetation.

From the sites with inventory data (n=143), we can describe vegetation life form distribution. Graminoids are the most abundant (76% cover) followed by forbs (33% cover) and shrubs (18% cover). Trees are least abundant with less than 7% cover.

There was a total of 380 different plant species identified. The most abundant was common cattail *(Typha latifolia)* followed by awned sedge (*Carex atherodes*). The most common plant was Canada thistle, found on 92% of all sites. Common dandelion (*Taraxacum officinale*), balsam poplar and Kentucky bluegrass were also very common, found on 75% of inventory sites. Of all of the plant species observed, over three quarters (81%) of them are native, about 10% are listed as disturbance and 4% are invasive.

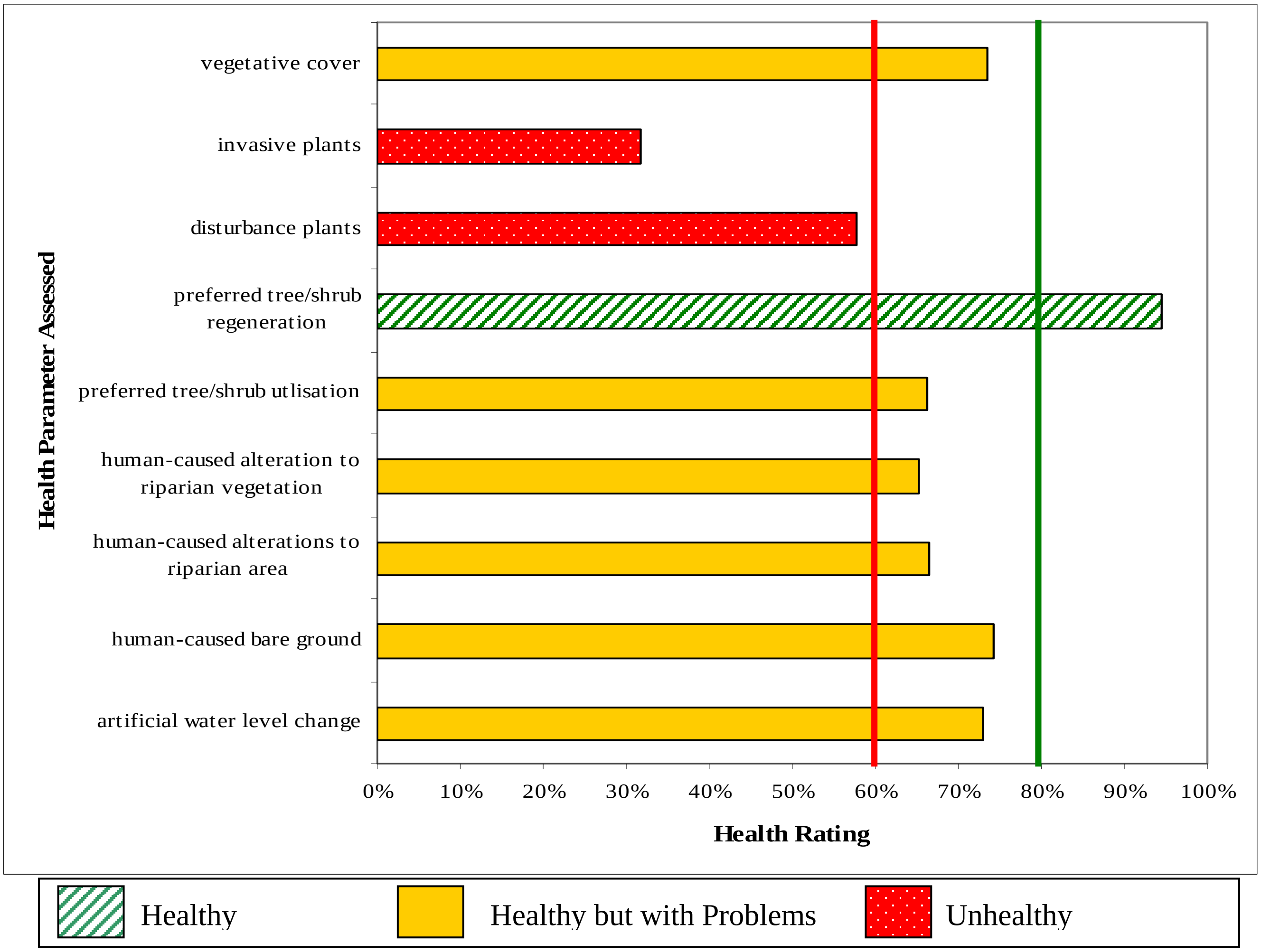


Figure 15. Evaluation of riparian health parameters for lakes and wetlands (n=168) in Alberta. Note: sample size may vary by parameter; see text for sample size specific to each parameter.

4.1.3.1.1 Woody Plants: Presence, Reproduction and Health

Trees and shrubs are an important characteristic of riparian health where they have the potential to grow. On lakes and wetlands sites, nearly all sites have that potential. There were 14 tree and 57 shrub species identified. The most abundant woody plant was balsam poplar and then yellow willow. Balsam poplar and beaked willow were the most common woody plants, occurring on 77% and 73% of inventoried sites, respectively.

<u>Preferred Tree and Shrub Establishment and Regeneration</u>

This parameter is based on all sites with the potential for preferred trees and shrubs (refer to Methods for details), and nearly all sites have that potential (n=166). Preferred tree and shrub regeneration and establishment along lakes and wetlands rates healthy, meaning that on average there is greater than 5% canopy cover of these woody species that are in the seedling and sapling age classes.

Preferred Tree and Shrub Utilisation

This parameter is based on all sites with potential for appropriate tree and shrub species, and that have available material to be browsed or otherwise utilised or removed (n=164). Utilisation of preferred woody plants is 5%-25% on average and thus rates healthy but with problems. About three quarters of sites (77%) had none or light utilisation. About 7% of sites show signs of heavy browse or utilisation on preferred trees and shrubs.

4.1.3.1.2 Non-Woody Plants: Diversity and Health

Non-woody plants include grass and grass-like (graminoid) species and broad-leaf plants (forbs). They are important aspect of diversity and health in riparian areas. On lake and wetland sites 76 graminoids and 233 forbs were identified. The most abundant non-woody plant is common cattail and the most common is Canada thistle.

Invasive Plants

This parameter is based on all lake and wetlands sites (n=168). Invasive plants found and assessed around lakes and wetlands, on average, have a canopy cover greater than 15% on each site and/ or a density and distribution of Class 8 or higher. That makes this parameter unhealthy.

From the 143 lake and wetland sites with inventory data, there are 14 plant species listed as invasive. Perennial sow thistle is the most abundant and Canada thistle is the most common invasive plant. Perennial sow thistle and Canada thistle each cover about 2% of the area and are found on 81% or 92% of sites, respectively. Of the other invasive plants observed in the basin, each occupy less than 1% of the area and are only found on a few sites. Although the cover and abundance of these other species is minimal, they should be monitored closely, controlled, and eradicated where possible. Eight lake and wetland sites were free of invasive plants.

Disturbance-Caused Undesirable Herbaceous Species (Disturbance Plants)

This parameter is common among all data collection methods and is based on all lakes and wetlands sites (n=168). On average, sites sampled have 25% – 45% of their area covered by disturbance plants resulting in an unhealthy rating for this parameter.

Based on the 143 sites with inventory data there were 38 disturbance plant species found on lakes and wetlands. Kentucky bluegrass is the most abundant disturbance species and common dandelion is the most common.

4.1.3.1.3 Alterations to Vegetation

Human-caused Alterations to Site Vegetation

This parameter is examined based on most lakes and wetland sites (n=152). Of these sites, on average, 5% to 35% of the areas vegetation has been altered by human activities and therefore the average health rating is healthy but with problems.

Causes of alterations to riparian vegetation can be interpreted from 142 sites with inventory data. Recreation and grazing are nearly equally frequent causes of vegetative alterations, although grazing affects more area. Other causes present, but affecting very few sites and smaller area, are cultivation, railroads, timber harvest, mining, and cottage development. Other, uncategorised causes were numerous, with vegetation removal the most commonly mentioned. Riprap, berms and spraying of broad leaf vegetation were each mentioned as causes of riparian vegetation alteration on one occasion.

4.1.3.2 Physical Parameters

For lakes and wetlands, there are two parameters related to physical aspects of the riparian area. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.1.3.2.1 Bare Ground and Alterations to Riparian Area

Human-caused Bare Ground

This parameter was assessed on all sites (n=168). These sites, on average, have 1% - 5% of the area soil or topography that is bare due to by human activities and therefore the average health rating is healthy but with problems.

Human-caused bare ground is caused by a number of types of activities. From 143 sites with inventory data on causes, the primary activity recorded as the source of human-caused bare ground along lakes and wetlands is grazing, although recreation is nearly as frequently the cause of human-caused bare ground. Both are important in overall area affected, but grazing affects a greater area. Construction and logging each comprise a small amount of area influenced, although construction is more frequently the cause of bare ground between the two causes. A variety of other non-categorised sources occurred on many sites as well, including mechanical clearing, beach development and roads.

Human-caused Alterations to the Physical Site

This parameter is examined based on most lake and wetland sites (n=152). Of these sites, on average, 5-15% of the area soil or topography has been altered by human activities and therefore the average health rating is healthy but with problems.

Alterations to the physical site of 142 lake and wetland sites are primarily caused by grazing. Grazing was the most common cause of alterations and affected the most area. Recreation, although it affected much less area, was also a very common cause of physical alterations. Roads and railroads were recorded numerous times as the cause of physical alterations. Other causes present, but affecting very few sites and very little area were cultivation, timber harvest, cottage development, water management and cultivation. Other diverse and unspecified categories were recorded on many sites, including rip rap, clearing, boat ramps and paths or trails.

4.1.3.3 Hydrologic Parameters

4.1.3.3.1 Artificial Water Level Change

This parameter is examined based on most lake and wetland sites (n=145) where the degree of artificial water level change could be determined. Of these sites, the results indicate that on average there are minor impacts of artificial water removal or addition to these water bodies which rates this parameter healthy but with problems.

4.1.3.4 Riparian Health Summary

With 27% rated as unhealthy, less than half (44%) of the lake and wetland sites rating healthy but with problems, and less than one third (29%) rated as healthy, overall health was affected by numerous parameters. One riparian health parameter scored healthy. Regeneration and establishment of preferred trees and shrubs was high, with sufficient proportions of seedlings and saplings to maintain riparian woody plant communities.

Six parameters have some concerns and rated healthy but with problems. Overall vegetative cover was not as high as it could have been, meaning that the riparian area is not as well covered by plants to help reduce erosion and support filtering and trapping of overland flow or high water levels. Although some of this unvegetated area that is bare ground is due to natural causes, unvegetated areas are more at risk of erosion, provide opportunities for invasive plants to establish, and do not contribute the functions of riparian areas as well as vegetated areas.

Utilisation of preferred trees and shrubs rated healthy but with problems, and this level of utilisation over the long-term will reduce the cover of woody species or may prevent reestablishment where required. Human-caused alterations to the vegetation community rated similarly for health, and this parameter includes changes to the plant community structure and composition. Health impacts related to the presence of disturbance-caused plants and utilisation of woody plants are likely contributing to changes to the expected plant community.

Bare ground resulting from human activities is of some concern, as it contributes negatively to water quality, fish habitat, and overall ability of riparian areas to function. Physical alterations to the riparian area are present, altering the soil profile, and bank or shore topography. Numerous sites examined had alterations to the hydrology of the lakes and wetlands, as evidenced by the healthy but with problems score for artificial water level changes. These alterations include both addition and removal of water in volumes or timing that may be negatively influencing the riparian area. In some cases this may be stabilisation of water levels at or higher than naturally fluctuating levels.

Two parameters are unhealthy: invasive and disturbance-caused plants. The prevalence of invasive and disturbance-caused species decreases bank and shoreline stability and may reduce filtration of runoff. The prevalence of these species also contributes negatively to the overall vegetative community, often resulting in increased area of herbaceous, shallow-rooted species and loss or reduction of some layers in the plant community.

Lakes and wetlands land use data is only present for a portion of sites (n=150). Note that multiple land uses may occur on a site. Based on how frequently each land use occurred, native pasture (grazing land) was the most common land use (41% of sites), followed closely by recreation (38%) (Appendix H-Table 1). No land use was also very common on the lake and wetland sites, with 33% of sites having no identifiable land use activity. Lawn, tame pasture, development, roads and other types of land uses were each recorded numerous times, and were found on less than 7% of the sites. Of the other unspecified categories, boat launches and beaches were some of the land uses mentioned. Cropping, perennial forage and logging were each only recorded once.

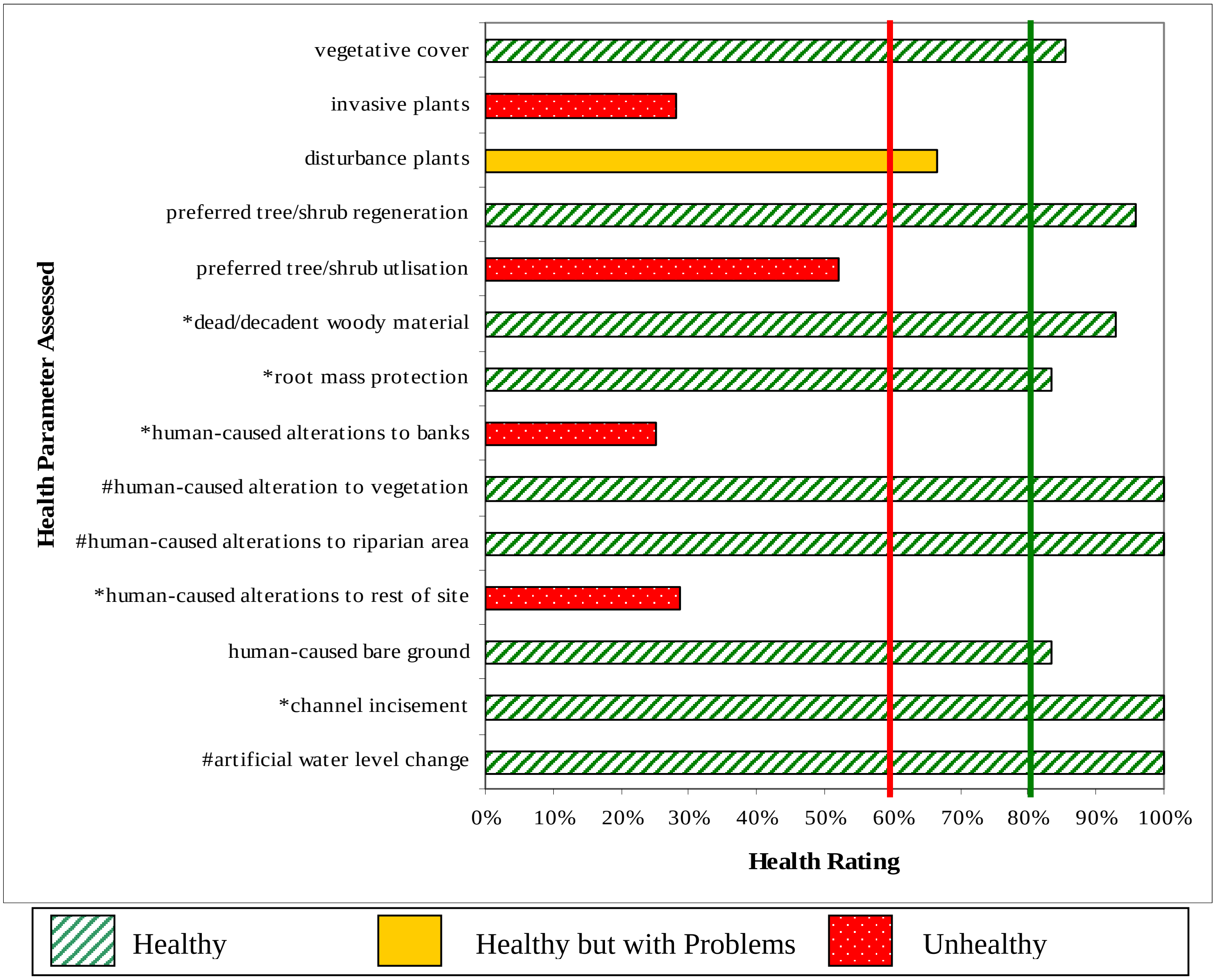
<u>Where Efforts Could be Focused to Maintain/Improve Riparian Health</u>

Many aspects of riparian health associated with lakes and wetlands are consistent with the other waterbody types in the province. Suggestions made in Section 6.0 are applicable here as well as the discussion to follow.

Current rates of utilisation of preferred trees and shrubs are less of a concern than other waterbody types, but still could be a problem with the reproduction of these plants in the future. Monitoring and potentially reducing overall utilisation would be beneficial to the plant communities on these waterbodies. On grazed lands, this may be achieved with a variety of strategies that ensure a rest period during the growing season and avoid use when woody plants are highly palatable. On areas with recreational or other uses, limiting direct human removal of woody plants will improve tree and shrub communities. In general, reducing utilisation levels should assist in future reproduction and establishment.

4.1.4 Springs and Seeps

Of riparian areas associated with seeps and springs, 16 sites were sampled. Of the fourteen riparian health parameters used in assessing the riparian health of seeps and spring (Section 2.4 Table 8), nine are healthy or functioning properly, one is healthy but with problems or functioning at risk, and four are unhealthy or non-functioning (Figure 16). Approximately two thirds of spring and seeps were sampled within the South Saskatchewan River basin (Appendix E). Because we have sampled an extremely small proportion of sites in the province, the discussion of riparian health parameters is limited to the sites we have sampled and is not be applicable to the entire province.



Note: parameter is assessed for all sites (n=16) unless otherwise indicated
* springs and seeps (lotic) only (n=14)
# springs and seeps (lentic) only (n=2)

Figure 16. Evaluation of riparian health parameters for springs and seeps (n=16) in Alberta. Note: sample size may vary by parameter; see text for sample size specific to each parameter.

4.1.4.1 Vegetation Parameters

For spring and seep riparian areas, there are seven parameters related to vegetation (not all applicable to all sites). The overall rating of each parameter is based on the number of applicable sites. Detailed discussion about each parameter is based on sites with inventory data that can support it.

Vegetative Cover of the Site

Overall vegetative cover is assessed for all of the springs and seeps (n=16). Throughout the applicable sites vegetation cover is high, rating healthy. This means on average, sites have over 85% of area covered by vegetation.

From the sites with inventory data (n=16), we can describe vegetation life form distribution. Graminoids are the most abundant (59% cover) followed by forbs (35% cover) and shrubs (21% cover). Trees are least abundant with 9% cover.

There was a total of 208 different plant species identified. The most abundant was Canada thistle followed by Kentucky bluegrass. The most common plants were Canada thistle and common wild rose (*Rosa woodsii)*, found on 81% of all sites. Of all of the plant species observed, over three quarters (83%) are native, about 14% are listed as disturbance and 2% are invasive.

4.1.4.1.1 Woody Plants: Presence, Reproduction and Health

Trees and shrubs are an important characteristic of riparian health where they have the potential to grow. On seeps and springs sites, all sites have that potential. There were seven tree and 35 shrub species identified. The most abundant woody plant was beaked willow, followed by buckbrush/snowberry. Common wild rose, along with buckbrush/snowberry and beaked willow were the most common woody plants, occurring on 81%, 75% and 63% of inventoried sites, respectively.

Preferred Tree and Shrub Establishment and Regeneration

This parameter is based on all sites with the potential for preferred trees and shrubs (refer to Methods for details), and is common among all data collection methods appropriate to this waterbody type (n=16). Preferred tree and shrub regeneration and establishment on springs and seeps sites rates healthy, meaning that overall there is greater than 5% canopy cover of these woody species that are in the seedling and sapling age classes.

Preferred Tree and Shrub Utilisation

This parameter is based on all sites with potential for preferred tree and shrub species, and that have available material to be browsed, utilised or otherwise removed by livestock, humans or wildlife (n=16). Utilisation of preferred woody plants is 25% -50% on average and thus rates unhealthy. Half of sites had none or light utilisation. The remaining 50% of sites show signs of moderate browse or utilisation on preferred trees and shrubs.

Dead and Decadent Standing Woody Material

This parameter was examined on sites with trees and shrubs and using lotic methods (n=14). It rates healthy on [lotic] seep and spring sites. This means that less than 25% of the total canopy cover of woody species on these sites is dead or decadent.

4.1.4.1.2 Non-Woody Plants: Diversity and Health

Non-woody plants include grass and grass-like (graminoid) species and broad-leaf plants (forbs). They are important aspect of diversity and health in riparian areas. On seep and spring sites 54 graminoids and 112 forbs were identified. The most abundant non-woody plant is Canada thistle. The most common non-woody species were Canada thistle and perennial sow thistle.

<u>Invasive Plants</u>

This parameter is based on all seep and spring sites (n=16). Invasive plants found and assessed on this waterbody type, on average, have a canopy cover greater than 15% on each site and/or a density and distribution of Class 8 or higher. That makes this parameter unhealthy.

From the 16 seep and spring sites that have inventory data, there are five plant species listed as invasive. Canada thistle is the most abundant and most common invasive plant. Next most common is perennial sow thistle, with tall buttercup (*Ranunculus acris*) as next most abundant. Canada thistle, tall buttercup and perennial sow thistle each occupy greater than 1% of the area and are found on 81%, 38%, and 63% of sites, respectively. No seep and spring sites were free of invasive plants. Of the other invasive plants observed around seeps and springs, each occupy less than 1% of the area and are only found on a few sites. Although the cover and abundance of these other species is minimal, they should be monitored closely, controlled, and eradicated where possible.

<u>Disturbance-Caused Undesirable Herbaceous Species (Disturbance Plants)</u>

This parameter is common among all data collection methods and therefore is based on all seep and spring sites (n=16). The majority of sites sampled have 5% - 25% of their area covered by disturbance plants resulting in a healthy but with problems parameter rating.

Based on the 16 sites with inventory data, there were 28 disturbance plant species found on seep and spring sites. Kentucky bluegrass is the most abundant and common disturbance species.

4.1.4.1.3 Alterations to Vegetation

<u>Human-caused Alterations to Site Vegetation</u>

This parameter is applicable to those sites assessed using either of the lentic inventory or lentic health survey methods (n=2). Of both sites, <5% of the area's vegetation has been altered by human activities and therefore the average health rating is healthy. Note that no discussion on causes of alterations is provided due to low sample size.

4.1.4.2 Physical Parameters

4.1.4.2.1 Banks and Floodplain: Structure, Stability and Accessibility

For seeps and springs, there are six parameters related to physical aspects of the riparian area. Detailed discussion about each parameter is based on sites with inventory data that can support it.

Root Mass Protection

This parameter is examined for some seep and spring sites (n=4); it was not collected where banks and near bank areas were obscured, such as by high water levels; where banks and channel were not defined; nor at any lentic sites. Overall, root mass protection rates healthy, meaning that more than 85% of the bank length assessed has adequate diversity of plants with deep binding roots to provide protection against erosion and lateral cutting.

Human-Caused Structural Alterations to Banks

This parameter is examined for some seep and spring sites (n=4); it was not collected where banks and near bank areas were obscured, such as by high water levels; where banks and channel were not defined; nor at any lentic sites. It rates unhealthy among these sites, meaning that on average, more than 35% of the bank area is structurally altered from human causes. No discussion on causes of alterations is provided due to low sample size.

Channel Incisement

This parameter was assessed on lotic sites where defined channel and banks were visible (n=4). On average, the channel is not incised, is vertically stable with high water accessing an appropriate floodplain every 1-2 years and therefore the average health rating is healthy.

4.1.4.2.2 Bare Ground and Alterations to Riparian Area

Human-Caused Bare Ground

This parameter was assessed for all seep and spring sites (n=16). On average, sites have less than 5% of exposed soil that is a result of human disturbance, rating this parameter healthy.

Only two causes of bare ground were recorded for this small group of sites (n=16). Grazing was the primary source of human-caused bare ground around seeps and springs, with both greatest number of sites and most area attributed to grazing. Recreational activities were the only other activity recorded, comprising a very small amount of area influenced.

Human-Caused Physical Alteration to the Rest of Site

This parameter was assessed on lotic seep and spring sites (n=14). Of these sites, on average, more than 25% of the area soil or topography has been altered by human activities and therefore the average health rating is unhealthy. No discussion on causes of alterations is provided due to low sample size.

Human-caused Alterations to the Physical Site

This parameter is examined based on both lentic sites (n=2). Of these sites, less than 5% of the area soil or topography has been altered by human activities and therefore the average health rating is healthy. No discussion on causes of alterations is provided due to low sample size.

4.1.4.3 Hydrologic Parameters

4.1.4.3.1 Artificial Water Level Change

This parameter is examined based on both lentic sites (n=2). Of these sites, there was no artificial water removal or addition to these water bodies which rates this parameter healthy.

4.1.4.4 Riparian Health Summary

Due to the very small sample size of seeps and springs, it is difficult to make overall observations of health of this type of waterbody and this summary should be considered to be specific to those sites examined. Of those sites examined, about one third are healthy (31%), half (50%) rate healthy but with problems and the remaining 19% are unhealthy.

Eight riparian health parameters scored healthy. Overall vegetative cover was high, meaning that the riparian area is normally well covered with plants to help reduce erosion and support filtering and trapping of material. Regeneration and establishment of preferred trees and shrubs was also good, with sufficient proportions of seedlings and saplings to maintain riparian woody plant communities. In the overall woody plant community, there was very little dead and decadent canopy, so most tree and shrub communities rated healthy for this parameter. Of the two sites assessed for human-caused alterations to the vegetation and physical sites, as well as artificial water level change, these parameters showed little or no alterations or modifications, which is positive.

Only one parameter rated healthy but with problems - disturbance-caused plants. This aspect of the plant community indicates that there are some concerns with the high abundance of these species, typically with shallow roots and reduced ability to withstand erosive energy of water.

The remaining four parameters rated unhealthy. As with all waterbody types, the prevalence of invasive species is a concern, as it decreases bank stability, reduces filtration and reduces bank holding capacity. Relatively high levels of utilisation of preferred trees and shrubs have likely reduced the vigour of woody plants. Human-caused alterations to the streambanks on the four applicable sites are of concern; these alterations reduce the ability of these sites to withstand the impact of water flow. The physical alterations to the rest of the site are extensive enough to rate unhealthy, and these modifications to floodplain soil profile and topography may reduce infiltration and water holding capacity of the soils.

Seeps and springs land use data is only present for a portion of sites (n=13). Note that multiple land uses may occur on a site. The most common land use, which was found on all sites, is native pasture grazing (Appendix H-Table 1). Recreation and other land uses are present on a few sites.

Where Efforts Could be Focused to Maintain/Improve Riparian Health

Many aspects of riparian health associated with seeps and springs are consistent with the other waterbody types in the province. Suggestions made in Section 6.0 are applicable.

The limited number of seeps and springs with riparian health data suggests there is a need for increased riparian health monitoring. Involvement of landowners and land users will be required in that process to initiate monitoring as well as make use of the information within management and decision making.

4.2 Riparian Health Parameters by Major River Basin

A discussion of riparian health for each of the seven major river basins in the province as delineated by Alberta Environment is presented in this section. The summaries provide details on riparian health parameters and attempts to identify the main influences on riparian health for each basin. A comparable table of the riparian health parameters ratings for the major river basins can be referred to in Appendix G. For information on land uses refer to the *Riparian Health Summary* section for each basin. Refer to Appendix H for a comparable table of land use occurrences in the major river basins of Alberta.

4.2.1 Hay River Basin

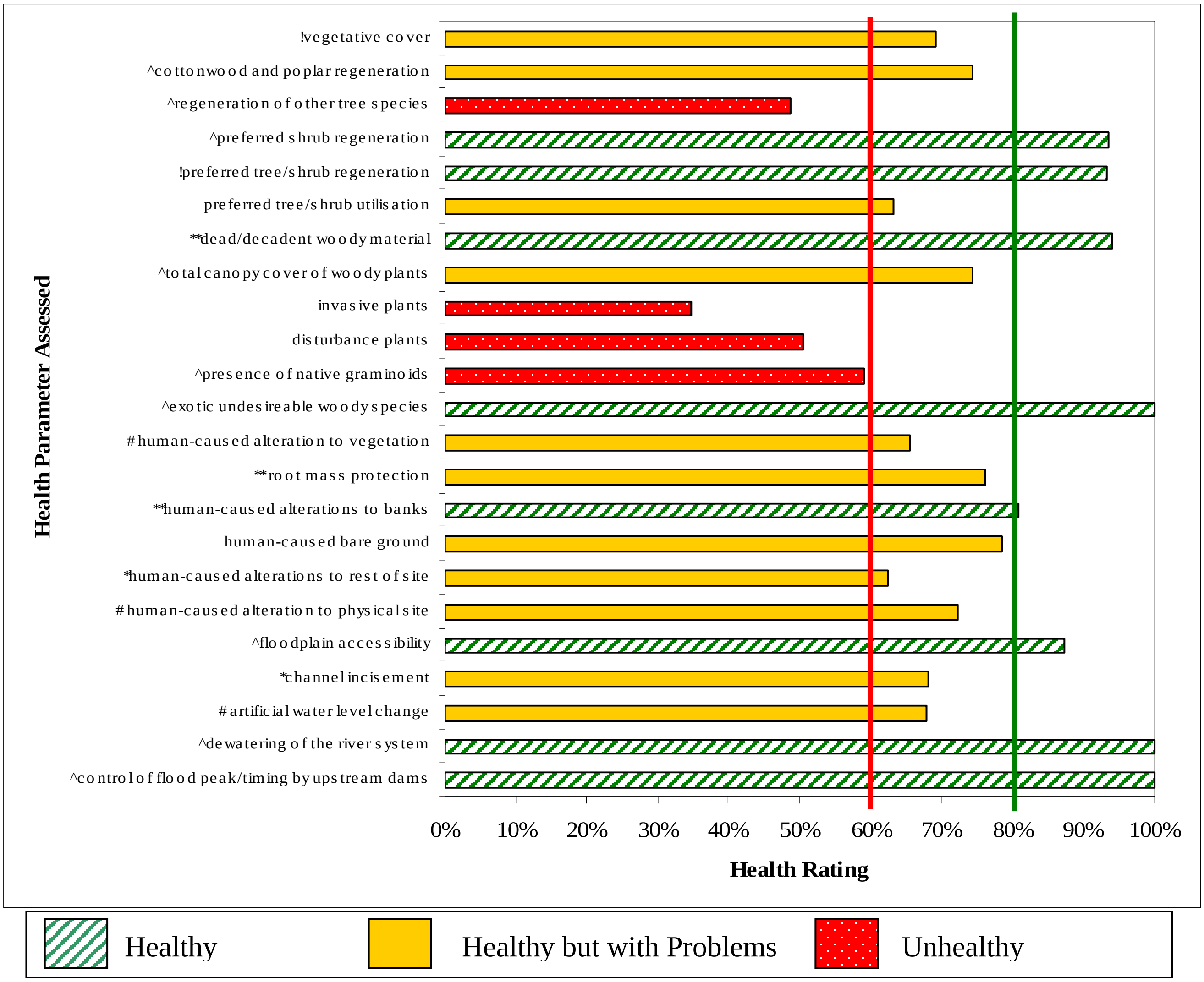
No riparian health data, collected and housed as described in Section 2.0, exists for the Hay River Basin.

4.2.2 Peace/Slave Rivers Basin

No riparian health data, collected and housed as described in Section 2.0, exists for the Peace/Slave Rivers Basin.

4.2.3 Athabasca River Basin

There are 23 riparian health parameters used in assessing the health of riparian sites in the Athabasca River basin. Of these 23 parameters, 8 are healthy or functioning properly, 11 are healthy but with problems or functioning at risk, and 4 are unhealthy or non-functioning (Figure 17). The majority of waterbodies sampled within the Athabasca River basin are lakes and wetlands, followed by large rivers and streams and small rivers (Appendix E). There has been one spring/seep sampled (lotic). Because we have only sampled a small proportion of the Athabasca River basin, the discussion of riparian health parameters is limited to the sites we have sampled and the results may not be applied to the entire watershed.



Note: parameter is assessed for all sites unless otherwise indicated

^ large rivers only

* streams and small rivers & springs and seeps (lotic) only

lakes and wetlands only

** large rivers & streams and small rivers & springs and seeps (lotic) only

! streams and small rivers & springs and seeps (lotic) & lakes and wetlands only

Figure 17. Evaluation of riparian health parameters for Athabasca River basin (n=110) in Alberta. Note: sample size may vary by parameter; see text for sample size specific to each parameter.

4.2.3.1 Vegetation Parameters

In the Athabasca River basin there are 13 parameters related to vegetation. Three parameters are common to all sites, six are specific to large rivers, two are common on non-large river lotic and all lentic systems, one is specific to lakes and wetlands and one is specific to non-large river lotic systems.

The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is limited to sites with inventory data that can support it.

Vegetative Cover of the Site

Overall vegetative cover is only measured on non-large river lotic sites, lentic sites, and large rivers assessed using inventory methods (n=84). The health rating for this parameter is based on both health survey and derived results. Throughout the applicable sites in the Athabasca River basin vegetation cover is adequate, rating healthy but with problems. This means on average, relevant sites have 85% to 95% of the riparian area covered by some vegetation.

From the 108 inventories completed in the Athabasca River basin, we can describe vegetation life form distribution. Graminoids are the most abundant (85% cover) with shrubs (27% cover) and forbs (24% cover) as next most abundant. Trees are least abundant with only about 4% of the cover.

There were a total of 282 different plant species identified in the Athabasca River basin. The most abundant plant was undifferentiated bluegrass species *(Poa* spp*.)* followed by bluejoint (or marsh reed grass) (*Calamagrostis canadensis)* and flat-leaved willow *(Salix planifolia).* The most common plant was Canada thistle (*Cirsium arvense*) found on approximately 90% of inventoried sites. Common dandelion *(Taraxacum officinale)* and common nettle *(Urtica dioca)* were found on 83% and 80% of inventoried sites, respectively. Of all of the plants observed, more than three quarters (80%) of them are native. About 11% are listed as disturbance and 3% are invasive.

4.2.3.1.1 Woody Plants: Presence, Reproduction and Health

Trees and shrubs are an important characteristic of riparian health on sites where they have the potential to grow. In the Athabasca River basin all except one site has that potential. There were nine different tree and 45 different shrub species identified from the inventories. The most abundant woody plant was flat-leaved willow followed by beaked willow *(Salix bebbiana).* Beaked willow, along with wild red raspberry *(Rubus idaeus)* and balsam poplar *(Populus balsamifera),* were the most common woody plants, occurring on 79% and 77% (both raspberry and poplar) of inventoried sites.

Preferred Tree and Shrub Establishment and Regeneration

This parameter is relevant to large river sites assessed using inventory methods, lotic non-large river sites and lentic sites that have potential to grow trees and shrubs (n=83). Preferred tree and shrub regeneration and establishment in the Athabasca River basin rates healthy, meaning that on average there is greater than 5% canopy cover of preferred woody species that are in the seedling and sapling age classes on sites where this parameter is measured.

Cottonwood and Poplar Regeneration

This parameter is specific to sites assessed using the large river health survey method and with the potential to grow cottonwood and poplar trees (n=26). It rates healthy but with problems which means that on average, 5% to 15% of the cottonwood/poplar canopy cover on these sites is established seedlings and/or saplings. Based on the 108 inventories, on sites in the Athabasca River basin, balsam poplar is the primary species found and assessed for this question.

Regeneration of Other Tree Species

This parameter is specific to sites assessed using large river health survey methods (n=26) and with the potential to grow other tree species other than cottonwoods and poplars. It rates unhealthy in the Athabasca River basin. The health rating means that on these sites less than 1% of the other tree (non-cottonwood) cover is seedlings and saplings, on average.

Other common tree species found and included in the assessment for the Athabasca River basin include trembling aspen *(Populus tremuloides)*, white birch *(Betula papyrifera)* and white spruce *(Picea glauca)* based on the 108 inventories completed.

Preferred Shrub Regeneration

This parameter is specific to sites assessed using the large river health survey method (n=26) and with the potential to grow preferred shrubs. In the Athabasca River basin it rates healthy. The health rating means that, on average, 1% to greater than 5% of the preferred shrub cover is seedlings and saplings on these sites.

Total Canopy Cover of Woody Plants

This parameter is specific to sites with completed large river health surveys (n=26) and potential to grow woody plants. It rates healthy but with problems in the Athabasca River basin. The health rating means that, on average, sites have 25% to 50% of the riparian area covered by woody plants.

Exotic Undesirable Woody Species

This parameter is specific to sites with completed large river health surveys (n=26) and rates healthy. This rating means that on average, less than 5% of the woody cover consists of exotic undesirable woody species. Only two sites in the Athabasca River basin had common caragana and the cover and distribution of the species was low. Although the cover and distribution is minimal, this species should be eradicated to prevent further spread. Russian olive (*Elaeagnus angustifolia)* was found in the basin but not on any large river systems.

Preferred Tree and Shrub Utilisation

This parameter is common among all waterbody types and data collection methods and is based on sites in the Athabasca River basin with woody plants existing on the site (n=109).

Utilisation of preferred woody plants is light to moderate overall and thus rates healthy but with problems. This means, on average, 5% to 50% of the second year and older available twigs of preferred woody species are browsed or otherwise removed. The majority of sites, approximately 93%, have either none, light or moderate use. Only about 7% of sites show signs of heavy browse or utilisation on preferred trees and shrubs.

Dead and Decadent Standing Woody Material

This parameter is common between non-large river lotic sites and sites with completed large river health surveys (n=50). It rates healthy for relevant sites in the Athabasca River basin. This means that less than 25% of the total canopy cover of woody species on these lotic sites is dead or decadent, on average.

4.2.3.1.2 Non-Woody Plants: Diversity and Health

Non-woody plants include grass and grass-like (graminoid) species and broad-leaf plants (forbs). They are important aspect of diversity and health in riparian areas. Based on the inventories completed in the Athabasca River basin, there were 61 different graminoids and 166 different forbs identified. The most abundant non-woody plant is undifferentiated bluegrass species. Bluejoint, awned sedge *(Carex atherodes)* and timothy *(Phleum pratense)* are next most abundant. Canada thistle is the most common non-woody plant found on 90% of sites. Common dandelion and common nettle were also common found on 84% and 80% of sites, respectively.

Invasive Plants

This parameter is common among all waterbody types and data collection methods and is based on all sites in the Athabasca River basin (n=110). Invasive plants found and assessed in the basin, on average, have a canopy cover 1% to 15% and a density and distribution of a single patch plus a few sporadically occurring individuals or more (DD Class 4-7). That makes this parameter unhealthy in the Athabasca River basin.

From the 108 inventories completed in the Athabasca River basin there are 10 plant species listed as invasive including common caragana. Canada thistle is the most abundant and most common invasive plant followed by perennial sow thistle *(Sonchus arvensis).* Of the other invasive plants observed in the basin, each occupy less than 1% of the area and are only found on a few sites. Russian olive was found on one site with very low cover. Although the cover and abundance of these other species is minimal, they should be monitored closely, controlled, and eradicated where possible as with all invasive plants. Only eight sites (7%) in the Athabasca River basin had no invasive plants observed.

Disturbance-Caused Undesirable Herbaceous Species (Disturbance Plants)

This parameter is common among all waterbodies and data collection methods and therefore is based on all sites in the Athabasca River basin (n=110). It rates unhealthy meaning that on average, sites have 25% to 45% of the riparian area covered by disturbance plants.

Based on the 108 inventories there were 32 disturbance plant species found and assessed in the Athabasca River basin. Timothy is the most abundant, followed by Kentucky bluegrass. The most common disturbance plant species is common dandelion. Kentucky bluegrass and alsike clover *(Trifolium hybridum)* are also common, found on 76% and 74% of sites, respectively.

Presence of Native Graminoids

This parameter is specific to sites with completed large river health forms (n=26) and rates unhealthy in the Athabasca River basin. The health rating means that on average, sites have 5% to 25% of the riparian area covered with native plants.

From the 108 inventories, there were 51 different native graminoid species identified in the Athabasca River basin. The most abundant and commonly occurring native graminoid species is bluejoint or marsh reed grass.

4.2.3.1.3 Alterations to Vegetation

Human-Caused Alterations to Site Vegetation

This parameter is only applicable to those sites on lakes and wetlands in the Athabasca River basin (n=60). On average, 5% to 35% of the riparian area vegetation has been altered by human activities and therefore the health rating is healthy but with problems.

Causes of alterations to riparian vegetation can be interpreted from 58 sites in the Athabasca River basin. Vegetation alterations from human causes are most commonly due to recreation and vegetation removal. Grazing is a less frequent cause yet it affects the most area. Other causes present, but affecting very few sites and smaller area, are cultivation, railroads, timber harvest, mining, and cottage development. Riprap and spraying of broad leaf vegetation were mentioned one time as additional causes of riparian vegetation alterations.

4.2.3.2 Physical Parameters

In the Athabasca River basin there are seven parameters related to physical aspects of the riparian area. One parameter is common to all sites, one is specific to large rivers, two are common for large river and non-large river lotic sites, one is specific to lakes and wetlands and two are specific to non-large river lotic sites. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.2.3.2.1 Banks and Floodplain: Structure, Stability and Accessibility

Root Mass Protection

This parameter is common between large river and non-large river lotic sites that have a defined bank (n=49) in the Athabasca River basin. Overall it rates healthy but with problems which means that on average, 65% to 85% of the river or stream bank assessed has adequate diversity of plants with deep binding roots to provide protection against erosion and lateral cutting.

Human-Caused Structural Alterations to Banks

This parameter is common between large river and non-large river lotic sites that have a defined stream or river bank (n=49) in the Athabasca River basin. It rates healthy among these sites meaning that on average, less than 15% of the bank length (for streams and small rivers) or less than 25% of the bank length (for large river sites assessed with large river health survey methods), is structurally altered from human causes. Refer to Appendix K-Tables 2 and 3 for more information on the health rating description.

Stream or riverbank alterations from 100 inventory sites in the Athabasca River basin were primarily caused by grazing. Grazing was the most common cause of alternations and affected the most length. Other causes present, but affecting very few sites and very little area were recreation, logging and construction. Other diverse and unspecified categories were recorded as present on more sites and affecting a larger area than these other causes but still less than grazing.

4.2.3.2.2 Bare Ground and Alterations to Riparian Area

Human-Caused Bare Ground

This parameter is common among all waterbody types and data collection methods and therefore is based on all sites in the Athabasca River basin (n=110). On average, sites in the basin have 1% to 5% or 5% to 25% of exposed soil that is a result of human disturbance rating this parameter healthy but with problems. Refer to Appendix K-Table 2 for more information on the health rating description.

Human-caused bare ground is a result of a number of types of activities. From 108 sites with inventory data on causes, the primary activity recorded as the source of human-caused bare ground in the Athabasca River basin, with both greatest number of sites and most area affected, is grazing. Recreational activities, construction and logging each comprise a very small amount of area influenced, although recreation was the most common of these types. A variety of other non-categorised sources occurred on many sites as well.

Human-Caused Physical Alteration to the Rest of Site

This parameter is specific to non-large river lotic sites (n=24) in the Athabasca River basin. On average it rates healthy but with problems which means that 5% to 25% of the riparian area soil or topography beyond the banks has been altered by human activities.

Based on sites from 2005 and 2006 with causes of physical alterations (n=15), the primary source of alterations is grazing. Grazing is the most frequently occurring cause and is the cause of alterations to the greatest area. Cultivation and logging each accounted for very minor amounts of altered area as well as occurring very infrequently. Other uncategorized types of causes occur on one site and contribute to a small area of alterations.

Human-Caused Alterations to the Physical Site

This parameter is applicable to those sites in the Athabasca River basin that are on lakes and wetlands (n=60). Of these sites, 5% to 15% of the area soil or topography has been altered by human activities and therefore the average health rating is healthy but with problems.

Causes of alterations to riparian physical site can be interpreted from 58 sites in the Athabasca River basin that have inventory data. Physical site alterations are most commonly from recreation and a number of 'other' uncategorised types. Grazing is a less frequent cause yet it affects the most area. Additional causes present, but affecting very few sites and small area, are railroads, timber harvest, cultivation, cottage development and water management.

Channel Incisement

This parameter was assessed on non-large river sites with a defined channel (n=23) throughout the Athabasca River basin. Of sites examined, the health rating is healthy but with problems which means that, on average, channels are slightly incised, in either an improving or degrading phase with 1-2 year high water flows accessing a narrow floodplain less than or slightly wider than expected.

Floodplain Accessibility

This parameter was assessed on all sites where large river health surveys were completed (n=26). Of these sites, on average, more than 65% of floodplain is accessible to flood flows, rating this site as healthy.

4.2.3.3 Hydrologic Parameters

In the Athabasca River basin there are three parameters related to hydrologic aspects of the riparian area. One parameter is specific to lakes and wetlands and two are specific to large river systems. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.2.3.3.1 Artificial Water Level Change

This parameter is applicable to those sites in the Athabasca River basin that are on lakes and wetlands and where the degree of artificial water level change could be determined (n=58). Of these sites, the results indicate that on average there is minor impact of artificial water removal or addition to these waterbodies which rates this parameter healthy but with problems.

4.2.3.3.2 Damming and Dewatering

Both parameters of Dewatering of the River System and Control of Floodpeak Timing by Upstream Dam(s) are applicable to large river sites assessed with large river health survey methods (n=26). In the Athabasca River basin, all sites have less than 10% of average river discharge removed during the critical growing season removed and less than 10% of the watershed upstream controlled by dams. As a result these are healthy parameters in the Athabasca River basin.

4.2.3.4 Riparian Health Summary

In the Athabasca River basin over one third (38%) of sites rate healthy, 40% rate healthy but with problems and 22% rate unhealthy. Numerous parameters are positively influencing riparian health in the Athabasca River basin and there are eight riparian health parameters scored healthy. These include: preferred shrub regeneration, preferred tree and shrub regeneration, dead and decadent woody material, exotic undesirable woody species, human-caused alterations to the banks, floodplain accessibility, dewatering of the river system and control of flood peak and timing by upstream dams.

Regeneration of shrubs, and trees and shrubs combined, is good, with high levels of young shrub communities, suggesting that sufficient young woody plants are present in these groups to maintain woody plant communities. A limited sign of dead canopy in trees or shrubs suggests that there is enough water to support these plant communities and there has been no dramatic overall impact from insects, disease, spray drift, or drought. The near absence of exotic woody species is positive—preventing future establishment of these species should be an important element of riparian management at all levels.

The limited amount of human-caused alterations to the stream and river banks is excellent within the Athabasca River basin. This means that the levels of human activity within riparian area are maintaining natural bank profiles. From a river dynamics perspective, another positive feature is that along the large river sites examined, high flows are generally unrestricted by human embankments and can access the floodplain—this is positive, as it allows energy and water to be spread across the floodplain rather than remain in the channel, thus contributing to the functioning of these sites. The minimal impacts to dewatering and control of flood peak/timing are positive—these aspects of riparian areas, when functioning, ensure available moisture for riparian plant community survival and thus they should not be negatively influencing tree regeneration or general riparian plant community survival.

Many parameters (11) rated in the healthy but with problems category which suggests some level of decline in their ability to contribute to proper riparian function. Vegetative cover, cottonwood/poplar regeneration, preferred tree and shrub utilisation, total canopy cover of woody plants, human-caused alterations to the vegetation, root mass protection, human-caused alterations to the rest of the site, human-caused alterations to the physical site, channel incisement, and artificial water level change all scored in the middle health category. Human-caused bare ground rated very high in the healthy but with problems category, almost healthy.

This suggests that human activities are most often not leading to noticeable amounts of exposed soil that could contribute to erosion, loss of water quality and reduced habitat.

There are some concerns with overall cover of plants, and regeneration of cottonwoods/poplars. This may be related to the level of tree and shrub utilisation. Human-caused physical alterations to riparian areas in the Athabasca River basin are not extensive, but are enough to be of some concern as they can contribute to soil loss into aquatic systems and limit the ability of the riparian soils to absorb and hold water. Lack of sufficient deep-binding roots is likely linked to the prevalence of invasive and disturbance-caused plants, as well as only a moderate rating for cover of woody plants. The potential for woody plants is high in the Athabasca River basin so there is room for improvement .in this aspect of riparian health. Stream and river channel incisement is present, resulting in a lower health rating, meaning that water does not overtop banks and access floodplain areas as frequently as the channel size would suggest, but rather is restricted to a narrower floodplain due to the downcutting of the channel bottom. Artificial changes to water levels are present and reducing the overall rating for lentic sites to healthy but with problems.

Four parameters are unhealthy, including regeneration of other tree species, invasive and disturbance-caused plants, and presence of native graminoids. The lack of seedlings and saplings of non-cottonwood tree species is a concern for long-term maintenance of woody plant communities dominated by these other tree species. Widespread invasive plant species and abundant disturbance-caused plants are likely intricately linked to the low presence of native graminoids, and collectively contribute to loss of root mass protection and increased alterations to the vegetation community, as native, deep-rooted species are replaced with non-native and shallower rooted species. These vegetative community changes are affecting the health of sites in the Athabasca River basin. Although the high abundance of non-native grasses is likely replacing native graminoids, the unhealthy rating on this parameter may be influenced by the question criteria (i.e. a relatively high coverage of native graminoids required to score healthy). Further research is required to determine the appropriate, expected cover of native graminoids in this basin. As of 2007, this question was removed from the large river riparian health assessment (survey).

In the Athabasca River basin, land use data is present for most sites (n=107). Note that multiple land uses may occur on a site. The most common land use is native pasture (grazing) which occurred on 40% of sites. This is closely followed by 38% of sites that had no land use. Recreation was also very common, followed by tame pasture, on 30% and 16% of sites respectively. Lawns, development, roads, and other uncategorised land uses are occasionally present being noted on 5%-12% of sites. Logging, railroads, perennial forage, and cropping were each recorded a few times (on less than 3% of sites).

<u>Where Efforts Could be Focused to Maintain/Improve Riparian Health</u>

Many aspects of riparian health in the Athabasca River basin are consistent with the other basins in the province. Suggestions made in Section 6.0 are applicable here as well as the discussion to follow.

Managing the watershed to reduce activities that increase the speed and volume of water delivery may be needed to help prevent further incisement of lotic systems, which is currently of concern. In conjunction with larger watershed scale management for this reason, on-site management that promotes well vegetated banks is necessary.

Maintaining the healthy condition of stream and river banks is key to the overall integrity of riparian areas in the Athabasca Basin. Being cognisant of human activities that could affect the current condition and promotion of land uses that do not cause a decline in this parameter of riparian health is recommended.

4.2.4 Beaver River Basin

Of the 13 riparian health parameters with data in the Beaver River Basin, seven are healthy or functioning properly, four are healthy but with problems or functioning at risk, and three are unhealthy or non-functioning (Figure 18). The majority of sites within the Beaver River Basin are on streams and small rivers, with a few lakes and wetlands. There have been no large rivers (completed with the large river health survey method) or springs/seeps sampled (Appendix E). Due to the small sample size, limited broad scale conclusions regarding riparian health in the Beaver River Basin can be made. The discussion of riparian health parameters is limited to the sampled sites and the results may not be applied to the entire watershed.

4.2.4.1 Vegetation Parameters

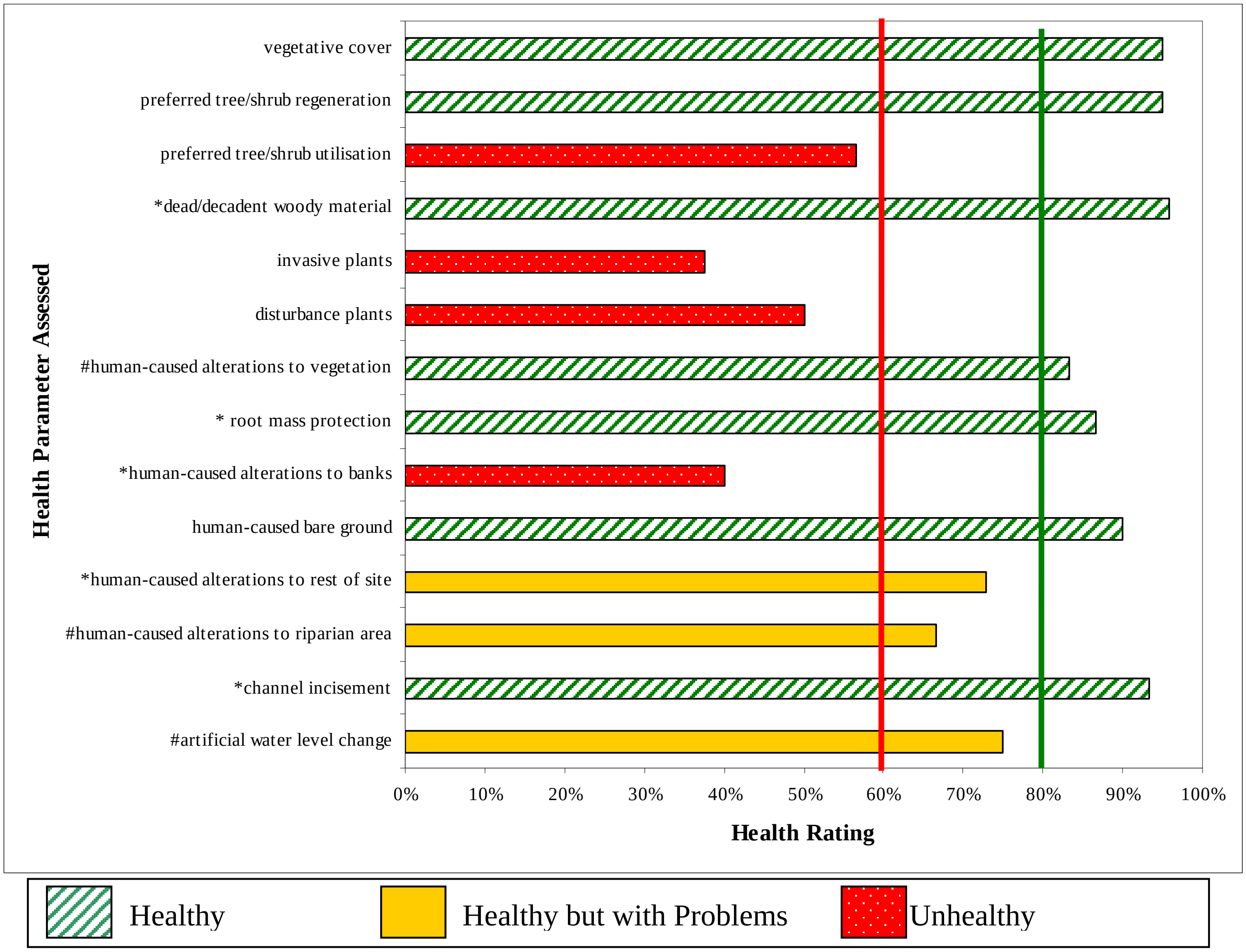
For the Beaver River basin there are seven parameters related to vegetation. Five parameters are common to all sites, one is specific to lakes and wetlands and one is specific to streams and small rivers. Detailed discussion about each parameter is based on sites with inventory data that can support it.

<u>Vegetative Cover of the Site</u>

This parameter is common to all sites assessed in the Beaver River basin (n=20). Vegetation cover is excellent, rating healthy, which means, on average, sites are more than 85% covered by some vegetation.

From the 19 inventories completed in the Beaver River basin, we can describe vegetation life form distribution. Graminoids are the most abundant (74% cover) with shrubs (36% cover) and forbs (26% cover) as next most abundant. Trees are least abundant with only about 14% of the cover.

There was a total of 167 different plant species identified. The most abundant were awned sedge, common cattail (*Typha latifolia*), small-bottle sedge *(Carex utriculata)* and bluejoint. The most commonly occurring plant was Canada thistle found on all (100%) of the inventoried sites. The next most common plants were balsam poplar, beaked willow, fowl bluegrass (*Poa palustris),* snowberry/buckbrush, common wild rose, and perennial sow thistle. Of all of the plant species observed, more than three quarters (82%) of them are native, about 14% are listed as disturbance and 3% are invasive.



Note: parameter is assessed for all sites unless otherwise indicated
* streams and small rivers only
\# lakes and wetlands only

Figure 18. Evaluation of riparian health parameters for Beaver River basin (n=20) in Alberta. Note: sample size may vary by parameter; see text for sample size specific to each parameter.

4.2.4.1.1 Woody Plants: Presence, Reproduction and Health

Trees and shrubs are an important characteristic of riparian health where they have the potential to grow. In the Beaver River basin all sites have that potential. There were six tree and 31 shrub species identified. The most abundant woody plant was yellow willow (*Salix lutea*) followed by basket willow *(Salix petiolaris)* and balsam poplar. Balsam poplar, along with beaked willow, snowberry/buckbrush, and common wild rose were the most common woody plants, each occurring on 95% of inventoried sites.

Preferred Tree and Shrub Establishment and Regeneration

This parameter is relevant to all sites (n=20) assessed in the Beaver River basin. Preferred tree and shrub regeneration and establishment in the Beaver River basin rates healthy, meaning that on average, greater than 5% canopy cover of these woody species are in the seedling and sapling age classes.

Preferred Tree and Shrub Utilisation

This parameter is common among all waterbody types and data collection methods and therefore is based on all sites in the Beaver River basin (n=20). Utilisation of preferred woody plants is moderate to light and rates unhealthy overall. This means, on average, 25% to 50% of the second year and older available twigs of preferred woody species are browsed or otherwise removed. The majority of sites (approximately 80%) have light or moderate use. Only about 10% of sites show signs of heavy browse or utilisation on preferred trees and shrubs.

Dead and Decadent Standing Woody Material

This parameter is specific to stream and small river sites assessed in the Beaver River basin (n=16) and rates healthy. This means that less than 25% of the total canopy cover of woody species on these sites is dead or decadent.

4.2.4.1.2 Non-Woody Plants: Diversity and Health

Non-woody plants include grass and grass-like (graminoid) species and broad-leaf plants (forbs). They are an important aspect of diversity and health in riparian areas. Based on inventory sites in the Beaver River basin there were 130 different non-woody species identified and of that 31 are graminoids and 99 are forbs.

The most abundant non-woody plants are awned sedge, common cattail, small bottle sedge and bluejoint or marsh reed grass. Canada thistle is the most common non-woody plant. Fowl bluegrass and perennial sow thistle were also common although slightly less so than Canada thistle.

Invasive Plants

This parameter is common among all waterbody types and data collection methods and therefore is based on all sites in the Beaver River basin (n=20). All sites assessed in the Beaver River basin had at least one invasive plant observed. Invasive plants found and assessed in the basin, on average, have a canopy cover of 1% to 15% and a density and distribution of a single patch plus a few sporadically occurring plants or more (DD class 4-7). That makes this parameter unhealthy on sites in the Beaver River basin.

From the 18 inventories completed in the Beaver River basin there are six plant species listed as invasive. Perennial sow thistle is the most abundant invasive plant followed by Canada thistle. Canada thistle is the most common invasive plant followed by perennial sow thistle.

Other invasive plants were observed in the Beaver River basin but their abundance and occurrence were minimal. Although these other species are not currently common or abundant, as with all invasive plants they should be monitored closely, controlled, and eradicated where possible.

Disturbance-Caused Undesirable Herbaceous Species (Disturbance Plants)

This parameter is common among all waterbody types and data collection methods and therefore is based on all sites in the Beaver River basin (n=20). This parameter rates unhealthy which means that on average, these sites have 25% to 45% of the riparian area covered by disturbance plants.

Based on the 18 inventories there were 24 disturbance plant species found and assessed in the Beaver River basin. Of the disturbance-caused plants, Kentucky bluegrass is the most abundant and common dandelion is the most commonly occurring.

4.2.4.1.3 Alterations to Vegetation

Human-Caused Alteration to Site Vegetation

This parameter is only applicable to those sites on lakes and wetlands in the Beaver River basin (n=4). Of these sites, less than 15% of the riparian area vegetation has been altered by human activities and therefore the average health rating is healthy.

There is insufficient data to report on the causes of alterations to vegetation from human activities for the Beaver River basin.

4.2.4.2 Physical Parameters

In the Beaver River basin there are six parameters related to physical aspects of the riparian area. One parameter is common to all sites, four are specific to streams and small rivers, and one is specific to lakes and wetlands. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.2.4.2.1 Banks and Floodplain: Structure, Stability and Accessibility

Root Mass Protection

This parameter is specific to stream and small river sites in the Beaver River basin (n=16). Overall it rates healthy which means that greater than 85% of the river or stream bank assessed has excellent diversity of plants with deep binding roots to provide protection against erosion and lateral cutting.

Human-Caused Structural Alterations to Banks

This parameter is specific to stream and small river sites in the Beaver River basin (n=16). It rates unhealthy among these sites meaning that on average 15% to 35% of the bank length is structurally altered due to human causes.

There is insufficient data to report on the causes of structural alterations to the stream or river banks from human activities for the Beaver River basin.

Channel Incisement

This parameter is specific to streams and small rivers and, of such sites assessed in the Beaver River basin, is only assessed if the site had a defined channel (n=10). Of sites examined, on average, the channel is generally not incised or has limited incisement meaning it is vertically stable with high water accessing a floodplain greater than the minimum expected every 1-2 years. Therefore this parameter rating is healthy.

4.2.4.2.2 Bare Ground and Alterations to Riparian Area

Human-Caused Bare Ground

This parameter is common among all waterbody types and data collection methods and therefore is based on all sites in the Beaver River basin (n=20). On average, sites in the basin have less than 5% of exposed soil that is a result of human disturbance, thus rating this parameter healthy.

From 19 sites with inventory data on causes in the Beaver River basin, grazing is the primary activity recorded as the source of human-caused bare ground, with both greatest number of sites and most area affected relative to this small data set.

Human-Caused Physical Alteration to the Rest of Site

This parameter is specific to stream and small river sites (n=16) in the Beaver River basin. Overall it rates healthy but with problems which means that 5 to 15% of the area's soil or topography beyond the banks has been altered by human activities.

Based on 15 sites from 2005 and 2006 in the Beaver River basin with causes of physical alterations recorded, the primary source of alterations is grazing. Grazing is the most frequently occurring cause and is the cause of alterations to the greatest area. Construction is also a very common activity but affects only a small area. Other uncategorized types of causes also occur in the Beaver River basin but they are infrequent and contribute to a very small area of alterations.

Human-Caused Alterations to the Physical Site

This parameter is applicable to those sites in the Beaver River basin that are on lakes and wetlands (n=4). Of these sites, 5% to 15% of the riparian area soil or topography has been altered, on average, by human activities, and therefore the rates healthy but with problems.

There is insufficient data to report on the causes of alterations to riparian area physical site from human activities for the Beaver River basin.

4.2.4.3 Hydrologic Parameters

In the Beaver River basin there is one parameter related to hydrologic aspects of the riparian area and it is specific to lakes and wetlands.

4.2.4.3.1 Artificial Water Level Change

This parameter is applicable to those sites in the Beaver River basin that are on lakes and wetlands (n=4). Of these sites, the results indicate that on average there is minor impact of artificial water removal or addition to these waterbodies which rates this parameter healthy but with problems.

4.2.4.4 Riparian Health Summary

Due to the very small sample size within the Beaver River basin, it is difficult to make overall observations of health for this basin and this summary should be considered to be specific to those sites examined. Of those sites examined, 60% are healthy, 20% are healthy but with problems and 20% are unhealthy.

Of the riparian health parameters examined, seven rated healthy. These include vegetative cover, preferred tree and shrub regeneration, dead and decadent woody material, human-caused alterations to vegetation, root mass protection, human-caused bare ground, and channel incisement. Overall vegetative cover was high, meaning that the riparian area is normally well covered with plants to help reduce erosion and support filtering and trapping of material. Regeneration and establishment of preferred trees and shrubs was also good, with sufficient proportions of seedlings and saplings to maintain riparian woody plant communities. In the overall woody plant community, there was very little dead and decadent canopy, so most tree and shrub communities were healthy for this parameter. Of the four sites assessed for human-caused alterations to the vegetation, there were little or no alterations, which is positive.

Three parameters rated healthy but with problems and these relate to alterations to the physical site and water level changes due to human causes. Human-caused alterations to the rest of the physical site (on lentic sites) and to the rest of the site (on lotic sites) have some concerns in terms of physical changes to the riparian area soil profile or site topography, which may affect infiltration and water storage. On the very limited number of lentic sites, there was some evidence of artificial water level changes, resulting in a reduced rating.

The remaining four parameters rated unhealthy. These are preferred tree and shrub utilisation, invasive plants, disturbance-caused plants and human-caused alterations to banks. As with all of the major river basins and waterbody types, the prevalence of invasive and disturbance-caused plants is a concern, as they decrease bank stability, filtration, and soil holding capacity. Relatively high levels of utilisation on preferred trees and shrubs have likely contributed to the reduced vigour of woody plants. This utilisation can be by livestock and/or wildlife browse or removal of material by other means. Human alterations to the banks on the ten applicable sites are of concern, as these alterations reduce a site's ability to withstand the impact of high energy water flow.

Land use data is present for most sites (n=19) within the Beaver River basin. Note that multiple land uses may occur on a site. Native pasture grazing was slightly more common than no land use, being recorded on 58% of sites versus 42%. Roads were also found on about one quarter (21%) of the sites.

<u>Where Efforts Could be Focused to Maintain/Improve Riparian Health</u>

Many aspects of riparian health in the Beaver River basin are consistent with the other basins in the province. Suggestions made in Section 6.0 are applicable here as well as the discussion to follow.

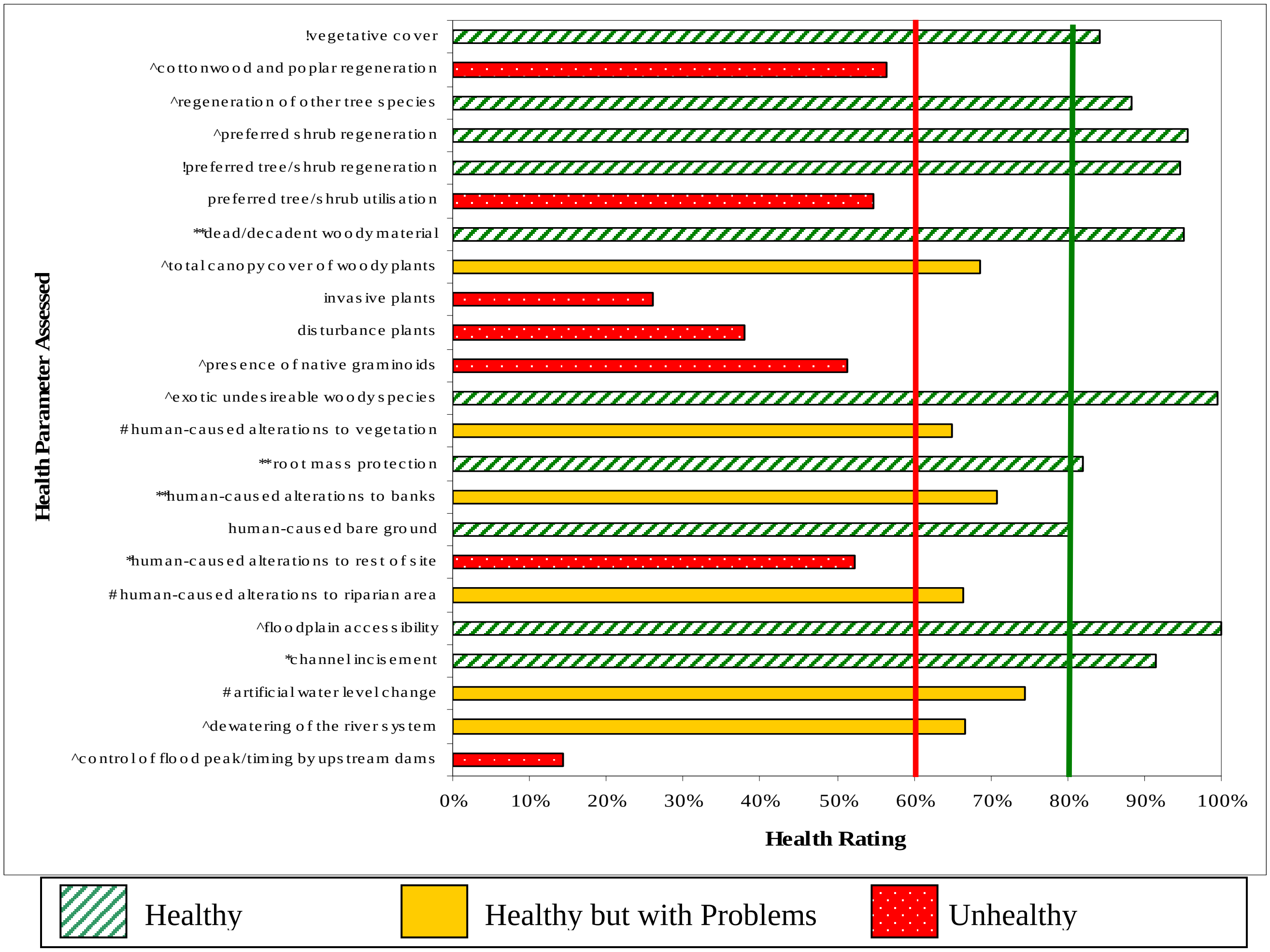
In the Beaver River basin, the limited number of sites with riparian health data suggests that one area to focus on would be increased monitoring of health, and involvement of various landowners and land users in that process to utilise the information and factor it into management and decision making.

Management to improve physical impacts to the riparian area should relate to both timing and intensity of all land uses. Strategies that limit access to riparian areas during moist soil conditions when compaction to soil will be greatest should be encouraged. This is especially important to promote recovery of areas that are already damaged.

The alteration to riparian vegetation from human activities is minimal and thus rates as healthy so this is something that should be maintained. Continuing to monitor land uses that could impact plant community composition and structure is suggested.

4.2.5 North Saskatchewan River Basin

There are 23 riparian health parameters used to assess riparian health in the North Saskatchewan River basin. Of these 23 parameters, ten are healthy, six are healthy but with problems, and seven are unhealthy (Figure 19). The majority of waterbody types sampled within the North Saskatchewan River basin are streams and small rivers, followed by large rivers and lakes and wetlands. There have been no springs/seeps sampled (Appendix E). Because we have only sampled a small proportion of the basin, the discussion of riparian health parameters is limited to the sites we have sampled and may not be applied to the entire watershed.



Note: parameter is assessed for all sites unless otherwise indicated
^ large rivers only (i.e. Battle River)
* streams and small rivers only
# lakes and wetlands only
** large rivers & streams and small rivers only
! streams and small rivers & lakes and wetlands only

Figure 19. Evaluation of riparian health parameters for North Saskatchewan River basin (n=253) in Alberta. Note: sample size may vary by parameter; see text for sample size specific to each parameter.

4.2.5.1 Vegetation Parameters

In the North Saskatchewan River basin there are 13 parameters related to vegetation. Three parameters are common to all sites, six are specific to large rivers, two are common on non-large river lotic systems and all lentic systems, one is specific to lakes and wetlands and one is specific to non-large river lotic systems. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

Vegetative Cover of the Site

Overall vegetative cover is only measured on non-large river lotic sites, lentic sites, and large rivers assessed using inventory methods (n=183). Throughout the applicable sites in the North Saskatchewan River basin vegetation cover is good to excellent, rating healthy. This means on average, sites have more than 85% of the riparian area covered by vegetation.

From the 227 inventories completed in the North Saskatchewan River basin, we can describe vegetation life form distribution. Graminoids are the most abundant (79% cover) with shrubs (42% cover) and forbs (22% cover) as the next most abundant. Trees are least abundant with about 14% of the cover.

There were a total of 396 different plants identified in the North Saskatchewan River basin. The most abundant plant was smooth brome followed by Kentucky bluegrass. The most common plant was Canada thistle found on 93% of inventoried sites. Found on 91% of sites, Kentucky bluegrass and perennial sow thistle were next most common followed by foxtail barley (*Hordeum jubatum*) on 89% of sites. Of all of the plants observed, more than three quarters (79%) of them are native, about 11% are listed as disturbance and 3% are invasive.

4.2.5.1.1 Woody Plants: Presence, Reproduction and Health

Trees and shrubs are an important characteristic of riparian health where they have the potential to grow. In the North Saskatchewan River basin all except one site has that potential. There were 13 different tree and 56 different shrub species identified. The most abundant woody plant was buckbrush/snowberry and then red-osier dogwood *(Cornus stolonifera).* Beaked willow and buckbrush/snowberry were the most common woody plants, occurring on 84% and 83% of inventoried sites, respectively.

Preferred Tree and Shrub Establishment and Regeneration

This parameter is relevant to non-large river lotic sites, lentic sites, and large river sites assessed using inventory methods; and those with the potential to grow trees and shrubs (n=182). Preferred tree and shrub regeneration and establishment in the North Saskatchewan River basin rates healthy, meaning that on average there is greater than 5% canopy cover of preferred woody species that are in the seedling and sapling age class.

Cottonwood and Poplar Regeneration

This parameter is specific to sites that were assessed using the large river health survey method and have potential to grow cottonwood and poplar trees (n=68). It rates unhealthy in the North Saskatchewan River basin which means that on average, less than 5% of the cottonwood/poplar canopy cover on these sites is established seedlings and/or saplings.

Based on the 227 inventories, balsam poplar is the primary species contributing to this parameter in the North Saskatchewan River basin and it is found on 63% of sites, some of which may be on waterbody types other than large rivers.

Regeneration of Other Tree Species

This parameter is specific to sites that were assessed using the large river health survey method (n=68) and have potential to grow other tree species (i.e. other than cottonwoods and poplars). It rates healthy in the North Saskatchewan River basin. The health rating means that on these sites 1% to greater than 5% of the other tree (non-cottonwood) cover is seedlings and saplings, on average.

On sites in the North Saskatchewan River basin, the main non-cottonwood tree species found is trembling aspen. From the 227 inventories, it occurred on 60% of sites, some of which may be on waterbody types other than large rivers. Manitoba maple is quite common, as it occurred on 37% of sites. Ten additional other tree species were identified in the North Saskatchewan River basin but they are less frequent and not as abundant as those already mentioned.

Preferred Shrub Regeneration

This parameter is specific to sites that were assessed using the large river health survey method (n=70) and have potential to grow preferred shrubs. On average, 1% to greater than 5% of the preferred shrub cover is seedlings and saplings on these sites and therefore this parameter rates healthy.

Total Canopy Cover of Woody Plants

This parameter is specific to sites that were assessed using the large river health survey method (n=70) and have potential to grow woody plants. It rates healthy but with problems in the North Saskatchewan River basin. The health rating means that, on average, sites have 25% to 50% of the riparian area covered by woody plants.

Exotic Undesirable Woody Species

This parameter is specific to sites that were assessed using the large river health survey method (n=70) and rates healthy. This rating means that on average, less than 5% of the woody cover consists of exotic undesirable woody species. Only one site in the North Saskatchewan River basin had common caragana and the cover and distribution of the species was low. Although the cover and distribution is minimal, this species should be eradicated to prevent further spread. Russian olive was not found in the North Saskatchewan River Basin.

Preferred Tree and Shrub Utilisation

This parameter is common among all waterbody types and data collection methods and is based on sites in the North Saskatchewan River basin with woody plants on site (n=250). Utilisation of preferred woody plants on the majority of sites (79% combined) is light to moderate and thus rates unhealthy. This means, on average, 25% to 50% of the second year and older available twigs of preferred woody species are browsed or otherwise removed. Only about 8% of sites show signs of heavy browse or utilisation on preferred trees and shrubs.

Dead and Decadent Standing Woody Material

This parameter is common between stream and small river sites and large river sites (n=182) and rates healthy in the North Saskatchewan River basin. This means that less than 25% of the total canopy cover of woody species on these lotic sites is dead or decadent, on average.

4.2.5.1.2 Non-Woody Plants: Diversity and Health

Non-woody plants include grass and grass-like (graminoid) species and broad-leaf plants (forbs). They are an important aspect of diversity and health in riparian areas. On sites in the North Saskatchewan River basin there were 77 different graminoids and 248 different forbs identified. The most abundant non-woody plant is Kentucky bluegrass. Canada thistle is the most common non-woody plant present on 93% of sites. Found on 91% of sites, Kentucky bluegrass and perennial sow thistle were the next most common non-woody plants followed by foxtail barley (*Hordeum jubatum*) on 89% of sites.

Invasive Plants

This parameter is common among all waterbody types and data collection methods and therefore is based on all sites in the North Saskatchewan River basin (n=253). Invasive plants found and assessed in the basin, on average, have a canopy cover greater than 15% and/or a density and distribution of a few patches plus a several sporadically occurring individuals or more (DD Class >8). That makes this parameter unhealthy on sites in the North Saskatchewan River basin.

From the 227 inventories completed in the North Saskatchewan River basin there are 14 invasive plant species listed including common caragana. Canada thistle and perennial sow thistle are the most abundant and most common invasive plants, found on 93% and 91% of sites, respectively. It is worth noting that butter-and-eggs (*Linaria vulgaris*) and scentless chamomile are found on 17% and 14% of sites, in that order. The area they cover is minimal. The remaining invasive plants observed in the basin cover a very small area and are infrequent. Although the cover and abundance of these other species is minimal, they should be monitored closely, controlled, and eradicated where possible. Ten sites (4%) in the North Saskatchewan River basin had no invasive plants observed.

Disturbance-Caused Undesirable Herbaceous Species (Disturbance Plants)

This parameter is common among all waterbody types and data collection methods and therefore is based on all sites in the North Saskatchewan River basin (n=253). It rates unhealthy meaning that on average, sites have 25% to 45% of the riparian area covered by disturbance plants.

Based on the 227 inventories there were 43 disturbance plant species found and assessed in the North Saskatchewan River basin. Smooth brome is the most abundant and Kentucky bluegrass is next most abundant. Kentucky bluegrass (91% of sites) and foxtail barley (89% of sites) are the most common disturbance plant species.

Presence of Native Graminoids

This parameter is specific to sites that were assessed using large river health survey methods (n=70) and rates unhealthy in the North Saskatchewan River basin. The health rating means that on average, these large river sites have 5% to 25% of the riparian area covered with native plants.

From the 227 inventories, there are 60 different native graminoid species in the North Saskatchewan River basin. The most abundant are foxtail barley and reed canary grass (*Phalaris arundinacea).* Occurring on 66% of sites, common tall manna grass (*Glyceria grandis)* is the most common native graminoid species. Reed canary grass is present on 62% of sites and common great bulrush *(Scirpus validus)* occurs on 60% of sites, making them the next most common native graminoids in the North Saskatchewan River basin.

4.2.5.1.3 Alterations to Vegetation

Human-Caused Alterations to Site Vegetation

This parameter is applicable to those sites on lakes and wetlands in the North Saskatchewan River basin (n=55). On average, 5% to 35% of the riparian area vegetation has been altered by human activities and therefore the average health rating is healthy but with problems.

Human-causes of alterations to riparian vegetation can be interpreted from 49 sites with inventory data in the North Saskatchewan River basin. Vegetation alterations from human causes are most commonly due to recreation. Grazing is a less frequent cause although it affects the most area. Other causes present but affecting very few sites and very little area, are roads and railroads, cultivation, and a few other uncategorized human activities.

4.2.5.2 Physical Parameters

In the North Saskatchewan River basin there are seven parameters related to physical aspects of the riparian area. One parameter is common to all sites, one is specific to large rivers, two are common on streams and small rivers and large rivers, one is specific to lakes and wetlands and two are specific to streams and small rivers. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.2.5.2.1 Banks and Floodplain: Structure, Stability and Accessibility

Root Mass Protection

This parameter is common between large river and stream and small river sites that have a defined bank (n=151) in the North Saskatchewan River basin. Overall it rates healthy which means that greater than 85% of the river or stream bank assessed has adequate to excellent diversity of plants with deep binding roots to provide protection against erosion and lateral cutting.

Human-Caused Structural Alterations to Banks

This parameter is common between large river and stream and small river sites that have a defined stream or river bank (n=151) in the North Saskatchewan River basin. It rates healthy but with problems among these sites meaning that on average, 5% to 15% of the bank length (for streams and small rivers) or 10% to 25% of the bank length (for large rivers assessed using the large river health survey method), is structurally altered from human causes. Refer to Appendix K-Table 2 and 3 for more details on the health rating description.

Stream or riverbank alterations, based on 183 inventory sites in the North Saskatchewan River basin, were primarily caused by grazing. Grazing was the most common cause observed and affected the most length. Another cause present, but affecting very few sites and very little area, was recreation. Other diverse and unspecified categories were recorded as present on a number of sites and affect a somewhat larger area than recreation but still less than grazing.

4.2.5.2.2 Bare Ground and Alterations to Riparian Area

Human-Caused Bare Ground

This parameter is common among all waterbody types and data collection methods and therefore is based on almost all sites in the North Saskatchewan River basin (n=252). On average, sites in the basin have less than 5% (all sites except those examined with large river health survey method) or less than 25% (for large rivers assessed using river health survey method) of exposed soil that is a result of human disturbance. Thus this parameter rates healthy. Refer to Appendix K-Table 2 for more details on the health rating description.

Human-caused bare ground is a result of a number of types of activities. From 227 sites with inventory data on causes, the primary activity recorded as the source of human-caused bare ground in the North Saskatchewan River basin, with both greatest number of sites and most area affected is grazing. Construction and logging each comprise a very small amount of area influenced. A diverse variety of other non-categorised sources occurred on many sites as well.

Human-Caused Physical Alteration to the Rest of Site

This parameter is specific to stream and small river sites and large river sites assessed using inventory methods (n=112) in the North Saskatchewan River basin. On average it rates unhealthy which means that 15% to 25% of the riparian area soil or topography beyond the banks has been altered by human activities.

Based on sites from 2005 and 2006 with causes of physical alterations (n=15), the primary source of alterations is grazing. Grazing is the most frequently occurring cause and is the cause of alterations to the greatest area. Cultivation and recreation each accounted for very minor amounts of altered area and occur very infrequently. Other uncategorized types of causes occur on a couple of sites and also contribute to a small area of alterations.

Human-Caused Alterations to the Physical Site

This parameter is only applicable to those sites in the North Saskatchewan River basin that are on lakes and wetlands (n=55). Of these sites, 5% to 15% of the area soil or topography has been altered by human activities and therefore the average health rating is healthy but with problems.

Causes of alterations to riparian physical site can be interpreted from 49 lentic inventory sites in the North Saskatchewan River basin. Physical site alterations are most commonly from recreation. Grazing is a slightly less frequent cause yet it affects the most area. Other causes present, but affecting very few sites and a small area, are roads and railroads, cultivation, and a few uncategorised human activities.

Channel Incisement

This parameter was assessed on stream and small river sites with a defined channel (n=86) throughout the North Saskatchewan River basin. Of sites examined, the health rating is healthy but with problems which means that, on average, channels are vertically stable, not incised and 1-2 year high water flows can access an appropriate floodplain.

Floodplain Accessibility

This parameter was assessed on all sites where the large river health survey method was used (n=70) in the North Saskatchewan River basin. Of these sites, on average, more than 85% of floodplain is accessible to flood flows, rating this site as healthy.

4.2.5.3 Hydrologic Parameters

In the North Saskatchewan River basin there are three parameters related to hydrologic aspects of the riparian area. One parameter is specific to lakes and wetlands and two are specific to large river systems. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.2.5.3.1 Artificial Water Level Change

This parameter is applicable to those sites in the North Saskatchewan River basin that are on lakes and wetlands and where knowledge of artificial water level change could be determined (n=51). On these sites, the results indicate that, on average, there are minor impacts of artificial water removal or addition which rates this parameter healthy but with problems.

4.2.5.3.2 Damming and Dewatering

Dewatering of the River System

This parameter is applicable to large river sites assessed using the large river health survey method (n=70). In the North Saskatchewan River basin, these are all sites on the Battle River.

On average these sites have 10% to 25% of the average river discharge removed during the critical growing season removed. That makes dewatering of the Battle River system within the North Saskatchewan River basin rate healthy but with problems.

Control of Floodpeak Timing by Upstream Dam(s)

Again, this parameter is applicable to large river sites assessed using the large river health survey method (n=70). In the North Saskatchewan River basin, these are all sites on the Battle River. On average these sites have greater than 50% of the watershed upstream controlled by dams. As a result, this parameter is unhealthy on the Battle River within the North Saskatchewan River basin.

4.2.5.4 Riparian Health Summary

With just under one fifth (19%) of sites in the North Saskatchewan River basin rating healthy, more than half (58%) rating healthy but with problems, and just under a quarter (22%) rating unhealthy, overall health is influenced by numerous parameters. Ten riparian health parameters rate healthy. Vegetative cover, regeneration of preferred trees and shrubs as well as other trees, dead and decadent woody material, exotic undesirable woody species, root mass protection, human caused bare ground, floodplain accessibility and channel incisement all rate healthy. Overall, this means that existing vegetation communities are adequately performing some key functions such as holding banks together and protection banks and channels from erosion and downcutting. Regeneration of shrubs and trees/shrubs combined is good, with high levels of young woody plant communities. This suggests that sufficient young woody plants are present in these groups to maintain woody plant communities into the future. Limited sign of dead canopy in trees or shrubs suggests that the current woody plant communities are not stressed from impacts such as drought, flooding, insects or disease. The near absence of exotic woody species is positive—preventing future establishment of these species should be an important element of riparian management.

From a river dynamics perspective, a positive feature is that along the large river sites examined on the Battle River, high flows are generally unrestricted by human embankments and can access the floodplain. This allows energy and water to be spread across the floodplain rather than remain in the channel, thus contributing to the functioning of these sites.

Six of the riparian health parameters rated in the middle category as healthy but with problems. These are total canopy cover of woody plants, human-caused alterations to vegetation, human-caused alterations to banks, human-caused alterations to physical site, artificial water level change and dewatering of the river system. Although regeneration and canopy health is good for trees and shrubs in the North Saskatchewan River basin, the total canopy cover of woody plants is of concern particularly on large and small river systems where trees and shrubs are a critical part of keeping a system stable. The impacts of human-caused alterations to banks and physical site are of some concern as they can contribute to soil loss into the aquatic system and limit the ability of the riparian soils to absorb and hold water.

The moderate impacts of dewatering of the Battle River system is something to pay attention to as adequate water levels during critical times of the year are an important part of the hydrology of our riparian systems and for maintaining riparian plant communities as well sustaining aquatic invertebrates, fish, wildlife, and water quality. A minor degree of impact exists for changing water levels in lentic systems as well. Allowing lakes and wetlands to fluctuate with season and precipitation is important to their health and other aspects of the ecosystem that depend on them.

Seven parameters are unhealthy, including cottonwood regeneration, utilisation of preferred trees and shrubs, invasive and disturbance caused plants, presence of native graminoids, human-caused alterations to rest of site and control of flood peak and timing by upstream dams. The lack of seedlings and saplings in cottonwood tree species is a concern for long-term maintenance of these successional plant communities. Utilisation by livestock and/or wildlife browse or removal of material by other means in any woody plant community can negatively impact the ability of young plants to become established and contribute to the value of woody cover.

Widespread invasive species and abundant disturbance-caused plants are likely intricately linked to low presence of native graminoids and affects the composition and structure of riparian plant communities as native, deep-rooted species are replaced with non-native and shallower rooted species. Although the high abundance of non-native grasses is likely replacing native graminoids, the unhealthy rating on this parameter may be influenced by the question criteria (i.e. a relatively high coverage of native graminoids required to score healthy). Further research is required to determine the appropriate, expected cover of native graminoids in this basin. As of 2007, this question was removed from the large river riparian health assessment (survey).

Control of flood peak and timing by upstream dams is only applicable to large river sites completed on the Battle River. However, the degree to which this system is controlled makes this parameter unhealthy and a negative contributor to overall riparian health on that system.

In the North Saskatchewan River basin, land use data is present for most sites (n=233). Note that multiple land uses may occur on a site. The most common land use is native pasture grazing, occurring on 73% of sites. No apparent land use, tame pasture, recreation and other uncategorized land uses are occasionally present on 9%-17% of sites. Lawns, development, tilled crop, perennial forage, roads, logging, mining and railroads were each recorded only a few times, and are present on less than 5% of sites.

<u>Where Efforts Could be Focused to Maintain/Improve Riparian Health</u>

Many aspects of riparian health in the North Saskatchewan River basin are consistent with the other basins in the province. Suggestions made in Section 6.0 are applicable here as well as the discussion to follow.

Managing the watershed to reduce activities that increase the speed and volume of water delivery will help to maintain the current healthy level of incisement on streams and small rivers. On-site management that promotes well vegetated banks is also necessary to maintain stable channel features.

Because most reaches of the large river sites on the Battle River do not have human embankments, this will allow high water access to a suitable floodplain and this should continue to be promoted wherever possible. Managing to maintain and increase current floodplain access will be important at both local site and area or regional scales.

Although shrub and other tree regeneration is generally good, regeneration of cottonwoods/poplars is somewhat limited, and may be of concern for long-term maintenance of riparian forests in the North Saskatchewan River basin. However, other tree species are thriving and these communities should be maintained. Managing utilisation of woody plants by livestock and/or wildlife and other means of removal as well as overall alteration of the riparian plant community is part of encouraging the establishment of young cottonwoods/poplar and maintaining existing woody plant communities in general.

4.2.6 South Saskatchewan River Basin

There are 23 riparian health parameters used in assessing the health of riparian sites in the South Saskatchewan River Basin. Of these 23 parameters, seven are healthy, ten are healthy but with problems, and six are unhealthy (Figure 20). The majority of waterbody types sampled within the South Saskatchewan River Basin are streams and small rivers, followed by large rivers. There have been some lakes and wetlands and springs and seeps sampled (Appendix E). Because we have only sampled a small proportion of the basin, the discussion of riparian health parameters is limited to the sites we have sampled and may not be applied to the entire watershed.

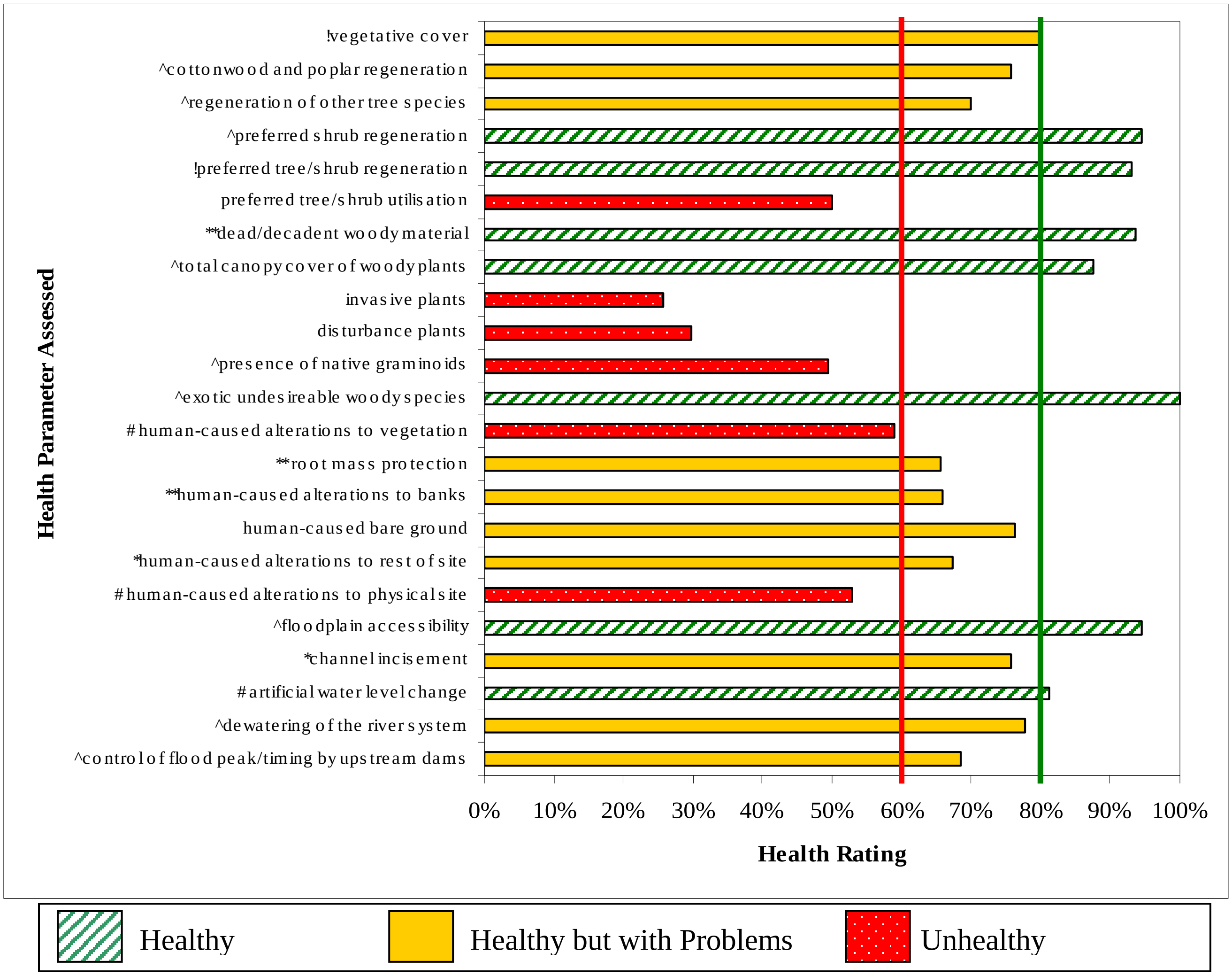
4.2.6.1 Vegetation Parameters

In the South Saskatchewan River basin there are 13 parameters related to vegetation. Three parameters are common to all sites, six are specific to large rivers, two are common on non-large river lotic and all lentic systems, one is specific to lakes and wetlands and one is specific to non-large river lotic systems. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

<u>Vegetative Cover of the Site</u>

Overall vegetative cover is only measured on non-large river lotic sites, lentic sites, and large rivers assessed using inventory methods (n=733). Throughout the applicable sites in the South Saskatchewan River basin vegetation cover is adequate to excellent which means a rating of healthy but with problems. Thus on average, sites have 85% to 95% of the riparian area covered by some vegetation.

From the 854 inventories completed in the South Saskatchewan River basin, we can describe vegetation life form distribution. Graminoids are the most abundant (72% cover) followed by shrubs (48% cover), trees (32% cover), and forbs (24% cover).



Note: parameter is assessed for all sites unless otherwise indicated

^ large rivers only

* streams and small rivers & springs and seeps (lotic) only

lakes and wetlands & springs and seeps (lentic) only

** large rivers & streams and small rivers & springs and seeps (lotic) only

! streams and small rivers & springs and seeps (lotic and lentic) & lakes and wetlands only

Figure 20. Evaluation of riparian health parameters for South Saskatchewan River basin (n=912) in Alberta. Note: sample size may vary by parameter; see text for sample size specific to each parameter.

There were a total of 662 different plant species identified in the South Saskatchewan River basin. The most abundant plant was smooth brome followed by balsam poplar and Kentucky bluegrass. The most common plants were Canada thistle and Kentucky bluegrass, each found on 94% of sites. Of all of the plants observed more than three quarters (80%) of them are native. About 9% are listed as disturbance and 4% are invasive.

4.2.6.1.1 Woody Plants: Presence, Reproduction and Health

Trees and shrubs are an important characteristic of riparian health where they have the potential to grow. In the South Saskatchewan River basin all except one site has that potential. There were 20 different tree and 92 different shrub species identified. The most abundant woody plant was balsam poplar. Buckbrush/snowberry was the most common woody plant, occurring on 86% of inventoried sites.

Preferred Tree and Shrub Establishment and Regeneration

This parameter is relevant to non-large river lotic sites, lentic sites, and large river sites assessed using inventory methods, that have with potential to grow trees and shrubs (n=732). Preferred tree and shrub regeneration and establishment in the South Saskatchewan River basin rates healthy, meaning that on average there is greater than 5% canopy cover of these woody species that are in the seedling and sapling age classes.

Cottonwood and Poplar Regeneration

This parameter is specific to sites assessed using large river health survey methods and with potential to grow cottonwood and poplar trees (n=179). It rates healthy but with problems which means that on average, 5% to 15% of the cottonwood/poplar canopy cover on these sites is established seedlings and/or saplings.

Based on the 854 inventories, balsam poplar is the primary species used to assess this question in the South Saskatchewan River basin. It is most abundant and is found on 58% of sites, some of which may be on sites that are waterbody types other than large rivers. Narrow-leaf cottonwood (*Populus angustifolia)* was found and is present on 8% of sites contributing a relatively small amount of cover. Plains cottonwood (*Populus deltoides)* was also found but it was only observed on just under 2% of sites and is not abundant.

Regeneration of Other Tree Species

This parameter is specific to sites assessed using large river health survey methods (n=139) and with potential to grow other tree species (i.e. other than cottonwoods and poplars). It rates healthy but with problems in the South Saskatchewan River basin. The health rating means that on these sites 1% to 5% of the other tree (non-cottonwood) cover is seedlings and saplings, on average.

On sites in the South Saskatchewan River basin, the most abundant other tree species found is white spruce. From the 854 inventories, it occurred on 39% of sites in the basin, some of which may be on waterbody types other than large rivers. Trembling aspen does occur on 29% of sites but does not contribute to much overall cover. Fifteen additional non-cottonwood tree species were identified in the South Saskatchewan River basin but most are infrequent and/or not abundant.

Preferred Shrub Regeneration

This parameter is specific to sites assessed using large river health survey methods (n=179) and with potential to grow preferred shrubs. On average, 1% to greater than 5% of the preferred shrub cover is seedlings and saplings and thus this parameter rates healthy.

Total Canopy Cover of Woody Plants

This parameter is specific to sites assessed using large river health survey methods (n=179) and with potential to grow woody plants. It rates healthy in the South Saskatchewan River basin. The health rating means that, on average, sites have 25% to greater than 50% of the riparian area covered by woody plants.

Exotic Undesirable Woody Species

This parameter is specific to sites assessed using large river health survey methods (n=178) and rates healthy. This rating means that on average, less than 5% of the woody cover consists of exotic undesirable woody species. Common caragana and Russian olive are the exotic undesirable woody species present and contributing a small amount of cover in the South Saskatchewan River basin. Although these species are not present in abundance, as invasive species they should be monitored, controlled and eradicated if possible.

Preferred Tree and Shrub Utilisation

This parameter is common among all waterbody types and data collection methods and is based on sites in the South Saskatchewan River basin with woody plants on site (n=906). Utilisation of preferred woody plants on the majority of sites (78% combined) is light to moderate and thus rates unhealthy. This means, on average, 25% to 50% of the second year and older available twigs of preferred woody species are browsed or somehow removed. About 13% of sites show signs of heavy browse or utilisation on preferred trees and shrubs.

Dead and Decadent Standing Woody Material

This parameter is common between non-large river lotic sites and sites assessed using large river health survey methods; and where existing trees and shrubs are present (n=846). It rates healthy for relevant sites in the South Saskatchewan River basin. This means that less than 25% of the total canopy cover of woody species on these lotic sites is dead or decadent, on average.

4.2.6.1.2 Non-Woody Plants: Diversity and Health

Non-woody plants include grass and grass-like (graminoid) species and broad-leaf plants (forbs). They are an important aspect of diversity and health in riparian areas. On sites in the South Saskatchewan River basin there were 129 different graminoids and 415 different forbs identified. The most abundant non-woody plant is smooth brome followed by Kentucky bluegrass. Canada thistle and Kentucky bluegrass are the most common non-woody plants and are present on 94% of sites.

Invasive Plants

This parameter is common among all waterbody types and data collection methods and therefore is based on all sites in the South Saskatchewan River basin (n=912). Invasive plants found and assessed in the basin, on average, have a canopy cover greater than 15% and/or a density and distribution of a few patches plus a several sporadically occurring individuals or more (DD Class >8). That makes this parameter unhealthy in the South Saskatchewan River basin.

From the 854 inventories completed in the South Saskatchewan River basin there are 24 plant species listed as invasive including common caragana and Russian olive as already mentioned. Canada thistle is the most abundant and most common invasive plant. Perennial sow thistle is found on 60% of sites. It should be mentioned that Russian knapweed (*Centaurea repens)* was found on 10% of sites. Of the other invasive plants observed in the basin, each occupy only a small amount of the area and are only found on a few sites. Although the cover and abundance of these other species is minimal, they should be monitored closely, controlled, and eradicated where possible. There were 25 sites (3%) in the South Saskatchewan River basin on which no invasive plants were observed.

Disturbance-Caused Undesirable Herbaceous Species (Disturbance Plants)

This parameter is common among all waterbody types and data collection methods and is based on almost all sites in the South Saskatchewan River basin (n=911). It rates unhealthy meaning that on average, sites have greater than 45% of the riparian area covered by disturbance plants.

Based on the 854 inventories there were 59 disturbance plant species found and assessed in the South Saskatchewan River basin. Smooth brome is the most abundant, followed by Kentucky bluegrass. The most common disturbance plant species is Kentucky bluegrass (94% of sites) and smooth brome is next most abundant (84% of sites).

Presence of Native Graminoids

This parameter is specific to sites assessed using large river health survey methods (n=179) and rates unhealthy in the South Saskatchewan River basin. The health rating means that on average, sites have 5% to 25% of the riparian area covered with native plants.

From the 854 inventories, there are 103 different native graminoid species in the South Saskatchewan River basin. The most abundant native graminoid is western wheatgrass (*Agropyron smithii).* Wire rush (*Juncus balticus)* is the most commonly occurring native graminoid species found on 71% of sites.

4.2.6.1.3 Alterations to Vegetation

Human-Caused Alterations to Site Vegetation

This parameter is applicable to those sites on lakes and wetlands in the South Saskatchewan River basin (n=17). On average, sites have 15% to 35% of the riparian area vegetation altered by human activities and therefore the average health rating is unhealthy.

Causes of alterations to riparian vegetation can be interpreted from 16 inventory sites in the South Saskatchewan River basin. Vegetation alterations from human causes are mostly due to grazing. Grazing is the most frequent cause and it affects the most area. Other causes present, but affecting very few sites and relatively small area, are road and railroads, recreation and a few uncategorized human activities.

4.2.6.2 Physical Parameters

In the South Saskatchewan River basin there are seven parameters related to physical aspects of the riparian area. One parameter is common to all sites, one is specific to large rivers, two are common on large river and non-large river lotic systems, one is specific to lakes and wetlands, and two are specific to non-large river lotic systems. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.2.6.2.1 Banks and Floodplain: Structure, Stability and Accessibility

Root Mass Protection

This parameter is common between large river and non-large river lotic sites that have a defined bank (n=873) in the South Saskatchewan River basin. Overall it rates healthy but with problems which means that 35% to 85% of the river or stream bank assessed has adequate diversity of plants with deep binding roots to provide protection against erosion and lateral cutting.

Human-Caused Structural Alterations to Banks

This parameter is common between large river and non-large river lotic sites that have a defined stream or river bank (n=873) in the South Saskatchewan River basin. It rates healthy but with problems among these sites meaning that on average, 5% to 35% of the bank length (for non-large river lotic sites) or 10% to 50% of the bank length (for large river sites assessed with large river health survey methods), is structurally altered from human causes. Refer to Appendix K-Tables 2 and 3 for more information about the health rating description.

Stream or riverbank alterations from 831 inventory sites in the South Saskatchewan River basin were primarily caused by grazing. Grazing was the most common cause observed and affected the most length. Other causes present, but affecting a relatively small number of sites and small area, are recreation, construction, logging, mining, cultivation.

Of these, recreation occurs the most times. A number of unspecified categories were also recorded and as a group are present on more sites and affecting a larger area than these other causes but still less than grazing.

4.2.6.2.2 Bare Ground and Alterations to Riparian Area

Human-Caused Bare Ground

This parameter is common among all waterbody types and data collection methods and is based on almost all sites in the South Saskatchewan River basin (n=911). On average, sites in the basin have 1% to 5% (all sites except those examined with large river health survey) or 5% to 25% (sites examined with large river health survey method) of exposed soil that is a result of human disturbance rating this parameter healthy but with problems. Refer to Appendix K-Table 2 for more information on the health rating description.

Human-caused bare ground is a result of a number of types of activities. From 856 sites with inventory data on causes, the primary activity recorded as the source of human-caused bare ground in the South Saskatchewan River basin, with both greatest number of sites and most area affected is grazing. Other causes present, but affecting a relatively small number of sites and small area, are recreation, construction, logging, and mine tailing. Of these, recreation occurs the most times and affects the largest area. A number of unspecified categories were recorded as present on more sites and affecting a larger area than these other causes but still less than grazing.

Human-Caused Physical Alteration to the Rest of Site

This parameter is specific to non-large river lotic sites (n=714) in the South Saskatchewan River basin. On average, it rates healthy but with problems, which means that 5% to 15% of the riparian area soil or topography beyond the banks has been altered by human activities.

Based on 134 inventory sites from 2005 and 2006 with causes of physical alterations, the primary source of alterations is grazing. Grazing is the most frequently occurring cause and is the cause of alterations to the greatest area. Recreation, construction and logging each accounted for very minor amounts of altered area as well as occurring very infrequently. Other uncategorized types of causes were recorded on two sites and contribute to a small area of alterations.

Human-Caused Alterations to the Physical Site

This parameter is applicable to those sites in the South Saskatchewan River basin that are on lakes and wetlands (n=17). Of these sites, 15% to 35% of the area soil or topography has been altered by human activities and therefore the average health rating is unhealthy.

Causes of alterations to riparian physical site can be interpreted from 16 sites in the South Saskatchewan River basin. Physical site alterations are most commonly from grazing.

Roads and railroads, recreation, water management, and some uncategorized types are other causes present, but affecting very few sites and a small area.

Channel Incisement

This parameter was assessed on stream and small river sites with a defined channel (n=698) throughout the South Saskatchewan River basin. Of sites examined, the health rating is healthy but with problems which means that, on average, channels are slightly incised, in either an improving or degrading phase with 1-2 year high water flows accessing a narrow floodplain less than or slightly wider than expected.

Floodplain Accessibility

This parameter was assessed on sites assessed using large river health survey methods (n=178). Of these sites, on average, more than 65% of floodplain is accessible to flood flows, rating this site as healthy.

4.2.6.3 Hydrologic Parameters

In the South Saskatchewan River basin there are three parameters related to hydrologic aspects of the riparian area. One parameter is specific to lakes and wetlands and two are specific to large river systems. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.2.6.3.1 Artificial Water Level Change

This parameter is applicable to those sites in the South Saskatchewan River basin that are on lakes and wetlands and where knowledge of artificial water level change could be determined (n=16). Of these sites, the results indicate that on average there are minor or no impacts of artificial water removal or addition to these waterbodies which rates this parameter healthy.

4.2.6.3.2 Damming and Dewatering

Both parameters of Dewatering of the River System and Control of Floodpeak Timing by Upstream Dam(s) are applicable to large river sites assessed with large river health survey methods (n=179). In the South Saskatchewan River basin, all applicable sites have 10% to 25% of average river discharge during the critical growing season removed and 10% to 25% of the watershed upstream controlled by dams. As a result these parameters are healthy but with problems in the South Saskatchewan River basin.

4.2.6.4 Riparian Health Summary

In the South Saskatchewan River basin one fifth (20%) of sites rate healthy, over half (52%) rate healthy but with problems and just over one quarter (28%) of sites rate unhealthy. There a number of influences affecting the health of these riparian areas. Seven riparian health parameters rated healthy.

These include preferred shrub regeneration, preferred tree and shrub regeneration, dead and decadent woody material, total canopy cover of woody plants, exotic undesirable woody species, floodplain accessibility, and artificial change in water levels. Regeneration of shrubs and trees/shrubs combined is good, with high levels of young shrub communities, limited signs of dead canopy in trees or shrubs, suggesting that sufficient young woody plants are present in these groups to maintain woody plant communities. The near absence of exotic woody species is positive—preventing future establishment of these species should be an important element of riparian management.

The hydrologic features that rated healthy are important in allowing maintenance of riparian ecosystems and processes. A positive feature related to large river dynamics is that the river sites are generally unrestricted by human embankments and can access the floodplain. This allows energy and water to be spread across the floodplain rather than remain in the channel, thus contributing to the functioning of these sites. On lake and wetland sites there are limited changes to water level, allowing natural hydrologic regimes, which is positive.

Ten riparian health parameters rated in the healthy but with problems category and include vegetative cover, cottonwood regeneration, regeneration of other tree species, root mass protection, human-caused alterations to the banks, human-caused bare ground, human-caused alterations to the rest of the site, channel incisement, dewatering and control of flood peak and timing by upstream dams. Overall, vegetative cover is good and rated very high in the healthy but with problems meaning that vegetative cover is good and would not require much in terms of improvement to move it into the healthy category.

There are some concerns with regeneration of trees, which may be related to high levels of utilisation and, on large rivers, hydrologic modifications, in terms of both flow removal and change in flow regime. Within the South Saskatchewan River basin, human-caused physical alterations to banks and rest of the riparian area are not extensive, but are of some concern as they may be contribute to erosion and reduce infiltration in riparian soils. Lack of sufficient deep-binding roots is likely linked to the prevalence of invasive and disturbance caused plants and limited native graminoid cover. Stream and river channel incisement is present and reducing the health rating, meaning that water does not overtop bank areas as frequently as the channel size would suggest, but rather is restricted to a narrower floodplain due to the downcutting of the channel bottom.

The remaining six parameters are unhealthy: utilisation of preferred trees and shrubs, invasive and disturbance caused plants, presence of native graminoids, human-caused alterations to the vegetation and physical site. High levels of utilisation from livestock or wildlife browse or other methods of twig removal may be impacting regeneration of woody plants as well as overall vegetation cover. Widespread invasive species and abundant disturbance-caused plants are likely intricately linked to low presence of native graminoids. Each of these individual vegetative features may collectively contribute to increased alterations within the vegetation community, as native, deep-rooted species are replaced with non-native and shallower rooted species. Although the high abundance of non-native grasses is likely replacing native graminoids, the unhealthy rating on this parameter may be influenced by the question criteria (i.e. a relatively high coverage of native graminoids required to score healthy).

Further research is required to determine the appropriate, expected cover of native graminoids in this basin. As of 2007, this question was removed from the large river riparian health assessment (survey). On the small number of lake and wetland sites, physical alterations are modifying the soil profile or site topography and are of concern.

South Saskatchewan River basin land use data is only present for a portion of sites (n=571). Note that multiple land uses may occur on a site. The most common land use is native pasture (grazing) (85%). No apparent land use, tame pasture, recreation, roads, development and other uncategorized land uses are also quite common, occurring on 11% to 13.5% of sites. Lawns, tilled crop, perennial forage, logging, mining and railroads were each recorded a few times (i.e. on less than 7% of sites).

Where Efforts Could be Focused to Maintain/Improve Riparian Health

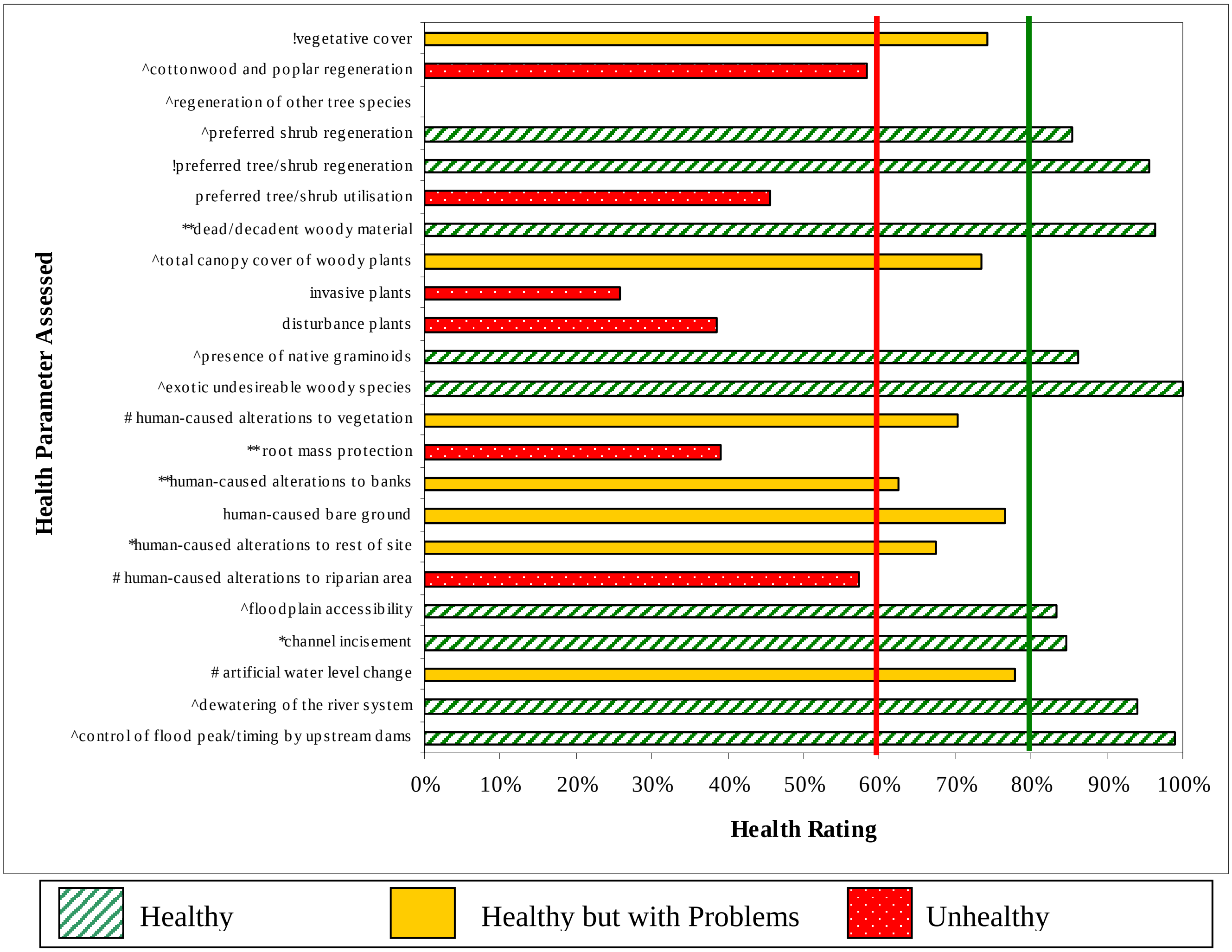
Many aspects of riparian health in the South Saskatchewan River basin are consistent with the other basins in the province. Suggestions made in Section 6.0 are applicable here as well as the discussion to follow.

Onsite and watershed scale management relating to timing, control and removal of flows may be hindering the ability of seedlings and saplings of trees and shrubs to establish, but older woody plant communities are healthy, with limited impacts to their current vigor. In some river reaches, removal of flow is occurring and influencing the health rating. As reported in the SSRB report (Cows and Fish 2005), where water removal was greater, tree regeneration tended to be lower. Ensuring suitable flows are present is critical for maintaining riparian ecosystems. Consideration of appropriate timing and levels of dewatering as well as minimizing any increase in upstream dams for control of flood peaks and timing will help promote sustainable cottonwood, other tree and shrub communities. Maintaining good floodplain accessibility and opportunity to deposit water and sediment on the floodplain is an important aspect of riparian health.

Although only a small number of sites in the South Saskatchewan River basin are on lakes and wetlands, human-caused alterations to vegetation and the physical site are high. Efforts to reduce these impacts on existing sites would be beneficial. Increased monitoring of this waterbody type is important for gaining more knowledge and understanding of these systems within this basin.

4.2.7 Milk River Basin

Of the 23 riparian health parameters measured in the Milk River Basin, nine are healthy, seven are healthy but with problems, and seven are unhealthy (Figure 21). The majority of waterbody types sampled within the Milk River Basin are large rivers and streams and small rivers, followed by lakes and wetlands. There have been only a few springs and seeps sampled (Appendix E). Because we have only sampled a small proportion of the basin, the discussion of riparian health parameters is limited to the sites we have sampled and may not be applied to the entire watershed.



Note: parameter is assessed for all sites unless otherwise indicated
^ large rivers only
* streams and small rivers & springs and seeps (lotic) only
# lakes and wetlands only
** large rivers & streams and small rivers & springs and seeps (lotic) only
! streams and small rivers & springs and seeps (lotic) & lakes and wetlands only

Figure 21. Evaluation of riparian health parameters for Milk River basin (n=195) in Alberta. Note: sample size may vary by parameter; see text for sample size specific to each parameter.

4.2.7.1 Vegetation Parameters

In the Milk River basin there are 13 parameters related to vegetation. Three parameters are common to all sites, six are specific to large rivers, two are common on non-large river lotic and all lentic systems, one is specific to lakes and wetlands and one is specific to non-large river lotic systems. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

Vegetative Cover of the Site

Overall vegetative cover is assessed on sites that are on non-large river lotic systems and lakes and wetlands (n=161). Throughout the Milk River basin vegetation cover is adequate and rates healthy but with problems. This means on average, sites are 85% to 95% covered by some vegetation.

From 189 inventories completed in the Milk River basin, we can describe vegetation life form distribution. Graminoids are the most abundant (85% cover) with shrubs (53% cover) and forbs (27% cover) as next abundant. Trees are least abundant with 13% of the cover.

There was a total of 364 different plant species identified in the Milk River basin. The most abundant was buckbrush/snowberry *(Symphoricarpos occidentalis)* followed by Kentucky bluegrass and sand grass *(Calamovilfa longifolia).* The most commonly occurring plants were buckbrush/snowberry and Canada thistle, each found on 89% of inventoried sites. Of all of the plant species observed, 84% of them are native. About 10% are listed as disturbance and almost 3% are invasive.

4.2.7.1.1 Woody Plants: Presence, Reproduction and Health

Trees and shrubs are an important characteristic of riparian health where they have the potential to grow. In the Milk River basin, all sites have the potential to grow trees and/or shrubs. From the inventories, there were 8 different tree and 51 different shrub species identified. The most abundant and common woody plant was buckbrush/ snowberry.

Preferred Tree and Shrub Establishment and Regeneration

This parameter is relevant to non-large river lotic sites and those on lakes and wetlands (n=161). Preferred tree and shrub regeneration and establishment in the Milk River basin rates healthy, meaning that on average there is greater than 5% canopy cover of preferred woody species that are in the seedling and sapling age class.

Cottonwood and Poplar Regeneration

This parameter is specific to sites assessed using large river health survey methods and potential to grow cottonwoods [and poplars]. Approximately one third (32%, n=11 of 34) large river sites in the Milk River basin have this potential. Based on these possible sites, cottonwood regeneration rates unhealthy and means that less than 5% of the existing cottonwood cover is established seedlings and/or saplings.

Based on the 189 inventories, plains cottonwood is the most abundant and commonly occurring cottonwood species in the Milk River basin. It is present on 18% of sites, some of which may include waterbody types other than large rivers. Narrow-leaf cottonwood was also found but it was only observed on just under 2% of sites and is not abundant.

Regeneration of Other Tree Species

This parameter is specific to sites assessed using large river health survey methods and potential to grow trees other than cottonwoods. Only one large river site was determined to have this potential in the Milk River basin. On this site, regeneration of other tree species rates unhealthy meaning that there was no other tree (non-cottonwood) cover present as seedlings and saplings.

On sites in the Milk River basin, the main other tree species found is white spruce. From the 189 inventories, it occurred on 28% of sites in the basin, some of which may be on waterbody types other than large rivers. Six additional other tree species were identified in the Milk River basin but they are infrequent and not abundant.

Preferred Shrub Regeneration

This parameter is specific to sites assessed using large river health survey methods (n=34) and rates healthy. All large river sites in the Milk River basin have potential to grow preferred shrubs. The health rating means that 1% to greater than 5% of the preferred shrub cover is seedlings and saplings, on average.

Total Canopy Cover of Woody Plants

This parameter is specific to sites assessed using large river health survey methods (n=34) and rates healthy but with problems in the Milk River basin. The health rating means that sites assessed have, on average, 25% to 50% of the area covered by woody plants.

Exotic Undesirable Woody Species

This parameter is specific to sites with completed large river health forms (n=34) and rates healthy for these sites in the Milk River basin. This means that on average less than 5% of the woody cover is exotic undesirable species. It should be noted that Russian olive was found on five large river sites in the Milk River basin but these sites were examined using lotic inventory methods, not large river health survey methods. Therefore they do not contribute to the health rating for this parameter.

Preferred Tree and Shrub Utilisation

This parameter is common among all waterbody types and data collection methods and therefore is based on all sites in the Milk River basin (n=195). It rates unhealthy. Utilisation of preferred woody plants is moderate or light on a majority of sites (43% and 32% respectively) and averages 25-50% of second year and older available twigs browsed or otherwise removed. Signs of heavy use are present on 15% of sites.

Dead and Decadent Standing Woody Material

This parameter is common between non-large river lotic sites and large rive sites assessed using large river health survey methods (n=177). It rates healthy on relevant sites in the Milk River basin. This means that less than 25% of the total canopy cover of woody species on these sites is dead or decadent.

4.2.7.1.2 Non-Woody Plants: Diversity and Health

Non-woody plants include grass and grass-like (graminoid) species and broad-leaf plants (forbs). They are important aspect of diversity and health in riparian areas. Based on the 189 inventories completed in the Milk River basin there were 87 different graminoids and 217 forbs identified. The most abundant non-woody plant is Kentucky bluegrass followed by sand grass. Canada thistle is the most common non-woody plant occurring on 89% of sites. Kentucky blue grass and common yarrow (*Achillea millefolium*) were also common in the Milk River basin although slightly less so than Canada thistle, occurring on 85% and 84% of sites respectively.

Invasive Plants

This parameter is common among all waterbody types and data collection methods and therefore is based on all sites in the Milk River basin (n=195). Invasive plants found and assessed in the basin, on average, have a canopy cover greater than 15% and/or a density and distribution of a few patches plus several sporadically occurring individuals or more (DD Class >8). That makes this parameter unhealthy on sites in the Milk River basin.

From the 189 inventories completed in the Milk River basin there are ten plant species listed as invasive including Russian olive as already mentioned. Canada thistle is the most abundant and most common invasive plant with presence on 89% of sites. Perennial sow thistle is another relatively common plant occurring on 57% of sites. Tall buttercup is present on about one quarter of sites (26%) and spotted knapweed (*Centaurea maculosa)* was found on 10% of sites. The other five invasive plants species occur less frequently and less abundantly. Although the cover and abundance of these other species is minimal, they should be monitored closely, controlled, and eradicated where possible as with all invasive plants. Six sites (3%) in the Milk River basin had no invasive plants observed.

Disturbance-Caused Undesirable Herbaceous Species (Disturbance Plants)

This parameter is common among all waterbody types and data collection methods and is based on all almost sites in the Milk River basin (n=194). On average, these sites have 25% to 45% of their area covered by disturbance plants resulting in an unhealthy parameter rating.

Based on the inventories there were 35 disturbance plant species found and assessed in the Milk River basin. Kentucky bluegrass is the most abundant and common disturbance plant species being found on 85% of sites. Smooth brome is the next most common disturbance plant species present on 73% of sites.

Presence of Native Graminoids

This parameter is specific to sites with completed large river health forms (n=34) and rates healthy in the Milk River basin where it was assessed. The health rating means that on average 25% to more than 50% of the relevant sites in the basin are covered by native graminoid species.

From the 189 inventories, there are 73 different native graminoid species in the Milk River basin. Sand grass is the most abundant native graminoid. Wire rush is the most common graminoid and it is present on 77% of sites in the Milk River basin.

4.2.7.1.3 Alterations to Vegetation

Human-Caused Alterations to Site Vegetation

This parameter is applicable to those sites on lakes and wetlands in the Milk River basin (n=18). Of these sites, on average, 5% to 15% of the area vegetation has been altered by human activities and therefore rates healthy but with problems.

Causes of alterations to riparian vegetation can be interpreted from 17 sites in the Milk River basin. Vegetation alterations from human causes are most commonly due to grazing and grazing also affects the most area. Recreation and other uncategorized causes are present but much less frequent.

4.2.7.2 Physical Parameters

In the Milk River basin there are seven parameters related to physical aspects of the riparian area. One parameter is common to all sites, one is specific to large rivers, two are common on large river and non-large river lotic systems, one is specific to lakes and wetlands, and two are specific to non-large river lotic systems. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.2.7.2.1 Banks and Floodplain: Structure, Stability and Accessibility

Root Mass Protection

This parameter is common between large river and non-large river lotic sites that have a defined bank (n=166) in the Milk River basin. Overall it rates unhealthy which means that 35% to 65% of the river or stream bank area assessed has some to an inadequate amount of plant species with deep binding roots to provide protection against erosion and lateral cutting.

Human-Caused Structural Alterations to Banks

This parameter is common between large river sites and non-large river lotic sites that have a defined bank (n=165) in the Milk River basin.

It rates healthy but with problems among these sites meaning that on average, 15% to 35% of the bank length (for non-large river lotic sites) or 25% to 50% of the bank length (for large river sites assessed with the large river health survey method), is structurally altered from human causes. Refer to Appendix K-Tables 2 and 3 for more information on the health rating description.

Stream or riverbank alterations from 154 sites with inventory date in the Milk River basin were primarily caused by grazing. Grazing was the most common and affected the most length. Construction and a variety of other unspecified categories were recorded as present on a smaller number of sites and affected a very small area.

4.2.7.2.2 Bare Ground and Alterations to Riparian Area

Human-Caused Bare Ground

This parameter is common among all waterbody types and data collection methods and is based on almost all sites in the Milk River basin (n=194). On average, sites in the basin have 1% to 5% or 5% to 25% of exposed soil that is a result of human causes rating this parameter healthy but with problems. Refer to Appendix K-Table 2 for more information on the health rating description.

From 189 sites with inventory data on causes, grazing is the primary activity recorded as the source of human-caused bare ground in the Milk River basin, with both greatest number of sites and most area affected. Recreational activities, construction and mine tailings each occurred very infrequently and comprise a very small amount of area influenced. A variety of other non-categorised sources occurred on many sites as well.

Human-Caused Physical Alteration to the Rest of Site

This parameter is specific to non-large river lotic sites (n=143) in the Milk River basin. Overall it rates healthy but with problems which means that 5 to 15% of the area soil or topography beyond the banks has been altered by human activities and therefore the average health rating is healthy but with problems.

Based on sites from 2005 and 2006 with causes of physical alterations away from the banks (n=19), the primary source of alterations is grazing. Grazing is the most frequently occurring cause and is the cause of alterations to the greatest area. A few other uncategorized types of causes occur in the basin and contribute to a small area of alterations.

Human-Caused Alterations to the Physical Site

This parameter is applicable to those sites in the Milk River basin that are on lakes and wetlands (n=18). Of these sites, the average area of soil or topography that has been altered by human activities is 15% to 35% of the and therefore the health rating is unhealthy.

Causes of alterations to riparian physical site can be interpreted from 17 sites in the Milk River basin. Physical site alterations are most commonly from grazing. Other causes present, but affecting one site each and small area, are railroads, recreation and water management. On two sites, other uncategorised activities were mentioned but also attribute to a small area.

Channel Incisement

This parameter was assessed on stream and small river sites with a defined channel (n=130) throughout the Milk River basin. Of sites examined, on average, the channel is generally not incised or with limited incisement meaning it is vertically stable with high water accessing a floodplain greater than the minimum required every 1-2 years. Therefore the health rating is healthy.

Floodplain Accessibility

This parameter was assessed on large rivers where large river health survey methods were used in the Milk River basin (n=34). Of these sites, on average, more than 65% of the floodplain is accessible to flood waters, rating this site as healthy.

4.2.7.3 Hydrologic Parameters

In the Milk River basin there are three parameters related to hydrologic aspects of the riparian area. One parameter is specific to lakes and wetlands and two are specific to large river systems. The overall rating of each parameter is based on the number of applicable sites in that waterbody type. Detailed discussion about each parameter is based on sites with inventory data that can support it.

4.2.7.3.1 Artificial Water Level Change

This parameter is applicable to those sites in the Milk River basin that are on lakes and wetlands and where knowledge of artificial water level change could be determined (n=18). Of these sites, the results indicate that on average there are minor impacts of artificial water removal or addition to these waterbodies which rates this parameter healthy but with problems.

4.2.7.3.2 Damming and Dewatering

Both parameters of Dewatering of the River System and Control of Floodpeak Timing by Upstream Dam(s) are applicable to large river sites assessed using large river health survey methods (n=34). In the Milk River basin, these parameters rate healthy. On average, sites have less than 25% of average river discharge during the critical growing season removed and less than 25% of the watershed upstream controlled by dams.

4.2.7.4 Riparian Health Summary

In the Milk River basin less than one quarter (22%) of sites rate healthy, just under half (46%) rate healthy but with problems, and about one third (31%) rate unhealthy. Nine parameters are healthy and positively influencing riparian health in the Milk River basin. These include preferred shrub regeneration, preferred tree and shrub regeneration, dead and decadent woody material, native graminoids, exotic undesirable woody species, floodplain accessibility, incisement, dewatering of river system, and control of flood peak and timing by upstream dams.

Regeneration of shrubs and trees/shrubs combined is good, with high levels of young shrub communities, limited signs of dead canopy in trees or shrubs. This suggests that sufficient young woody plants are present in these groups to maintain woody plant communities. The near absence of exotic woody species is positive and preventing future establishment of these species should be an important element of riparian management. The high cover of native graminoids is a positive attribute of riparian areas in the Milk River basin.

From a river dynamics perspective, another positive feature is that along the large river sites examined, high flows are generally unrestricted by incisement or human embankments and can access the floodplain. This allows energy and water to be spread across the floodplain rather than remain in the channel where accelerated erosion can occur. The minimal impacts to dewatering and control of flood peak/timing are also positive. These aspects of riparian areas, when functioning, ensure available moisture for riparian plant community survival and thus they should not be negatively influencing tree regeneration or general riparian plant community survival.

Seven parameters have some concerns and are in the middle category and rated healthy but with problems. These are vegetative cover, total canopy cover of woody plants, human-caused alterations to the vegetation, human-caused alterations to the banks, human-caused bare ground, human-caused alterations to the rest of site, and artificial water level change. There are some concerns with overall cover of plants and with limited cover of trees and shrubs. This may be related to the high level of tree and shrub utilisation.

Human-caused physical alterations to riparian areas back from stream and river banks in the Milk River basin are not extensive, but are of some concern as they can contribute to soil loss into the aquatic system and limit the ability of the riparian soils to absorb and hold water. Vegetation change to the plant community structure by human activities on the small number of lentic sites is of some concern and is linked to the degree of disturbance and invasive plants. Artificial changes to water levels are also present and reducing the overall rating for these few lentic sites to healthy but with problems.

Seven parameters are unhealthy, including regeneration of cottonwoods and other tree species, invasive and disturbance caused plants, utilisation of trees and shrubs, root mass protection and human-caused alterations to the physical site. The lack of seedlings and saplings trees is a concern for long-term maintenance of the woody plant community. Widespread invasive species and abundant disturbance-caused plants are likely linked and collectively contribute to lack of deep-binding roots. Of the relatively small number of lake and wetland sites in the Milk River Basin alterations to the riparian area soil and physical structure are affecting sufficient area and are a concern. Relatively high utilisation of trees and shrubs may also be contributing to poor regeneration of tree species.

In the Milk River basin, land use data is present for about half of sites (n=93). Note that multiple land uses may occur on a site. The most common land use is native pasture (grazing) (86%). The next most common, but comparatively less common land use was all other uncategorized land uses (14%). Recreation, tame pasture, development and roads were all present on a very small number of sites (i.e. on less than 7% of sites).

Where Efforts Could be Focused to Maintain/Improve Riparian Health

Many aspects of riparian health in the Milk River basin are consistent with the other basins in the province. Suggestions made in Section 6.0 are applicable here as well as the discussion to follow.

Although shrub regeneration is generally good, cottonwood regeneration is limited, and may be of concern for long-term maintenance of these riparian forests in the Milk River basin. Moderate and high levels of utilisation from livestock and/or wildlife browse, or other forms of removal, could be impacting tree reproduction. Strategies that encourage reduction of overall utilisation to promote and maintain tree and shrub communities are recommended. Fostering establishment of other tree species where they have the potential to grow is also an important component of the riparian woody plant community in the Milk River basin.

The lack of deep binding root mass is a concern within the Milk River basin. It is likely linked to the high abundance of disturbance and invasive plants and the limited presence of trees and shrubs. Consideration of strategies to encourage establishment of trees and shrubs and native graminoid communities could improve bank protection from erosion.

Native graminoid plant communities are adapted to the region in which they grow and thus provide the best resiliency to disturbance or climatic change. The amount of native graminoid cover in the Milk River basin is healthy and every effort should be made to maintain these plant communities.

5.0 DATA GAPS AND FUTURE NEEDS

The primary intent of this report is to provide an overview of existing data previously collected and currently housed by Cows and Fish. As such, this section provides an overview of that data and related observations rather than an extensive literature review of the data gaps and future needs related to riparian health and riparian health monitoring.

5.1 Geographic Distribution

As discussed in the Methods, there are some regions of the province where little or no riparian health assessment or inventory data exists, particularly the non-settled regions of Alberta (Green Zone) and the north eastern regions of the province. As of 2006, no sites had been examined in the Peace/ Slave or Hay River basins (subsequently, sites have been completed in the Peace River basin). Increasing benchmark data in basins with limited monitoring may be an important area to which Watershed Planning and Advisory Councils (WPACs) of the major river basins can contribute.

As the land use information indicates, a large proportion of sites were located on agricultural, particularly grazing, lands. This land use does occupy a large area within Alberta, and thus the sites included in this report are likely generally representative of the White Zone's (settled lands) and adjacent areas riparian health in Alberta.

Sites categorised as urban development (including all aspects of towns and cities) along riparian areas are not very commonly represented in this report. Although they constitute a relatively small area of the province, and so may be appropriately represented relative to land base, urban areas may be an area on which to focus future monitoring due to expanding populations and increasing potential land use intensity. Industrial development outside settlements, including all types of oil and gas development, has extremely limited representation within the provincial data set, but this is an area requiring current and future monitoring efforts due to existing and predicted future expansion of this land use.

Increasing baseline information in many of these underrepresented regions, basins, and land use types will require further resources and additional effort to work with landowners, natural resource managers, land users and land use sectors (e.g. urban, forestry, oil and gas sector) that have previously seen limited involvement in riparian health monitoring, within this context. These resources likely will need to come from individual efforts and partnerships between government, communities and various industry or private sectors.

5.2 Waterbody Type

The very limited number of seeps and springs sites with riparian health data suggests that one area to focus for further understanding of health would be increased monitoring of these waterbody types. These waterbodies are often relatively small, and may be overlooked, so involving landowners and land users to utilise the information and factor it into management would be appropriate. Similarly, bogs and fens are not generally included, except where they form or are associated with the riparian of another waterbody (i.e. stream, river, lake, marsh or other wetland). Although the riparian health assessment and inventory methods have not been designed with bog and fen wetland types in mind, monitoring their ecological integrity should be in integral part of understanding the health of our provincial riparian and aquatic resources.

Streams and rivers are relatively well represented in the provincial data set. In comparison, the limited amount of riparian health work done on wetlands is a significant data gap, and to a lesser degree, lack of riparian health data on lakes poses a gap in our understanding and monitoring of these waterbodies as well. The limited number of lake sites examined is partly related to small number of lakes in the province, in comparison to the more widespread presence of rivers and streams but is also reflective of the community groups and landowners we have been invited to work with. Collection of more riparian health data for wetlands and lakes would provide a more complete picture of riparian, and thus aquatic, health in the province.

Watershed stewardship groups frequently form as a result of interest related to public drinking water supplies and sport fisheries, and request riparian health evaluations as part of their initiatives. Wetlands have not typically formed the focal point around which these groups form, and they are infrequently selected by natural resource agencies for monitoring or restoration projects. As a result, stronger or more diverse engagement efforts may be needed to emphasize the importance of wetlands in contributing to overall riparian health. Continued awareness, education and management tools related to wetlands should encourage further inclusion of wetlands community-based stewardship and riparian health evaluation efforts.

5.3 Knowledge of Riparian / Waterbody Statistics and Sample Intensity

In Alberta, to our knowledge, no inventory of waterbodies, total length of streams and rivers or of lakes and wetland shoreline length is available. Consequently, the riparian health sample intensity or proportion relative to the amount of riparian area that exists provincially cannot be determined. From a provincial perspective, understanding the total amount of riparian area in Alberta, or even the total length of defined lotic waterbodies (streams and rivers) or lentic shoreline (lakes and wetlands) would be a useful addition to quantify sample intensity of riparian monitoring. While we are confident that results presented for waterbody types and basins with large sample sizes are generally reflective of the actual status in those areas, it is important to recognise that the data in this report represent a small fraction of total riparian areas in Alberta. The proportion of actual riparian areas in Alberta that it represents is unknown.

5.4 Benchmark Establishment and Monitoring using Riparian Health Data

Collection of riparian health data in any form requires resources to work with agencies, organizations, local watershed groups and individuals. These resources need to enable not only establishment of benchmark data, but also education and capacity building opportunities and re-examination of those sites in the future to monitor riparian health status over time. Particularly critical to ensure value to monitoring efforts is a consistency of approach, scientific validation of methods and, most importantly, a planned mechanism to make use of the data to inform, educate and improve management.

The known volume of riparian health data collected and housed outside of Cows and Fish (Riemersma and Andrews 2007) suggests that the health assessment (survey) methods outlined in this report are being widely accepted and used. The abundant use of the riparian health methods within and outside Alberta also highlights the utility of this tool and suggests further use across Alberta would be accepted and appropriate. However, due to diverse data collection, management, confidentiality and propriety needs, it may not ever be possible to include such data in an overall examination of riparian health. Because of those limitations, the importance of having consistently collected and housed data, such as that housed by Cows and Fish, is emphasised. This will ensure provincial and regional or basin-wide baseline monitoring is possible.

Riparian health assessment and inventory methods, as described in this report, are intended to examine the suite of ecological functions that riparian areas can perform, identify to what extent these functions are occurring on a site and the potential ability of a site to perform them. A diversity of other methods and techniques have been applied to examine riparian areas, including ground, air, and office-based methods. In general, these other methods are not focused on capturing all characteristics of the riparian area, and may focus on a selection of features that can be determined by the method chosen. They may or may not define the boundaries of the riparian area ecologically; if not, boundaries may be predetermined administratively, or be constricted by methodological limitations. These other methods of examining riparian areas have value, each dependent upon methods and application.

Many other methods have both educational and monitoring values, but to our knowledge, none provide a cohesive, validated methodology that identifies the level of ecological functions of the entire riparian area, which the riparian health inventory and assessment methods described in this report do. Riparian health assessment and inventories are readily applicable for education, monitoring, and decision-making purposes.

5.5 Application of Riparian Health Methods

Initial baseline riparian health establishment can be used to identify areas of concern, which may lead to management efforts that address identified issues. Similarly, benchmark riparian health information at the local and larger watershed scale can educate and motivate communities to learn about and then take actions to improve the status of riparian health in their area. Using individual site details at numerous scales, priority areas can be selected for monitoring or restoration efforts, such as species-specific habitat monitoring. Within the monitoring process, an important end product is finding areas that are healthy and well-managed. These healthy sites provide motivation and learning opportunities, so that the management strategies or land use decisions can assist other landowners and resource managers in managing riparian areas.

Monitoring riparian health across much of the settled regions in Alberta requires the involvement and support of private landowners, since much of the riparian area is privately owned or surrounded by and accessed through private lands. Ensuring provincial, regional and local support to promote interest and involvement at this local level is thus key to establishing initial riparian health baseline information, monitoring trends and implementing management changes. This is also key to the ability of the Alberta government to report on the status and trends in aquatic health within the *Water for Life* Strategy. The ability to make progress and change trends at a local, regional, or provincial level relies upon the active participation and involvement of landowners, resource managers and users as well as local and regional groups of all sorts, since the application of management choices, and impact to riparian health, will be implemented at these scales.

In addition to the utility of riparian health assessment and inventory for monitoring purposes, it is important to understand their suitability for a wide number of purposes. Their value for benchmark establishment and general monitoring is apparent, but the full benefit of that data is really only met when it is used for more than just monitoring. In addition to locating issues, identifying priorities, and tracking changes in a broad sense (whether riparian as a whole, or specific parameter, habitat or species changes), the greater utility of the method is to motivate and provide direction for management and land use decisions. The suitability of riparian health methods for motivating practice change has been shown in experience, as well as independent evaluations (Bateman 2001). Collection of baseline riparian health data should thus be planned within the context of a larger approach, including education and management applications that will lead to improved health and function of these areas in the future.

6.0 *WHERE EFFORTS COULD BE FOCUSED TO MAINTAIN AND IMPROVE RIPARIAN HEALTH*

The long-term goal of management should be to keep existing, functioning sites healthy and aim for no further loss of function in healthy but with problems sites and unhealthy sites. Because approximately a quarter of the sites sampled are healthy, promoting management practices and principles that resulted in that level of health is central to maintaining those sites and improving other sites. It is important to recognise that not all reductions in riparian health are due to human activities, or to on-site management. Natural events such as flooding or drought can increase natural bare ground and reduce vegetative cover, providing additional opportunities for invasive or disturbance-caused plants to become established. Landscape level changes to plant communities and hydrologic patterns such as intensity of runoff and flow removal can influence on-site vegetation and physical features, so management at a site level must consider these watershed characteristics even if there is no direct control of landscape level changes. Because of this relationship between local sites and the larger watershed, decision making that influences riparian health must be factored into both land use and watershed planning.

A number of the riparian health parameters measured were found to be healthy overall, including: high levels of shrub regeneration, combined tree and shrub regeneration, appropriate floodplain access, very low levels of exotic woody plants, limited dead and decadent woody plants, and channel incisement. Efforts should be made to encourage these aspects of riparian systems and maintain them at current levels. High levels of regeneration of woody plants (excluding trees on rivers sites) suggests that in most cases these plant communities are reproducing as expected along streams, small rivers, lakes and wetlands. The near absence of invasive woody plants is extremely positive, and management and monitoring must ensure invasion of woody plants already present in Montana, USA does not occur in Alberta. In general, although they did not always rate as healthy, overall vegetative cover and woody plant cover of river sites was quite good, meaning that land use and management are generally sufficient to allow vegetation to persist. It is extremely important to maintain these plant communities, since trees and shrubs are integral to terrestrial and aquatic riparian habitat for fish and wildlife, bank and shoreline stability, and erosion protection.

Because few sites have berms or other restrictive features, floodplain access is generally good along large rivers. Where they are present, they are often in association with infrastructure (i.e. roads or railroads) and urban settlements. Future planning and development should focus on minimising and avoiding infrastructure and urban developments on flood prone areas, since avoiding such development removes the need for creating restrictions to floodwaters.

Despite the level of broad scale landscape change in Alberta, channel incisement is generally good, and streams can generally access a suitable floodplain, which is positive. Prevention of incisement is key, since downcut systems may lose much of their active riparian area and healing or restoration to the previous channel location may be impossible. Since land conversion, clearing and addition of hardened surfaces typically contribute to greater peaks and volumes of water, it is important to manage watersheds to avoid flow peaks and rates that are greater than historic norms, which can lead to downcutting of the channel, and reduction of floodplain access.

Regeneration of trees along rivers is showing some issues, both for *Populus* spp. as well as for other tree species. Reduced levels of regeneration may be related to water management, since previous research has clearly linked the importance of natural flow events for successful seedling establishment (Bradley *et al*. 1991, Rood and Mahoney 1990). The overall rating for control of flood peaks by damming on large rivers rated at the lower end of the healthy but with problems category, suggesting that a review of water quantity and timing management may be needed to ensure maintenance of riparian forests. Individual reaches and rivers need to be examined for this relationship, since areas of concern could be masked by large number of sites with no control of flooding by dams. Within specific basins and sub-basins identified within this report and previously (Cows and Fish 2005), high levels of flow modification and damming have been recorded, and may be associated with reduced levels of tree regeneration. Further baseline monitoring to examine riparian tree regeneration is warranted, since maintenance of riparian forests is an integral part of many riparian sites.

Some parameters were consistently rated low, indicating those aspects of riparian health are impaired and are likely not contributing the functions expected at those riparian areas. Utilisation of preferred trees and shrubs as well as coverage of invasive and disturbance-caused plants was relatively high. Current rates of utilisation of preferred trees and shrubs could jeopardise the long-term stability and presence of woody plant communities; reducing utilisation will be required to improve health of this parameter. Loss of woody plants through heavy use, or replacement by disturbance caused undesirable herbaceous species affects the vegetative community's ability to filter water, provide wildlife and fisheries habitat and bank and shoreline stability and erosion protection.

Invasive species were widespread in most areas; fortunately, in most areas they still do not contribute significant cover on the sites examined. The presence of disturbance species is however, quite high. It is likely unrealistic to expect significant removal of non-native tame grass species where they are very abundant, widespread and well established both within and outside of riparian areas. Where this is the case, limiting or preventing expansion should be the focus, particularly through suitable timing and intensity of use. For those sites where invasive and disturbance-caused plants are prevalent, the long-term maintenance of riparian ecosystems will likely require considerable effort to limit spread of these plants, or achieve reduced coverage of these species. Yet significant efforts should be made to remove invasive plants in particular, since they are likely to spread further without careful management, and they contribute little to ecological functions of a site. Invasive plants, and often disturbance-caused plants, establish unintentionally due to their prevalence on the landscape as a whole and within other areas of the same waterbody. Disturbance resulting from grazing, recreation, development (e.g. urban areas, parks) and other land uses all require weed control for invasive plants. To reduce these impacts to riparian areas, management approaches should eliminate intentional establishment in riparian areas, such as tame forage species or lawns, and strive to use management that encourages native, deep-rooted species and discourages invasive or disturbance-caused plant species. Reducing the presence of disturbance plants (or limiting further expansion) as well as invasive plants will require a combination of weed control measures and strategies that prevent human-caused bare soil and promote plant vigour.

In order to increase the vigour of non-woody native plant communities and reduce the utilisation levels on preferred trees and shrubs, a rest period during the growing season is recommended for grazed lands. To increase this benefit, it will be useful to minimise grazing during periods when graminoids are less palatable, as livestock will focus more use on trees and shrubs during these periods. Attention to livestock management principles such as distribution, timing, rotation, and stocking rate should enable preferred trees and shrubs to be maintained and increase as well as address herbaceous plant community needs. Where ungulate populations are contributing to utilisation levels, their use must be factored into management decisions. In locations where woody plant removal by humans (e.g. cutting, clearing, etc) exists, it diminishes the ability of a site to function. Such utilisation is most often located around urban areas and lakefront settlements; such removal should be reduced or eliminated wherever possible to increase the health of woody plant communities.

Root mass protection and human-caused alterations to stream and riverbanks are highly variable between basins and waterbody types. In some areas, there are significant health issues for root mass protection, even though preferred tree and shrub regeneration (the source of deep binding roots in many cases) is rated healthy. Likely the prevalence of disturbance-caused plants is preventing sufficient deep-rooted species from protecting the banks. The health rating for human-caused alterations to the banks is frequently not directly linked to root mass protection, but certainly is of concern, since bank alterations can contribute to erosion, sedimentation and reduced ability to resist erosive forces and infiltrate water. Minimising high intensity use and use during saturated soil conditions will be fundamental to reducing bank alterations and improving conditions for deep-rooted species.

Although somewhat variable, physical alterations to the riparian area (excluding streambanks) are generally widespread and of some concern. These impacts often involve soil compaction, changes to soil profile and to soil structure, which alter the soil's ability to resist erosion and to store large amounts of water. As with both other health parameters, the key to reducing or eliminating physical impacts is to manage intensity of use as well as timing, in order to avoid saturated soil conditions and minimise physical alterations.

In order to encourage altered plant communities and structural alterations time to heal, management of land uses, including livestock and recreation activities, will require a combination of strategies that incorporate rest and minimise human impacts. In doing so, the ability of the riparian area to act as a buffer, filtering and trapping sediments and nutrients from surface runoff of adjacent lands will be enhanced. This will help reduce negative impacts such as erosion, which may otherwise contribute to increased sedimentation, reduced water quality and loss of aquatic health. Management to improve both vegetative and physical impacts should relate to both timing and intensity of all land uses. In particular, minimising or avoiding use of these areas during moist soil conditions, when compaction to soil will be greatest, will assist in the recovery or maintenance of physical integrity of riparian areas. Similarly, reducing or eliminating high intensity and duration activities in the near-water areas, will reduce physical impacts to the bank, shore and channel profile.

Many aspects of riparian health were variable, dependent upon waterbody type and basin. In part, this is due to the disparity of sample size regionally and by waterbody type.

However, it may warrant some targeted awareness and management tools specific to waterbody type and geographic location. Overall, this variability in many parameters suggests the potential exists for improved health in areas where parameters are currently rated lower than in other basins or waterbody types. This variability also emphasizes the need for specific management approaches to be applied to individual sites with an understanding of the underlying functions of riparian areas.

Distinguishing between site level management and landscape or watershed level activities or management is necessary because some aspects of riparian systems are influenced by one or both of these scales. Within the vegetative community, the spread of invasive plants (including exotic woody plants), as well as expansion of disturbance-caused species, requires local community, regional and provincial action to help manage these species at the site level. Physical and hydrologic features of riparian areas can also be affected by watershed scale management. Specifically, removal of natural flows and modifications to timing of flooding can impact the health of entire riparian ecosystems. Understanding of the linkages between the site and watershed scale management or land use choices is thus vital to ensuring improved riparian health.

Current Impacts to Riparian Areas in Alberta

The intent of this report was to identify the current status of riparian health in Alberta and to characterize the parameters that constitute and contribute to riparian health. One means to characterise the data is to describe the land use present on the sites examined; 69% of the sites included in this report have land use data. Because it is a subset of the total data, we cannot directly relate the health data presented in this report to the land use data of the subset of sites, but we can characterise the data subset by land use, and make general observations with respect to the entire data set. The current impacts identified below include information related to this report, such as land use data, as well as extensive experience, observations and data collection from the mid-1990s to 2008.

Because native pasture grazing was the most common land use recorded (77%), this land use was often the primary cause of alterations, if alterations were present. Recreation was the next most frequently recorded land use, and it was often an important cause of alterations, after native pasture. Tame pasture, roads and other uncategorized land uses occurred frequently as well, although the latter two of these accounted for limited area. Other land uses, including lawn, development, tilled cropland, perennial forage, logging and railroads were recorded on numerous sites, but collectively, they accounted for a small area. All of these land uses, plus others, have the potential to impact riparian health. In general, riparian areas today are showing the results of decades of land use and management decisions. Frequently, sites are showing signs of stress, loss of function and health. Provincially, extensive grazing that has not ensured the principles of balanced, sustainable grazing management has led to heavy use in many riparian areas. Similarly, interest in working, living and recreating in or near waterbodies has led to extensive development and changes in these riparian areas as well. There is not any one land use that automatically assures a healthy riparian area, yet many land uses, including grazing and recreation, can exist in riparian areas if they are implemented in a sustainable manner.

The solution to lack of health in riparian areas is not to remove all land uses, since even sites without any observable human activity can require management, such as to control invasive species. The key to healthy riparian areas is to understand how these ecosystems function and to use and manage the areas to maintain those functions.

Riparian health is a description of the level of ecological functioning of a site at a given point in time. Thus, health can vary over time due to both natural and human-caused factors, both on the site, and in the entire watershed. Although extreme events, such as significant floods, drought, or intensive short duration human activities can lead to very rapid changes, often changes to riparian health occur over the course of years, including both improvements and declines in health. Current on-site land use or management is therefore often only one aspect of the site's health; site history can be an important factor that influences current health status.

7.0 CONCLUSION

The riparian health analysis within this report provides the basis for information on the status of riparian areas and will contribute to the initial assessment of aquatic ecosystem health in Alberta. The current status of riparian health in Alberta shows that the ability of riparian areas to perform ecological functions are considerably impaired on at least 27% of sites, and impaired to some degree on an additional half of sites examined. This means that less than one quarter of riparian areas in Alberta are functioning as well as they could, providing the goods and services that healthy riparian areas can provide. Clearly, there is considerable room for improvement in riparian health. Fortunately, improvements can occur on unhealthy sites, but the potential for noticeable, relatively rapid improvement is often greater for sites that are healthy but with problems, because the impairments to function are not as great, and management or land use changes may thus result in more rapid responses. These improvements will require thoughtful and sustainable management at both local and regional scales.

The ability of riparian areas to perform numerous ecological functions can be altered due natural and human causes. Since both nature and humans can directly influence riparian health, management systems must consider both sources of influence. The goal of riparian management should be to maintain and improve riparian health, by preventing further losses of function due to human activities, and modifying human activities to allow recovery of naturally-impacted sites.

Riparian areas are fundamentally important to humans, fish, wildlife, and overall aquatic and terrestrial landscape health – conservation and management efforts must focus on improving the functional integrity of these systems. Improvements to ecosystem functions must not rely upon the collection of monitoring data that catalogues the level of function, but rather monitoring should be used within the context of a larger approach to improve the health of riparian and other ecosystems. Current loss of riparian health and continued pressures in these areas will only increase the likelihood of further losses to function unless concerted, collective efforts are made to reduce those impacts to riparian landscapes. Long-term impacts and current high intensity or inappropriate uses are still causing additional losses to riparian and aquatic ecosystem functions, despite public and government sensitisation to the value of riparian areas. These losses are likely to continue to a level that is irreversible and has significant negative consequences unless there is a concerted province-wide effort.

Many individual and group initiatives have been working on improving riparian areas, but we must strengthen and expand those initiatives, while aligning broad planning, land use and management strategies to ensure that losses to riparian area function do not increase, but instead begin to achieve a net improvement. The approach to achieve that improvement must include education and capacity building to help landowners, managers and users to apply sustainable management.

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APPENDIX A
Riparian Health by Waterbody Type in Alberta 1997-2006

Waterbody Type		Healthy	Healthy but with Problems	Unhealthy	Total
Streams and Small Rivers	**% of Sites**	18.1%	54.2%	27.7%	100.0%
	N=	164	490	250	904
Large Rivers	**% of Sites**	26.6%	48.8%	24.6%	100.0%
	N=	107	196	99	402
Lakes and Wetlands	**% of Sites**	28.6%	44.0%	27.4%	100.0%
	N=	48	74	46	168
Springs and Seeps	**% of Sites**	31.3%	50.0%	18.8%	100.0%
	N=	5	8	3	16
Provincial Total	**% of Sites**	21.7%	51.5%	26.7%	100.0%
	N=	324	768	398	1490

Note riparian health ratings are defined as:

- *Healthy (Score Range 80-100%) – Little or no impairment to riparian functions;*
- *Healthy but with Problems (Score Range 60-79%) – Some impairment to riparian functions due to human or natural causes; and*
- *Unhealthy (Score Range <60%) – Impairment to many riparian functions due to human or natural causes.*

APPENDIX B
Riparian Health for Major River Basins in Alberta 1997-2006

Major Basin		Healthy	Healthy but with Problems	Unhealthy	Total
Athabasca River Watershed	**% of Sites**	38.2%	40.0%	21.8%	100.0%
	N=	42	44	24	110
Beaver River Watershed	**% of Sites**	60.0%	20.0%	20.0%	100.0%
	N=	12	4	4	20
North Saskatchewan River Watershed	**% of Sites**	19.0%	58.9%	22.1%	100.0%
	N=	48	149	56	253
South Saskatchewan River Watershed	**% of Sites**	20.4%	52.0%	27.6%	100.0%
	N=	186	474	252	912
Milk River Watershed	**% of Sites**	22.1%	46.2%	31.8%	100.0%
	N=	43	90	62	195
Provincial Total	**% of Sites**	22.2%	51.1%	26.7%	100.0%
	N=	331	761	398	1490

Note riparian health ratings are defined as:

- *Healthy (Score Range 80-100%) – Little or no impairment to riparian functions;*
- *Healthy but with Problems (Score Range 60-79%) – Some impairment to riparian functions due to human or natural causes; and*
- *Unhealthy (Score Range <60%) – Impairment to many riparian functions due to human or natural causes.*

APPENDIX C
Riparian Health Data Collection Methods in Alberta 1997-2006

Table C-1. Riparian health data collection methods by waterbody type in Alberta 1997-2006.

Note: Only years in which a method was used or waterbody type was sampled are shown.

Waterbody Type	YEAR	Riparian Health Data Collection Method Lentic Health Survey	Lentic Inventory	Lotic Health Survey	Lotic Inventory	Large River Health Survey	Total	Percent of Total (Waterbody)	Percent of Total (Provincial)
Streams and Small Rivers	1997	0	0	0	2	0	2	0.2%	
	1998	0	0	45	2	0	47	5.2%	
	1999	0	0	0	98	0	98	10.8%	
	2000	0	0	1	151	0	152	16.8%	
	2001	0	0	2	93	0	95	10.5%	
	2002	0	0	11	151	0	162	17.9%	
	2003	0	0	6	53	0	59	6.5%	
	2004	0	0	0	90	0	90	10.0%	
	2005	0	0	1	121	0	122	13.5%	
	2006	0	0	2	75	0	77	8.5%	
Streams and Small Rivers Total		**0**	**0**	**68**	**836**	**0**	**904**		**60.7%**
Large Rivers	1997	0	0	0	5	0	5	1.2%	
	1999	0	0	1	73	19	93	23.1%	
	2000	0	0	0	0	39	39	9.7%	
	2001	0	0	0	1	51	52	12.9%	
	2002	0	0	0	2	27	29	7.2%	
	2003	0	0	1	0	62	63	15.7%	
	2004	0	0	0	2	82	84	20.9%	
	2005	0	0	2	5	16	23	5.7%	
	2006	0	0	0	1	13	14	3.5%	
Large Rivers Total		**0**	**0**	**4**	**89**	**309**	**402**		**27.0%**
Lakes and Wetlands	2000	16	0	0	0	0	16	9.5%	
	2001	6	21	0	0	0	27	16.1%	
	2002	1	33	0	0	0	34	20.2%	
	2003	1	49	0	0	0	50	29.8%	
	2004	1	9	0	0	0	10	6.0%	
	2005	0	10	0	0	0	10	6.0%	
	2006	0	21	0	0	0	21	12.5%	
Lakes and Wetlands Total		**25**	**143**	**0**	**0**	**0**	**168**		**11.3%**
Springs and Seeps	1997	0	0	0	1	0	1	6.3%	
	2000	0	2	0	0	0	2	12.5%	
	2002	0	0	0	3	0	3	18.8%	
	2003	0	0	0	4	0	4	25.0%	
	2004	0	0	0	5	0	5	31.3%	
	2005	0	0	0	1	0	1	6.3%	
Springs and Seeps Total		**0**	**2**	**0**	**14**	**0**	**16**		**1.1%**
Provincial Total		**25**	**145**	**72**	**939**	**309**	**1490**		**100.0%**
Percent of Total (Provincial)		1.7%	9.7%	4.8%	63.0%	20.7%	100.0%		

Table C-2. Riparian health data collection methods for major river basins in Alberta 1997-2006.

Note: Only years in which a method was used are shown.

Major Basin	YEAR	Riparian Health Data Collection Method: Lentic Health Survey	Lentic Inventory	Lotic Health Survey	Lotic Inventory	Large River Health Survey	Total	Percent of Total (Basin)	Percent of Total (Provincial)
Athabasca River Watershed	2000	1	0	0	2	0	3	2.7%	
	2001	1	0	0	9	3	13	11.8%	
	2002	0	25	0	2	13	40	36.4%	
	2003	0	27	0	2	0	29	26.4%	
	2004	0	1	0	3	0	4	3.6%	
	2005	0	1	0	4	0	5	4.5%	
	2006	0	4	1	1	10	16	14.5%	
Athabasca River Watershed Total		**2**	**58**	**1**	**23**	**26**	**110**		**7.4%**
Beaver River Watershed	2002	0	1	0	0	0	1	5.0%	
	2005	0	3	1	15	0	19	95.0%	
Beaver River Watershed Total		**0**	**4**	**1**	**15**	**0**	**20**		**1.3%**
North Saskatchewan River Watershed	2000	13	0	0	0	0	13	5.1%	
	2001	5	19	1	55	25	105	41.5%	
	2002	1	2	0	3	0	6	2.4%	
	2003	1	8	0	0	0	9	3.6%	
	2004	1	6	0	9	37	53	20.9%	
	2005	0	3	2	0	8	13	5.1%	
	2006	0	12	1	41	0	54	21.3%	
North Sask. River Watershed Total		**21**	**50**	**4**	**108**	**70**	**253**		**17.0%**
South Saskatchewan River Watershed	1998	0	0	45	0	0	45	4.9%	
	1999	0	0	0	112	19	131	14.4%	
	2000	1	2	1	142	15	161	17.7%	
	2001	0	2	1	30	23	56	6.1%	
	2002	0	2	10	123	11	146	16.0%	
	2003	0	2	3	35	61	101	11.1%	
	2004	0	2	0	85	45	132	14.5%	
	2005	0	3	0	108	2	113	12.4%	
	2006	0	3	0	21	3	27	3.0%	
South Sask. River Watershed Total		**1**	**16**	**60**	**656**	**179**	**912**		**61.2%**
Milk River Watershed	1997	0	0	0	8	0	8	4.1%	
	1998	0	0	0	2	0	2	1.0%	
	1999	0	0	1	59	0	60	30.8%	
	2000	1	0	0	7	24	32	16.4%	
	2002	0	3	1	28	3	35	17.9%	
	2003	0	12	4	20	1	37	19.0%	
	2005	0	0	0	0	6	6	3.1%	
	2006	0	2	0	13	0	15	7.7%	
Milk River Watershed Total		**1**	**17**	**6**	**137**	**34**	**195**		**13.1%**
Provincial Total		**25**	**145**	**72**	**939**	**309**	**1490**		**100.0%**
Percent of Total (Provincial)		1.7%	9.7%	4.8%	63.0%	20.7%	100.0%		

APPENDIX D
Summary of Site Lengths for Riparian Areas in Alberta 1997-2006

Table D-1. Summary of sites, by year, for waterbody types with available length data in Alberta 1997-2006.

YEAR	Streams and Small Rivers	Large Rivers	Lakes and Wetlands	Springs and Seeps	Total	Percent of Total
1997	2	5	0	1	8	0.5%
1998	47	0	0	0	47	3.2%
1999	98	93	0	0	191	12.8%
2000	152	39	16	2	209	14.0%
2001	95	52	27	0	174	11.7%
2002	162	29	34	3	228	15.3%
2003	59	63	50	4	176	11.8%
2004	90	84	10	5	189	12.7%
2005	122	23	10	1	156	10.5%
2006	77	14	21	0	112	7.5%
Total Sites	904	402	168	16	1490	100.0%
Percent of Total	60.7%	26.9%	11.3%	1.1%	100.0%	
Total Length (km)	737.7	564.5	71.5	6.1	1379.8	

Table D-2. Summary of sites by year for the major river basins with available length data in Alberta 1997-2006.

YEAR	Athabasca River Watershed	Beaver River Watershed	North Saskatchewan River Watershed	South Saskatchewan River Watershed	Milk River Watershed	Total	Percent of Total
1997	0	0	0	0	8	8	0.5%
1998	0	0	0	45	2	47	3.2%
1999	0	0	0	131	60	191	12.8%
2000	2	0	16	160	31	209	14.0%
2001	12	0	106	56	0	174	11.7%
2002	42	1	4	146	35	228	15.3%
2003	29	0	8	101	38	176	11.8%
2004	4	0	52	133	0	189	12.7%
2005	5	19	13	113	6	156	10.5%
2006	16	0	54	27	15	112	7.5%
Total Sites	110	20	253	912	195	1490	100.0%
Percent of Total	7.4%	1.3%	17.0%	61.2%	13.1%	100.0%	
Total Length (km)	65.4	14.7	185.1	936.4	178.2	1379.8	

* Total length of riparian areas in this provincial data set is based on 98% of sites. Lengths for the other 2% of sites cannot be calculated due to missing data, or there is insufficient accuracy in older global positioning system data.

APPENDIX E
Riparian Health Sites in Alberta 1997-2006

Note: Only years in which sites on a waterbody type were collected in a major basin are shown.

		Waterbody Type						
Major Basin	**YEAR**	**Streams and Small Rivers**	**Large Rivers**	**Lakes and Wetlands**	**Springs and Seeps**	**Total**	**Percent of Total (Basin)**	**Percent of Total (Provincial)**
Athabasca River Watershed	2000	2	0	1	0	3	2.7%	
	2001	9	3	1	0	13	11.8%	
	2002	2	13	25	0	40	36.4%	
	2003	2	0	27	0	29	26.4%	
	2004	2	1	1	0	4	3.6%	
	2005	3	0	1	1	5	4.5%	
	2006	2	10	4	0	16	14.5%	
Athabasca River Watershed Total		**22**	**27**	**60**	**1**	**110**		**7.4%**
Beaver River Watershed	2002	0	0	1	0	1	5.0%	
	2005	14	2	3	0	19	95.0%	
Beaver River Watershed Total		**14**	**2**	**4**	**0**	**20**		**1.3%**
North Saskatchewan River Watershed	2000	0	0	13	0	13	5.1%	
	2001	55	26	24	0	105	41.5%	
	2002	2	1	3	0	6	2.4%	
	2003	0	0	9	0	9	3.6%	
	2004	9	37	7	0	53	20.9%	
	2005	0	10	3	0	13	5.1%	
	2006	42	0	12	0	54	21.3%	
North Sask. River Watershed Total		**108**	**74**	**71**	**0**	**253**		**17.0%**
South Saskatchewan River Watershed	1998	45	0	0	0	45	4.9%	
	1999	98	33	0	0	131	14.4%	
	2000	143	15	1	2	161	17.7%	
	2001	31	23	2	0	56	6.1%	
	2002	129	12	2	3	146	16.0%	
	2003	35	62	2	2	101	11.1%	
	2004	79	46	2	5	132	14.5%	
	2005	105	5	3	0	113	12.4%	
	2006	20	4	3	0	27	3.0%	
South Sask. River Watershed Total		**685**	**200**	**15**	**12**	**912**		**61.2%**
Milk River Watershed	1997	2	5	0	1	8	4.1%	
	1998	2	0	0	0	2	1.0%	
	1999	0	60	0	0	60	30.8%	
	2000	7	24	1	0	32	16.4%	
	2002	29	3	3	0	35	17.9%	
	2003	22	1	12	2	37	19.0%	
	2005	0	6	0	0	6	3.1%	
	2006	13	0	2	0	15	7.7%	
Milk River Watershed Total		**75**	**99**	**18**	**3**	**195**		**13.1%**
Provincial Total		**904**	**402**	**168**	**16**	**1490**		**100.0%**
Percent of Total (Provincial)		60.7%	27.0%	11.3%	1.1%	100.0%		

APPENDIX F
Detailed Examination of Riparian Health Parameters by Waterbody Type in Alberta 1997-2006

Note riparian health ratings are defined as: Healthy (80-100%) – Little or no impairment to riparian functions; Healthy but with Problems (60-79%) – Some impairment to riparian functions due to human or natural causes; and Unhealthy (<60%) – Impairment to many riparian functions due to human or natural causes.

Healthy	Healthy but with Problems	Unhealthy

	Streams and Small Rivers		Large Rivers		Lakes and Wetlands		Seeps and Springs	
Health Parameter Assessed	**Health Rating**	**N=**	**Health Rating**	**N=**	**Health Rating**	**N=**	**Health Rating**	**N=**
!vegetative cover	82.0%	904	62.7%	93	73.5%	168	85.4%	16
^cottonwood and poplar regeneration	NA	NA	70.3%	284	NA	NA	NA	NA
^regeneration of other tree species	NA	NA	72.7%	237	NA	NA	NA	NA
^preferred shrub regeneration	NA	NA	93.6%	309	NA	NA	NA	NA
!preferred tree/shrub regeneration	93.1%	903	98.6%	93	94.4%	166	95.8%	16
preferred tree/shrub utilisation	49.4%	898	49.7%	402	66.3%	164	52.1%	16
**dead/decadent woody material	93.3%	855	96.2%	402	NA	NA	92.9%	14
^total canopy cover of woody plants	NA	NA	80.7%	309	NA	NA	NA	NA
invasive plants	26.9%	904	24.3%	402	31.7%	168	28.1%	16
disturbance plants	30.7%	903	30.7%	401	57.8%	168	66.7%	16
^presence of native graminoids	NA	NA	54.8%	309	NA	NA	NA	NA
^exotic undesirable woody species	NA	NA	99.9%	308	NA	NA	NA	NA
#human-caused alt to vegetation	NA	NA	NA	NA	65.1%	152	100.0%	2
** root mass protection	67.4%	850	58.3%	395	NA	NA	83.3%	4
**human-caused alterations to banks	58.3%	849	79.5%	395	NA	NA	25.0%	4
human-caused bare ground	73.8%	902	86.4%	401	74.2%	168	83.3%	16
*human-caused alterations to rest of site	65.2%	902	75.3%	93	NA	NA	28.6%	14
#human-caused alterations to physical site	NA	NA	NA	NA	66.4%	152	100.0%	2
^floodplain accessibility	NA	NA	93.9%	308	NA	NA	NA	NA
*channel incisement	77.9%	854	82.0%	89	NA	NA	100.0%	4
#artificial water level change	NA	NA	NA	NA	73.0%	145	100.0%	2
^dewatering of the river system	NA	NA	78.9%	309	NA	NA	NA	NA
^control of flood peak/timing by dams	NA	NA	62.2%	309	NA	NA	NA	NA

Note: parameter is assessed for all sites unless otherwise indicated
^ large rivers only
# lakes and wetlands & springs and seeps (lentic) only
** large rivers & streams and small rivers & springs and seeps (lotic) only
* streams and small rivers & springs and seeps (lotic) only
! streams and small rivers & springs and seeps (lotic and lentic) & lakes and wetlands only

APPENDIX G
Detailed Examination of Riparian Health Parameters for the Major River Basins in Alberta 1997-2006

Note riparian health ratings are defined as: Healthy (80-100%) – Little or no impairment to riparian functions; Healthy but with Problems (60-79%) – Some impairment to riparian functions due to human or natural causes; and Unhealthy (<60%) – Impairment to many riparian functions due to human or natural causes.

Healthy | Healthy but with Problems | Unhealthy

	Athabasca River Basin		Beaver River Basin		North Saskatchewan River Basin		South Saskatchewan River Basin		Milk River Basin	
Health Parameter Assessed	**Health Rating**	**N=**	**Health Rating**	**N=**	**Health Rating**	**N=**	**Health Rating**	**N=**	**Health Rating**	**N=**
!vegetative cover	69.8%	84	95.0%	20	84.2%	183	79.9%	733	74.1%	161
^cottonwood and poplar regeneration	74.4%	26	NA	NA	56.4%	68	75.6%	179	58.3%	11
^regeneration of other tree species	48.7%	26	NA	NA	88.2%	68	70.0%	139	0.0%	1
^preferred shrub regeneration	93.6%	26	NA	NA	95.7%	70	94.4%	179	85.3%	34
!preferred tree/shrub regeneration	93.6%	83	95.0%	20	94.7%	182	93.0%	732	95.7%	161
preferred tree/shrub utilisation	63.9%	109	56.7%	20	54.8%	250	50.0%	906	45.6%	195
**dead/decadent woody material	94.0%	50	95.8%	16	95.1%	182	93.6%	846	96.4%	177
^total canopy cover of woody plants	74.4%	26	NA	NA	68.6%	70	87.7%	179	73.5%	34
invasive plants	35.2%	110	37.5%	20	26.0%	253	25.7%	912	25.7%	195
disturbance plants	51.5%	110	50.0%	20	37.9%	253	29.7%	911	38.7%	194
^presence of native graminoids	59.0%	26	NA	NA	51.4%	70	49.5%	179	86.3%	34
^exotic undesirable woody species	100.0%	26	NA	NA	99.5%	70	100.0%	178	100.0%	34
#human-caused alterations to vegetation	65.6%	60	83.3%	4	64.8%	55	58.8%	17	70.4%	18
** root mass protection	76.2%	49	86.7%	10	81.9%	151	65.5%	873	39.0%	166
**human-caused alterations to banks	80.9%	49	40.0%	10	70.9%	151	65.8%	873	62.5%	165
human-caused bare ground	79.1%	110	90.0%	20	80.3%	252	76.2%	911	76.5%	194
*human-caused alterations to rest of site	62.5%	24	72.9%	16	52.4%	112	67.3%	714	67.4%	143
#human-caused alterations to physical site	73.9%	60	66.7%	4	66.4%	55	52.9%	17	57.4%	18
^floodplain accessibility	87.2%	26	NA	NA	100.0%	70	94.6%	178	83.3%	34
*channel incisement	68.1%	23	93.3%	10	91.5%	86	75.7%	698	84.6%	130
#artificial water level change	68.4%	58	75.0%	4	74.5%	51	81.3%	16	77.8%	18
^dewatering of the river system	100.0%	26	NA	NA	66.7%	70	77.7%	179	94.1%	34
^control of flood peak/timing by upstream dams	100.0%	26	NA	NA	14.3%	70	68.5%	179	99.0%	34

Note: parameter is assessed for all sites unless otherwise indicated
^ large rivers only
# lakes and wetlands & springs and seeps (lentic) only
** large rivers & streams and small rivers & springs and seeps (lotic) only
* streams and small rivers & springs and seeps (lotic) only
! streams and small rivers & springs and seeps (lotic and lentic) & lakes and wetlands only

APPENDIX H
Land Use Data for Riparian Sites in Alberta 1997-2006

Table H-1. Land use by waterbody type in Alberta 1997-2006.

	Provincial		Streams & Small Rivers		Large Rivers		Lakes and Wetlands		Seeps and Springs	
Total Number of Sites	1490		904		402		168		16	
Number of Sites with Land Use Data	1023		595		265		150		13	
Percent of Total Sites	68.7%		65.8%		65.9%		89.3%		81.3%	
Land Use Types	Number of Sites	Constancy*	Number of Sites	Constancy*	Number of Sites	Constancy*	Number of Sites	Constancy*	Number of Sites	Constancy*
No Land use	152	14.9%	42	7.1%	60	22.6%	50	33.3%	0	0.0%
Lawn	22	2.2%	3	0.5%	9	3.4%	10	6.7%	0	0.0%
Tame pasture	106	10.4%	53	8.9%	44	16.6%	9	6.0%	0	0.0%
Native pasture	790	77.2%	526	88.4%	189	71.3%	62	41.3%	13	100.0%
Recreation	145	14.2%	38	6.4%	48	18.1%	57	38.0%	2	15.4%
Development	34	3.3%	16	2.7%	12	4.5%	6	4.0%	0	0.0%
Tilled Crop	23	2.2%	9	1.5%	13	4.9%	1	0.7%	0	0.0%
Perennial forage	15	1.5%	3	0.5%	11	4.2%	1	0.7%	0	0.0%
Roads	83	8.1%	48	8.1%	28	10.6%	7	4.7%	0	0.0%
Logging	8	0.8%	3	0.5%	4	1.5%	1	0.7%	0	0.0%
Mining	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Railroads	11	1.1%	9	1.5%	2	0.8%	0	0.0%	0	0.0%
Other	85	8.3%	40	6.7%	25	9.4%	17	11.3%	3	23.1%

*Constancy is the number of times the land use occurs divided by the number of sites with land use data within the waterbody type.

Table H-2. Land use for major river basins in Alberta 1997-2006.

	Athabasca River Watershed		**Beaver River Watershed**		**North Saskatchewan River Watershed**		**South Saskatchewan River Watershed**		**Milk River Watershed**	
Total Number of Sites	110		20		253		912		195	
Number of Sites with Land Use Data	107		19		233		571		93	
Percent of Total Sites	97.3%		95.0%		92.1%		62.6%		47.7%	
Land Use types	Number of Sites	Constancy*	Number of Sites	Constancy*	Number of Sites	Constancy*	Number of Sites	Constancy*	Number of Sites	Constancy*
No Land use	41	38.3%	8	42.1%	39	16.7%	64	11.2%	0	0.0%
Lawn	10	9.3%	0	0.0%	4	1.7%	8	1.4%	0	0.0%
Tame pasture	17	15.9%	0	0.0%	35	15.0%	49	8.6%	5	5.4%
Native pasture	43	40.2%	11	57.9%	171	73.4%	485	84.9%	80	86.0%
Recreation	32	29.9%	0	0.0%	32	13.7%	75	13.1%	6	6.5%
Development	6	5.6%	0	0.0%	3	1.3%	23	4.0%	2	2.2%
Tilled Crop	3	2.8%	0	0.0%	11	4.7%	9	1.6%	0	0.0%
Perennial forage	3	2.8%	0	0.0%	4	1.7%	8	1.4%	0	0.0%
Roads	6	5.6%	4	21.1%	6	2.6%	65	11.4%	2	2.2%
Logging	2	1.9%	0	0.0%	1	0.4%	5	0.9%	0	0.0%
Mining	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Railroads	2	1.9%	0	0.0%	2	0.9%	7	1.2%	0	0.0%
Other	13	12.1%	0	0.0%	22	9.4%	37	6.5%	13	14.0%

* Constancy is the number of times the land use occurs divided by the number of sites with land use data within the basin.

APPENDIX I
Photographs of Riparian Areas in Alberta Representing Each Riparian Health Category

Figure 1. Example of site assessed as *healthy*.

Figure 2. Example of site assessed as *healthy*.

Figure 3. Example of site assessed as *healthy*.

Figure 4. Example of site assessed as *healthy but with problems*.

Figure 5. Example of site assessed as *healthy but with problems*.

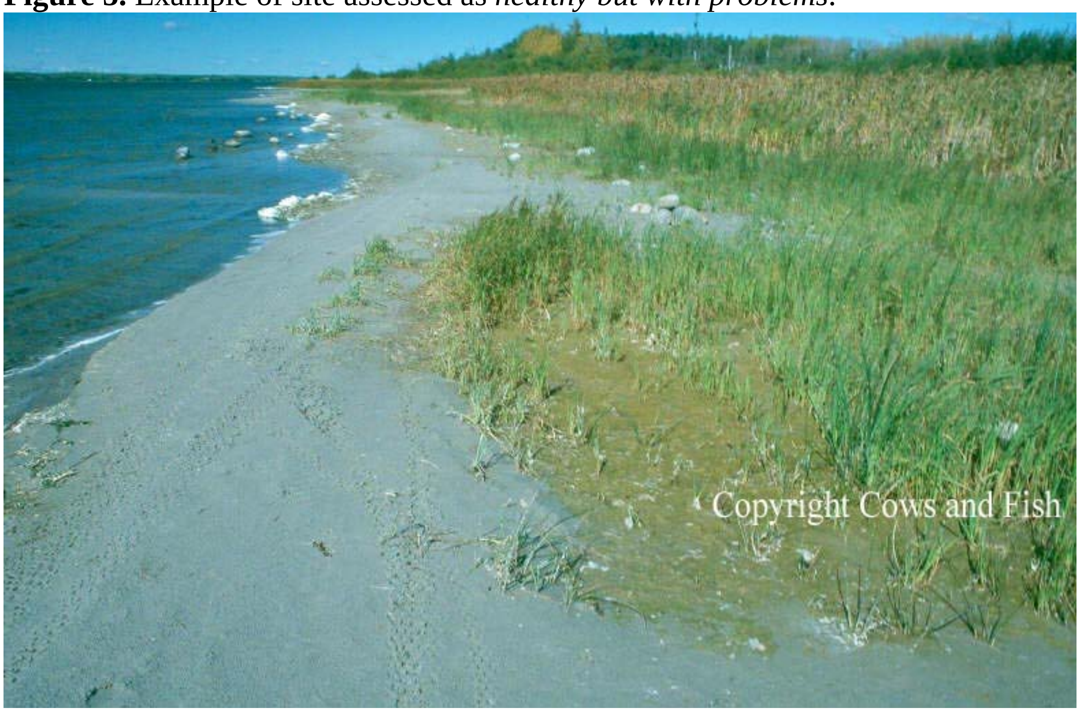

Figure 6. Example of site assessed as *healthy but with problems*.

Figure 8. Example of site assessed as *unhealthy*

Figure 9. Example of site assessed as *unhealthy*

Figure 10. Example of site assessed as *unhealthy*

APPENDIX J
Provincial Riparian Plant Species List for Alberta 1997-2006

This provincial plant list is based on 1393 sites with inventory data. The total area of these sites is 10,271 ha. There is potential for overlap of species canopy cover therefore the total area by species may not equal the total area assessed.

[1] Plant status is determined by Cows and Fish in association with Alberta Sustainable Resource Development Rangeland Management Branch, the *Alberta Weed Control Act*, and *Flora of Alberta* by E.H. Moss (1994). *Disturbance* and *invasive* plant status categories are designated for riparian health assessment and inventory purposes. *Unknown* is a plant not identified to species and therefore the origin and riparian health category could not be determined.

[2] Percent canopy cover is based on visual estimates of the amount of ground the canopy of a plant species covers. The percent cover values are collected and presented using the following class codes which represent the mid-value of a range (see below).

Mid-Value	Range	Mid-Value	Range
0.5%	less than 1%	50%	45% - 55%
3%	1% - 5%	60%	55%-65%
10%	5% - 15%	70%	65% - 75%
20%	15%-25%	80%	75% - 85%
30%	25% - 35%	90%	85% - 95%
40%	35% - 45%	97.5%	greater than 95%

[3] The *Average* canopy cover is calculated as a weighted average (by site area) using only sites on which a species was found.

[4] Constancy is the number of times a species occurs divided by the total number of sites with plant species data.

[1,2,3,4] - for note descriptions refer to Appendix J title page

APPENDIX J
Provincial Riparian Plant Species List for Alberta 1997-2006

Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Abies balsamea (balsam fir)	native	0.19	2.02%	0.00%	3.00%	0.29%
Abies lasiocarpa (subalpine fir)	native	0.63	2.44%	0.00%	60.00%	0.86%
Abies spp. (fir)	unknown, not unique	0.03	0.50%	0.00%	0.50%	0.07%
Acer glabrum (mountain maple)	native	0.04	0.50%	0.00%	0.50%	0.22%
Acer negundo (Manitoba maple)	native	120.90	8.16%	0.00%	50.00%	13.57%
Achillea millefolium (common yarrow)	native	46.69	0.57%	0.00%	10.00%	80.47%
Achillea sibirica (many-flowered yarrow)	native	9.17	0.50%	0.00%	0.50%	13.42%
Acorus americanus (sweet flag)	native	4.27	9.58%	0.00%	10.00%	0.14%
Actaea rubra (red and white baneberry)	native, poisonous	5.05	0.63%	0.00%	20.00%	10.27%
Agastache foeniculum (giant hyssop)	native	0.17	0.50%	0.00%	0.50%	0.50%
Agoseris aurantiaca (orange false dandelion)	native	0.01	0.50%	0.00%	0.50%	0.07%
Agoseris glauca (yellow false dandelion)	native	2.47	0.50%	0.00%	3.00%	4.31%
Agrimonia striata (agrimony)	native	5.73	0.84%	0.00%	10.00%	6.46%
Agrocybe praecox (spring agrocybe)	native	0.00	0.50%	0.00%	0.50%	0.07%
Agrohordeum macounii (Macoun's wild rye)	native	45.11	7.70%	0.00%	20.00%	2.58%
Agropyron dasystachyum (northern wheat grass)	native	46.28	3.32%	0.00%	30.00%	8.61%
Agropyron elongatum (tall wheat grass)	introduced	0.68	0.57%	0.00%	3.00%	0.79%
Agropyron intermedium (intermediate wheat grass)	introduced	1.51	0.72%	0.00%	20.00%	1.65%
Agropyron pectiniforme (crested wheat grass)	disturbance, introduced	46.87	1.92%	0.00%	30.00%	16.08%
Agropyron repens (quack grass)	disturbance, introduced	362.30	6.68%	0.00%	50.00%	48.24%
Agropyron smithii (western wheat grass)	native	338.78	6.67%	0.00%	40.00%	36.04%
Agropyron spicatum (bluebunch wheat grass)	native	0.74	2.69%	0.00%	10.00%	0.36%
Agropyron spp. (wheat grass)	unknown, not unique	11.33	3.13%	0.00%	30.00%	5.24%
Agropyron trachycaulum (slender wheat grass)	native	220.03	4.07%	0.00%	50.00%	41.35%

[1,2,3,4] - for note descriptions refer to Appendix J title page

APPENDIX J
Provincial Riparian Plant Species List for Alberta 1997-2006

Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Agropyron trachycaulum var. unilaterale (variation of slender wheat grass)	native	57.42	2.67%	0.00%	20.00%	19.60%
Agrostis scabra (rough hair grass)	native	15.91	2.22%	0.00%	20.00%	8.97%
Agrostis spp. (Agrostis)	unknown, not unique	0.13	0.74%	0.00%	3.00%	0.36%
Agrostis stolonifera (redtop)	introduced	270.28	4.84%	0.00%	80.00%	42.50%
Alisma plantago-aquatica (broad-leaved water-plantain)	native	0.65	0.50%	0.00%	0.50%	0.57%
Allium cernuum (nodding onion)	native	4.37	0.50%	0.00%	0.50%	4.24%
Allium schoenoprasum (wild chives)	native	0.89	0.50%	0.00%	0.50%	1.22%
Allium textile (prairie onion)	native	2.30	0.50%	0.00%	0.50%	3.09%
Alnus crispa (green alder)	native	43.90	3.42%	0.00%	50.00%	8.04%
Alnus tenuifolia (river alder)	native	37.34	4.96%	0.00%	30.00%	7.97%
Alopecurus aequalis (short-awned foxtail)	native	11.86	0.98%	0.00%	30.00%	8.97%
Alopecurus geniculatus (water foxtail)	introduced	0.03	10.00%	0.00%	10.00%	0.07%
Alopecurus occidentalis (alpine foxtail)	native	0.27	0.70%	0.00%	10.00%	0.65%
Alopecurus pratensis (meadow foxtail)	introduced	1.37	2.10%	0.00%	20.00%	1.22%
Alopecurus spp. (foxtail)	unknown, not unique	0.87	0.55%	0.00%	3.00%	1.22%
Amaranthus albus (tumbleweed)	native	0.02	0.50%	0.00%	0.50%	0.07%
Amaranthus graecizans (prostrate amaranth)	native	2.43	0.53%	0.00%	3.00%	7.11%
Amaranthus retroflexus (red-root pigweed)	disturbance, introduced	5.90	1.36%	0.00%	10.00%	2.30%
Amaranthus spp. (amaranthus)	unknown, not unique	0.20	0.50%	0.00%	0.50%	0.29%
Ambrosia trifida (great ragweed)	introduced	0.00	0.50%	0.00%	0.50%	0.14%
Amelanchier alnifolia (saskatoon)	native	305.48	4.89%	0.00%	40.00%	53.98%
Anaphalis margaritacea (pearly everlasting)	native	0.18	0.50%	0.00%	0.50%	0.86%
Androsace septentrionalis (northern fairy candelabra)	native	0.13	0.50%	0.00%	0.50%	0.07%
Anemone canadensis (Canada anemone)	native	28.23	0.68%	0.00%	10.00%	40.27%
Anemone cylindrica (long-fruited anemone)	native	3.60	0.50%	0.00%	0.50%	4.59%
Anemone multifida (cut-leaved anemone)	native	5.22	0.57%	0.00%	3.00%	7.54%

[1,2,3,4] - for note descriptions refer to Appendix J title page

APPENDIX J
Provincial Riparian Plant Species List for Alberta 1997-2006

Plant Species	Plant Status[1]		Percent Canopy Cover[2]			
		Area by Species		Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Anemone occidentalis (western anemone)	native	0.02	0.50%	0.00%	0.50%	0.07%
Anemone parviflora (small wood anemone)	native	0.03	0.50%	0.00%	0.50%	0.07%
Anemone patens (prairie crocus)	native	0.67	0.50%	0.00%	0.50%	1.08%
Anemone quinquefolia (wood anemone)	native	0.01	0.50%	0.00%	0.50%	0.07%
Anemone spp. (anemone)	unknown, not unique	0.05	0.50%	0.00%	0.50%	0.22%
Angelica arguta (white angelica)	native	0.61	0.64%	0.00%	10.00%	2.44%
Angelica dawsonii (yellow angelica)	native	0.01	1.17%	0.00%	10.00%	0.14%
Angelica spp. (angelica)	unknown, not unique	0.20	0.50%	0.00%	0.50%	0.57%
Antennaria aprica (low everlasting)	disturbance, native	0.05	0.50%	0.00%	0.50%	0.22%
Antennaria neglecta (broad-leaved everlasting)	disturbance, native	0.02	0.50%	0.00%	0.50%	0.22%
Antennaria parvifolia (small-leaved everlasting)	disturbance, native	17.06	0.73%	0.00%	20.00%	20.32%
Antennaria pulcherrima (showy everlasting)	disturbance, introduced	1.78	0.65%	0.00%	3.00%	2.23%
Antennaria rosea (rosy everlasting)	disturbance, native	0.14	0.50%	0.00%	0.50%	0.43%
Antennaria spp. (everlastings)	disturbance, unknown, not unique	0.32	0.80%	0.00%	3.00%	0.65%
Apocynum androsaemifolium (spreading dogbane)	disturbance, native, poisonous	0.08	0.50%	0.00%	0.50%	0.29%
Apocynum cannabinum (Indian hemp)	native, poisonous	12.39	0.88%	0.00%	10.00%	5.96%
Aquilegia brevistyla (blue columbine)	native	0.01	0.50%	0.00%	0.50%	0.14%
Aquilegia flavescens (yellow columbine)	native	0.25	0.50%	0.00%	0.50%	0.43%
Arabis holboellii (reflexed rock cress)	native	0.04	0.50%	0.00%	0.50%	0.14%
Arabis spp. (rock cress)	unknown, not unique	0.07	0.50%	0.00%	0.50%	0.07%
Aralia nudicaulis (wild sarsaparilla)	native	17.85	3.16%	0.00%	20.00%	6.17%
Arctium lappa (great burdock)	introduced	0.03	0.50%	0.00%	0.50%	0.07%
Arctium minus (common burdock)	disturbance, introduced	14.83	0.80%	0.00%	10.00%	14.36%
Arctostaphylos rubra (alpine bearberry)	native	0.07	0.50%	0.00%	0.50%	0.29%
Arctostaphylos uva-ursi (common bearberry)	native	50.22	4.25%	0.00%	30.00%	9.62%

[1,2,3,4] - for note descriptions refer to Appendix J title page

APPENDIX J
Provincial Riparian Plant Species List for Alberta 1997-2006

Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Aristida longiseta (red three-awn)	native	0.03	0.50%	0.00%	0.50%	0.07%
Arnica chamissonis (leafy arnica)	native	1.74	0.50%	0.00%	0.50%	1.94%
Arnica cordifolia (heart-leaved arnica)	native	0.04	0.72%	0.00%	3.00%	0.72%
Arnica fulgens (shining arnica)	native	4.16	6.07%	0.00%	10.00%	0.57%
Arnica latifolia (broad-leaved arnica)	native	0.00	0.50%	0.00%	0.50%	0.07%
Arnica mollis (cordilleran arnica)	native	0.02	0.50%	0.00%	0.50%	0.22%
Artemisia absinthium (absinthe wormwood)	introduced	20.33	1.89%	0.00%	30.00%	7.18%
Artemisia biennis (biennial sagewort)	native	1.72	0.53%	0.00%	3.00%	1.58%
Artemisia campestris (plains wormwood)	native	26.03	0.72%	0.00%	10.00%	18.88%
Artemisia cana (silver sagebrush)	native	60.36	3.82%	0.00%	20.00%	7.61%
Artemisia dracunculus (dragonwort)	native	0.13	0.50%	0.00%	0.50%	0.29%
Artemisia frigida (pasture sagewort)	introduced	45.81	1.02%	0.00%	90.00%	31.66%
Artemisia longifolia (long-leaved sagewort)	native	0.06	0.50%	0.00%	0.50%	0.14%
Artemisia ludoviciana (prairie sagewort)	introduced	35.63	0.75%	0.00%	20.00%	46.59%
Artemisia spp. (artemisia)	unknown, not unique	5.35	2.54%	0.00%	10.00%	1.15%
Asclepias speciosa (showy milkweed)	native, poisonous	11.76	0.57%	0.00%	10.00%	8.54%
Asparagus officinalis (asparagus)	introduced	2.80	0.50%	0.00%	0.50%	1.08%
Aster alpinus (alpine aster)	native	0.01	0.50%	0.00%	0.50%	0.07%
Aster ascendens (western aster)	native	0.00	0.50%	0.00%	0.50%	0.07%
Aster borealis (marsh aster)	native	0.05	0.50%	0.00%	0.50%	0.22%
Aster campestris (meadow aster)	native	0.00	0.50%	0.00%	0.50%	0.07%
Aster ciliolatus (Lindley's aster)	native	1.78	0.72%	0.00%	3.00%	4.09%
Aster conspicuus (showy aster)	native	3.43	0.81%	0.00%	10.00%	4.81%
Aster ericoides (tufted white prairie aster)	native	19.09	0.79%	0.00%	90.00%	20.39%
Aster falcatus (creeping white prairie aster)	native	0.19	0.50%	0.00%	0.50%	0.36%

[1,2,3,4] - for note descriptions refer to Appendix J title page

APPENDIX J
Provincial Riparian Plant Species List for Alberta 1997-2006

Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Aster hesperius (western willow aster)	native	7.08	0.59%	0.00%	10.00%	11.20%
Aster laevis (smooth aster)	native	22.01	0.59%	0.00%	10.00%	36.90%
Aster puniceus (purple-stemmed aster)	native	0.77	0.57%	0.00%	3.00%	1.22%
Aster spp. (aster)	unknown, not unique	6.42	0.53%	0.00%	3.00%	11.41%
Astragalus alpinus (alpine milk vetch)	native	0.65	0.81%	0.00%	3.00%	0.72%
Astragalus americanus (American milk vetch)	native	0.06	0.50%	0.00%	0.50%	0.14%
Astragalus bisulcatus (two-grooved milk vetch)	native, poisonous	0.07	0.50%	0.00%	0.50%	0.14%
Astragalus canadensis (Canadian milk vetch)	native, poisonous	0.42	0.63%	0.00%	3.00%	0.72%
Astragalus cicer (cicer milk vetch)	introduced	0.54	0.50%	0.00%	0.50%	0.07%
Astragalus dasyglottis (purple milk vetch)	native	0.50	0.50%	0.00%	0.50%	0.50%
Astragalus drummondii (Drummond's milk vetch)	native	0.00	0.50%	0.00%	0.50%	0.07%
Astragalus eucosmus (milk vetch)	native	0.05	3.00%	0.00%	3.00%	0.07%
Astragalus spp. (milk vetch)	unknown, not unique, maybe poisonous	1.10	0.50%	0.00%	0.50%	1.51%
Athyrium filix-femina (lady fern)	native	0.00	0.50%	0.00%	0.50%	0.07%
Atriplex nuttallii (Nuttall's atriplex)	native	1.77	0.50%	0.00%	0.50%	1.51%
Avena fatua (wild oat)	disturbance, introduced	12.21	3.16%	0.00%	30.00%	1.79%
Avena sativa (cultivated oat)	disturbance, introduced	0.77	0.70%	0.00%	3.00%	0.72%
Axyris amaranthoides (Russian pigweed)	introduced	0.34	0.73%	0.00%	3.00%	0.36%
Balsamorhiza sagittata (balsamroot)	native	0.06	0.50%	0.00%	0.50%	0.07%
Beckmannia syzigachne (slough grass)	native	36.55	0.95%	0.00%	97.50%	31.59%
Berberis repens (creeping mahonia)	native	0.33	0.50%	0.00%	0.50%	0.22%
Betula glandulosa (bog birch)	native	27.24	4.78%	0.00%	40.00%	5.89%
Betula occidentalis (water birch)	native	195.57	4.92%	0.00%	30.00%	23.04%
Betula papyrifera (white birch)	native	11.00	1.72%	0.00%	40.00%	8.61%
Betula pumila (dwarf birch)	native	0.59	2.28%	0.00%	10.00%	0.43%
Betula spp. (birch)	unknown, not unique	0.10	0.50%	0.00%	0.50%	0.29%

[1,2,3,4] - for note descriptions refer to Appendix J title page

APPENDIX J
Provincial Riparian Plant Species List for Alberta 1997-2006

Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Bidens cernua (nodding beggarticks)	native	2.43	0.79%	0.00%	10.00%	4.59%
Botrychium virginianum (Virginia grape fern)	native	0.01	0.50%	0.00%	0.50%	0.07%
Bouteloua gracilis (blue grama)	native	27.85	2.23%	0.00%	20.00%	5.31%
Brassica campestris (rape)	disturbance, introduced	0.08	0.50%	0.00%	0.50%	0.07%
Brassica kaber (wild mustard)	disturbance, introduced	0.07	0.50%	0.00%	0.50%	0.14%
Brassica napus (rutabaga)	introduced	24.94	66.64%	0.00%	70.00%	0.14%
Brassica spp. (mustard)	unknown, not unique	1.95	0.75%	0.00%	10.00%	3.02%
Bromus anomalus (nodding brome)	native	0.02	3.00%	0.00%	3.00%	0.07%
Bromus biebersteinii (meadow brome)	introduced	5.00	19.41%	0.00%	30.00%	0.22%
Bromus ciliatus (fringed brome)	native	10.05	1.10%	0.00%	20.00%	11.63%
Bromus inermis (smooth brome)	disturbance, introduced	1751.04	19.78%	0.00%	97.50%	78.46%
Bromus inermis ssp pumpellianus (northern awnless brome)	native	14.48	1.92%	0.00%	20.00%	5.96%
Bromus japonicus (Japanese chess)	disturbance, introduced	4.51	1.45%	0.00%	30.00%	1.72%
Bromus spp. (brome grass)	unknown, not unique	0.24	0.50%	0.00%	3.00%	0.72%
Bromus tectorum (downy chess)	invasive, introduced	7.29	0.78%	0.00%	10.00%	5.10%
Calamagrostis canadensis (bluejoint)	native	236.92	4.35%	0.00%	70.00%	49.53%
Calamagrostis inexpansa (northern reed grass)	native	62.52	2.49%	0.00%	40.00%	21.32%
Calamagrostis montanensis (plains reed grass)	native	0.05	0.50%	0.00%	0.50%	0.07%
Calamagrostis rubescens (pine reed grass)	native	1.56	2.19%	0.00%	20.00%	1.15%
Calamagrostis spp. (reed grass)	unknown, not unique	1.15	1.84%	0.00%	20.00%	1.15%
Calamagrostis stricta (narrow reed grass)	native	0.33	2.82%	0.00%	40.00%	0.36%
Calamovilfa longifolia (sand grass)	native	203.85	9.14%	0.00%	40.00%	8.90%
Calla palustris (water arum)	native	0.00	0.50%	0.00%	0.50%	0.07%
Calochortus apiculatus (mariposa lily)	native	0.09	0.50%	0.00%	0.50%	0.14%

[1,2,3,4] - for note descriptions refer to Appendix J title page

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			Constancy[4]
				Range		
		Hectares	Average[3]	Min	Max	
Caltha natans (floating marsh-marigold)	native	0.04	0.50%	0.00%	0.50%	0.07%
Caltha palustris (marsh-marigold)	native	0.55	0.62%	0.00%	3.00%	1.65%
Calypogeja sphagnicola (liverwort)	native	0.01	0.50%	0.00%	0.50%	0.07%
Camassia quamash (blue camas)	native	0.08	0.50%	0.00%	0.50%	0.22%
Campanula rotundifolia (harebell)	native	15.39	0.51%	0.00%	10.00%	23.98%
Capsella bursa-pastoris (shepherd's-purse)	disturbance, introduced	2.61	0.50%	0.00%	3.00%	4.59%
Caragana arborescens (common caragana)	invasive, introduced	5.14	1.53%	0.00%	10.00%	3.59%
Cardaria chalepensis (hoary cress)	introduced	0.41	0.50%	0.00%	0.50%	0.50%
Cardaria draba (heart-podded hoary cress)	introduced	0.00	0.50%	0.00%	0.50%	0.07%
Carduus nutans (nodding thistle)	invasive, introduced	0.57	0.50%	0.00%	0.50%	0.14%
Carex aquatilis (water sedge)	native	180.94	4.58%	0.00%	60.00%	40.49%
Carex atherodes (awned sedge)	native	231.17	9.69%	0.00%	60.00%	23.83%
Carex athrostachya (long-bracted sedge)	native	0.01	0.50%	0.00%	0.50%	0.07%
Carex aurea (golden sedge)	native	1.19	0.63%	0.00%	3.00%	1.36%
Carex bebbii (Bebb's sedge)	native	12.62	2.09%	0.00%	10.00%	2.15%
Carex brevior (slender-beaked sedge)	native	0.02	0.50%	0.00%	0.50%	0.07%
Carex capillaris (hair-like sedge)	native	0.34	2.50%	0.00%	20.00%	0.43%
Carex crawei (Crawe's sedge)	native	0.15	0.50%	0.00%	0.50%	0.22%
Carex deweyana (Dewey's sedge)	native	0.01	0.50%	0.00%	0.50%	0.14%
Carex disperma (two-seeded sedge)	native	0.00	0.50%	0.00%	0.50%	0.07%
Carex filifolia (thread-leaved sedge)	native	0.57	0.93%	0.00%	3.00%	0.50%
Carex interior (inland sedge)	native	0.03	0.50%	0.00%	0.50%	0.22%
Carex lanuginosa (woolly sedge)	native	68.48	1.89%	0.00%	30.00%	33.81%
Carex lasiocarpa (hairy-fruited sedge)	native	0.03	3.00%	0.00%	3.00%	0.07%
Carex microglochin (short-awned sedge)	native	3.34	0.91%	0.00%	10.00%	6.53%

[1,2,3,4] - for note descriptions refer to Appendix J title page

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Carex nigricans (black alpine sedge)	native	0.04	0.50%	0.00%	0.50%	0.07%
Carex norvegica (Norway sedge)	native	0.13	0.50%	0.00%	0.50%	0.43%
Carex paysonis (Payson's sedge)	native	0.18	0.50%	0.00%	0.50%	0.07%
Carex praegracilis (graceful sedge)	native	0.03	0.50%	0.00%	0.50%	0.07%
Carex prairea (prairie sedge)	native	3.46	0.96%	0.00%	10.00%	4.09%
Carex praticola (meadow sedge)	native	0.03	0.50%	0.00%	0.50%	0.07%
Carex rostrata (beaked sedge)	native	35.77	2.86%	0.00%	40.00%	10.55%
Carex sartwellii (Sartwell's sedge)	native	9.21	1.50%	0.00%	20.00%	8.54%
Carex scirpoidea (rush-like sedge)	native	0.29	0.50%	0.00%	0.50%	0.14%
Carex siccata (hay sedge)	native	8.39	4.05%	0.00%	20.00%	1.36%
Carex spp. (sedge)	unknown, not unique	13.95	1.09%	0.00%	30.00%	12.85%
Carex sprengelii (Sprengel's sedge)	native	45.14	10.93%	0.00%	70.00%	2.87%
Carex utriculata (small bottle sedge)	native	289.95	5.61%	0.00%	70.00%	47.67%
Carex vesicaria (blister sedge)	native	0.00	0.50%	0.00%	0.50%	0.07%
Carex viridula (green sedge)	native	0.19	2.21%	0.00%	3.00%	0.29%
Carex xerantica (white-scaled sedge)	native	0.34	0.82%	0.00%	3.00%	0.72%
Carum carvi (caraway)	introduced	0.07	0.50%	0.00%	0.50%	0.22%
Castilleja lutescens (stiff yellow paintbrush)	native	0.20	1.75%	0.00%	3.00%	0.14%
Castilleja miniata (common red paintbrush)	native	2.01	0.50%	0.00%	0.50%	3.73%
Castilleja occidentalis (lance-leaved paintbrush)	native	0.45	0.50%	0.00%	0.50%	0.65%
Castilleja spp. (paintbrush)	unknown, not unique	0.07	0.50%	0.00%	0.50%	0.43%
Catabrosa aquatica (brook grass)	native	2.21	4.52%	0.00%	10.00%	1.79%
Centaurea cyanus (cornflower)	introduced	0.01	0.50%	0.00%	0.50%	0.07%
Centaurea diffusa (diffuse knapweed)	invasive, introduced	2.55	2.27%	0.00%	10.00%	0.36%
Centaurea maculosa (spotted knapweed)	invasive, introduced	7.86	1.51%	0.00%	10.00%	2.08%
Centaurea repens (Russian knapweed)	invasive, introduced	0.78	0.67%	0.00%	10.00%	0.43%
Cerastium arvense (field mouse-ear chickweed)	disturbance, native	4.12	0.74%	0.00%	10.00%	10.55%

[1,2,3,4] - for note descriptions refer to Appendix J title page

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]	Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Cerastium nutans (long-stalked mouse-ear chickweed)	disturbance, native	0.32	0.50%	0.00%	0.50%	0.65%
Cerastium spp. (mouse-ear chickweed)	unknown, not unique	0.30	0.50%	0.00%	0.50%	0.79%
Cerastium vulgatum (common mouse-ear chickweed)	disturbance, introduced	0.13	0.50%	0.00%	0.50%	0.22%
Ceratophyllum demersum (hornwort)	native	0.03	0.50%	0.00%	0.50%	0.22%
Chenopodium album (lamb's-quarters)	disturbance, introduced	23.70	0.77%	0.00%	30.00%	26.27%
Chenopodium capitatum (strawberry blite)	native	0.01	0.50%	0.00%	0.50%	0.07%
Chenopodium desiccatum (goosefoot)	native	0.02	0.50%	0.00%	0.50%	0.07%
Chenopodium gigantospermum (maple-leaved goosefoot)	native	1.47	3.89%	0.00%	10.00%	1.01%
Chenopodium salinum (oak-leaved goosefoot)	native	0.07	0.50%	0.00%	0.50%	0.22%
Chenopodium spp. (goosefoot)	unknown, not unique	0.52	0.50%	0.00%	0.50%	0.86%
Chrysanthemum leucanthemum (ox-eye daisy)	invasive, introduced	10.39	0.68%	0.00%	10.00%	7.11%
Chrysothamnus nauseosus (rabbitbrush)	native	0.01	0.50%	0.00%	0.50%	0.07%
Cichorium intybus (chicory)	introduced	0.02	0.50%	0.00%	0.50%	0.07%
Cicuta maculata (water-hemlock)	native, poisonous	19.71	0.62%	0.00%	20.00%	36.97%
Circaea alpina (small enchanter's nightshade)	native	0.00	0.50%	0.00%	0.50%	0.07%
Cirsium arvense (Canada thistle)	invasive, introduced	269.45	2.72%	0.00%	50.00%	92.96%
Cirsium hookerianum (white thistle)	native	0.48	0.74%	0.00%	3.00%	0.36%
Cirsium undulatum (wavy-leaved thistle)	native	5.55	0.65%	0.00%	10.00%	5.03%
Cirsium vulgare (bull thistle)	introduced	9.04	0.52%	0.00%	3.00%	16.65%
Clematis ligusticifolia (western clematis)	native	23.61	1.22%	0.00%	3.00%	5.74%
Clematis occidentalis (purple clematis)	native	2.77	1.00%	0.00%	20.00%	1.44%
Clematis spp. (clematis)	unknown, not unique	0.59	0.50%	0.00%	0.50%	0.29%
Clematis tangutica (yellow clematis)	introduced	0.23	2.33%	0.00%	3.00%	0.14%
Cleome serrulata (bee plant)	native	1.41	0.50%	0.00%	0.50%	1.79%
Collema limosum (jelly lichen)	native	0.01	0.50%	0.00%	0.50%	0.07%

[1,2,3,4] - for note descriptions refer to Appendix J title page

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Collomia linearis (narrow-leaved collomia)	native	0.79	0.50%	0.00%	0.50%	1.36%
Comandra umbellata (bastard toadflax)	native	0.23	0.50%	0.00%	0.50%	0.72%
Convolvulus arvensis (field bindweed)	invasive, introduced	0.17	0.50%	0.00%	0.50%	1.36%
Convolvulus sepium (wild morning-glory)	disturbance, native	0.51	0.50%	0.00%	0.50%	1.01%
Convolvulus spp. (bindweed)	unknown, not unique	0.72	0.50%	0.00%	0.50%	0.93%
Corallorhiza maculata (spotted coralroot)	native	0.01	0.50%	0.00%	0.50%	0.14%
Corallorhiza striata (striped coralroot)	native	0.00	0.50%	0.00%	0.50%	0.07%
Corallorhiza trifida (pale coralroot)	native	0.00	0.50%	0.00%	0.50%	0.07%
Coreopsis tinctoria (common tickseed)	native	0.02	0.50%	0.00%	0.50%	0.22%
Cornus canadensis (bunchberry)	native	4.20	0.95%	0.00%	20.00%	7.18%
Cornus stolonifera (red-osier dogwood)	native	377.44	5.89%	0.00%	70.00%	53.12%
Corydalis aurea (golden corydalis)	native	0.05	0.50%	0.00%	0.50%	0.36%
Corylus cornuta (beaked hazelnut)	native	2.22	1.04%	0.00%	20.00%	3.02%
Coryphantha vivipara (cushion cactus)	native	0.02	0.50%	0.00%	0.50%	0.07%
Crataegus douglasii (Douglas hawthorn)	native	0.66	2.37%	0.00%	10.00%	0.43%
Crataegus rotundifolia (round-leaved hawthorn)	native	16.56	1.78%	0.00%	50.00%	8.04%
Crepis runcinata (scapose hawk's-beard)	native	0.15	0.50%	0.00%	0.50%	0.14%
Crepis spp. (crepis)	unknown, not unique	0.01	0.50%	0.00%	0.50%	0.07%
Crepis tectorum (annual hawk's-beard)	disturbance, introduced	2.21	0.50%	0.00%	0.50%	3.09%
Cynoglossum officinale (hound's-tongue)	invasive, introduced, poisonous	22.36	1.07%	0.00%	20.00%	16.51%
Cypripedium passerinum (sparrow's-egg lady's-slipper)	native	0.15	0.50%	0.00%	0.50%	0.14%
Cypripedium spp. (lady's slipper)	unknown, not unique	0.02	0.50%	0.00%	0.50%	0.07%
Cystopteris fragilis (fragile bladder fern)	native	0.03	0.50%	0.00%	0.50%	0.43%
Dactylis glomerata (orchard grass)	introduced	10.93	1.17%	0.00%	30.00%	6.68%

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Danthonia californica (California oat grass)	native	7.65	2.81%	0.00%	20.00%	1.01%
Danthonia parryi (Parry oat grass)	native	0.69	0.90%	0.00%	3.00%	1.58%
Danthonia spicata (poverty oat grass)	native	0.06	3.00%	0.00%	3.00%	0.07%
Danthonia spp. (oat grass)	unknown, not unique	0.88	3.44%	0.00%	10.00%	0.65%
Danthonia unispicata (one-spike oat grass)	native	0.07	0.50%	0.00%	0.50%	0.14%
Delphinium bicolor (low larkspur)	native, poisonous	0.54	0.50%	0.00%	0.50%	2.15%
Delphinium glaucum (tall larkspur)	native, poisonous	2.04	0.51%	0.00%	3.00%	6.10%
Deschampsia cespitosa (tufted hair grass)	native	140.93	3.18%	0.00%	60.00%	44.87%
Descurainia sophia (flixweed)	disturbance, introduced	23.76	0.72%	0.00%	20.00%	29.07%
Descurainia spp . (mustard)	unknown, not unique	0.01	0.50%	0.00%	0.50%	0.07%
Disporum trachycarpum (fairybells)	native	0.89	0.50%	0.00%	0.50%	2.80%
Distichlis stricta (salt grass)	native	47.99	4.16%	0.00%	60.00%	7.97%
Dodecatheon conjugens (mountain shooting star)	native	0.00	0.50%	0.00%	0.50%	0.07%
Dodecatheon pulchellum (saline shooting star)	native	1.39	0.50%	0.00%	0.50%	2.87%
Draba aurea (golden whitlow-grass)	native	0.00	0.50%	0.00%	0.50%	0.14%
Draba incerta (whitlow-grass)	native	0.03	0.50%	0.00%	0.50%	0.07%
Dracocephalum parviflorum (American dragonhead)	native	0.18	0.50%	0.00%	0.50%	0.22%
Dryas drummondii (yellow mountain avens)	native	16.90	5.10%	0.00%	20.00%	1.36%
Dryas octopetala (white mountain avens)	native	0.43	1.94%	0.00%	3.00%	0.22%
Echinochloa crusgalli (barnyard grass)	introduced	0.05	0.50%	0.00%	0.50%	0.14%
Echium vulgare (viper's-bugloss)	invasive, introduced	8.70	1.17%	0.00%	3.00%	2.94%
Elaeagnus angustifolia (Russian olive)	invasive, introduced	0.58	0.50%	0.00%	0.50%	0.72%
Elaeagnus commutata (silverberry)	native	607.20	8.93%	0.00%	90.00%	56.35%
Eleocharis acicularis (needle spike-rush)	native	0.01	0.50%	0.00%	0.50%	0.14%
Eleocharis compressa (flattened spike-rush)	native	0.02	0.50%	0.00%	0.50%	0.07%

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Eleocharis palustris (creeping spike-rush)	native	51.89	1.09%	0.00%	20.00%	39.77%
Eleocharis spp. (spike-rush)	unknown, not unique	0.15	0.50%	0.00%	0.50%	0.22%
Elymus canadensis (Canada wild rye)	native	61.13	2.02%	0.00%	20.00%	11.99%
Elymus glaucus (smooth wild rye)	native	0.07	0.50%	0.00%	0.50%	0.22%
Elymus innovatus (hairy wild rye)	native	16.97	1.97%	0.00%	30.00%	6.68%
Elymus junceus (Russian wild rye)	introduced	2.51	0.89%	0.00%	3.00%	0.79%
Elymus piperi (giant wild rye)	native	13.40	1.77%	0.00%	20.00%	2.87%
Elymus spp. (wild rye)	unknown, not unique	5.50	1.30%	0.00%	20.00%	3.16%
Epilobium angustifolium (common fireweed)	native	12.34	0.89%	0.00%	20.00%	22.25%
Epilobium ciliatum (northern willowherb)	native	13.69	1.10%	0.00%	10.00%	15.36%
Epilobium glaberrimum (willowherb)	native	0.48	1.20%	0.00%	10.00%	0.86%
Epilobium lactiflorum (willowherb)	native	0.04	0.50%	0.00%	0.50%	0.07%
Epilobium latifolium (broad-leaved fireweed)	native	5.96	1.01%	0.00%	20.00%	4.67%
Epilobium spp. (willow-herb)	unknown, not unique	0.10	0.50%	0.00%	0.50%	0.36%
Equisetum arvense (common horsetail)	native, poisonous	107.15	1.42%	0.00%	97.50%	69.85%
Equisetum fluviatile (swamp horsetail)	native	0.03	0.50%	0.00%	0.50%	0.14%
Equisetum hyemale (common scouring-rush)	native	26.43	0.73%	0.00%	97.50%	26.49%
Equisetum laevigatum (smooth scouring-rush)	native	0.03	0.50%	0.00%	0.50%	0.14%
Equisetum pratense (meadow horsetail)	native	0.15	0.50%	0.00%	0.50%	0.36%
Equisetum spp. (horsetail)	unknown, not unique	1.65	0.53%	0.00%	3.00%	2.08%
Erigeron acris (northern daisy fleabane)	native	0.00	0.50%	0.00%	0.50%	0.07%
Erigeron aureus (golden fleabane)	native	0.03	0.50%	0.00%	0.50%	0.07%
Erigeron caespitosus (tufted fleabane)	native	0.01	0.50%	0.00%	0.50%	0.07%
Erigeron canadensis (horseweed)	native	2.67	0.50%	0.00%	3.00%	1.87%
Erigeron elatus (tall fleabane)	native	0.00	0.50%	0.00%	0.50%	0.07%
Erigeron flagellaris (creeping fleabane)	native	0.17	0.50%	0.00%	0.50%	0.22%

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Erigeron glabellus (smooth fleabane)	native	2.16	0.52%	0.00%	3.00%	4.09%
Erigeron hyssopifolius (wild daisy fleabane)	native	0.02	0.50%	0.00%	0.50%	0.07%
Erigeron lanatus (woolly fleabane)	native	0.00	0.50%	0.00%	0.50%	0.07%
Erigeron philadelphicus (Philadelphia fleabane)	native	7.27	0.50%	0.00%	0.50%	12.71%
Erigeron speciosus (showy fleabane)	native	0.12	0.50%	0.00%	0.50%	0.14%
Erigeron spp. (erigeron)	unknown, not unique	2.85	0.50%	0.00%	10.00%	3.73%
Eriogonum flavum (yellow umbrella-plant)	native	0.00	0.50%	0.00%	0.50%	0.07%
Eriophorum gracile (slender cotton grass)	native	0.08	0.50%	0.00%	0.50%	0.22%
Eriophorum polystachion (tall cotton grass)	native	0.06	0.50%	0.00%	0.50%	0.22%
Eriophorum spp. (cotton grass)	unknown, not unique	0.00	0.50%	0.00%	0.50%	0.07%
Eriophorum vaginatum (sheathed cotton grass)	native	0.02	0.50%	0.00%	0.50%	0.14%
Erodium cicutarium (stork's-bill)	invasive, introduced	0.09	0.50%	0.00%	0.50%	0.14%
Erucastrum gallicum (dog mustard)	disturbance, introduced	5.99	0.55%	0.00%	3.00%	6.60%
Erysimum asperum (prairie rocket)	native	0.13	0.50%	0.00%	0.50%	0.22%
Erysimum cheiranthoides (wormseed mustard)	disturbance, introduced	2.38	0.68%	0.00%	3.00%	2.44%
Erysimum spp. (rocket)	unknown, not unique	0.10	0.50%	0.00%	0.50%	0.29%
Euphorbia esula (leafy spurge)	invasive, introduced, poisonous	78.54	6.56%	0.00%	60.00%	4.24%
Euphorbia spp. (Spurge)	unknown, not unique, maybe poisonous	0.01	0.50%	0.00%	0.50%	0.14%
Eurotia lanata (winter-fat)	native	0.04	0.50%	0.00%	0.50%	0.07%
Fagopyrum tartaricum (tartary buckwheat)	disturbance, introduced	0.01	0.50%	0.00%	0.50%	0.07%
Ferns spp. (fern)	unknown, not unique	0.04	0.50%	0.00%	0.50%	0.36%
Festuca campestris (foothills rough fescue)	native	6.38	3.71%	0.00%	40.00%	3.16%
Festuca hallii (plains rough fescue)	native	0.02	0.50%	0.00%	0.50%	0.07%
Festuca idahoensis (bluebunch fescue)	native	0.92	2.55%	0.00%	10.00%	0.43%
Festuca ovina (sheep fescue)	introduced	0.01	0.50%	0.00%	0.50%	0.14%

[1,2,3,4] - for note descriptions refer to Appendix J title page

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Festuca pratensis (meadow fescue)	introduced	0.02	0.50%	0.00%	0.50%	0.07%
Festuca rubra (red fescue)	native	15.40	18.17%	0.00%	30.00%	0.43%
Festuca saximontana (Rocky Mountain fescue)	native	13.05	3.79%	0.00%	20.00%	1.65%
Festuca scabrella (rough fescue)	native	0.66	1.34%	0.00%	10.00%	0.22%
Festuca spp. (fescue)	unknown, not unique	20.63	5.41%	0.00%	30.00%	4.81%
Forb (Forb)	unknown, not unique	9.93	0.90%	0.00%	20.00%	9.05%
Fragaria vesca (woodland strawberry)	disturbance, native	0.10	0.50%	0.00%	0.50%	0.36%
Fragaria virginiana (wild strawberry)	disturbance, native	32.57	0.75%	0.00%	30.00%	46.23%
Fraxinus pennsylvanica (green ash)	introduced	0.02	0.50%	0.00%	0.50%	0.14%
Fraxinus spp. (ash)	introduced, not unique	0.12	0.50%	0.00%	0.50%	0.57%
Fritillaria pudica (yellowbell)	native	0.04	0.50%	0.00%	0.50%	0.07%
Gaillardia aristata (gaillardia)	native	9.30	0.50%	0.00%	0.50%	12.71%
Galeopsis tetrahit (hemp-nettle)	disturbance, introduced	4.79	0.68%	0.00%	10.00%	8.69%
Galium aparine (cleavers)	invasive, introduced	0.23	0.50%	0.00%	0.50%	0.72%
Galium boreale (northern bedstraw)	native	28.20	0.55%	0.00%	3.00%	52.76%
Galium triflorum (sweet-scented bedstraw)	native	1.24	0.50%	0.00%	0.50%	3.73%
Galium verum (yellow bedstraw)	introduced	0.06	0.50%	0.00%	0.50%	0.07%
Gaultheria hispidula (creeping snowberry)	native	0.00	0.50%	0.00%	0.50%	0.07%
Gaura coccinea (scarlet butterflyweed)	native	0.02	0.50%	0.00%	0.50%	0.07%
Gentiana affinis (prairie gentian)	native	0.59	0.50%	0.00%	0.50%	1.08%
Gentiana calycosa (mountain gentian)	native	0.46	0.50%	0.00%	0.50%	0.36%
Gentianella amarella (felwort)	native	1.37	0.50%	0.00%	0.50%	2.15%
Gentianella crinita (fringed gentian)	native	0.00	0.50%	0.00%	0.50%	0.07%
Geocaulon lividum (northern bastard toadflax)	native	0.41	1.09%	0.00%	3.00%	0.29%
Geranium pratense (meadow crane's-bill)	introduced	0.02	0.50%	0.00%	0.50%	0.14%
Geranium richardsonii (wild white geranium)	native	1.78	0.76%	0.00%	10.00%	5.60%
Geranium spp. (geranium)	unknown, not unique	0.02	0.50%	0.00%	0.50%	0.29%

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Geranium viscosissimum (sticky purple geranium)	native	5.70	0.68%	0.00%	3.00%	13.71%
Geum aleppicum (yellow avens)	native	12.55	0.55%	0.00%	10.00%	25.99%
Geum macrophyllum (large-leaved yellow avens)	native	2.50	0.68%	0.00%	10.00%	4.52%
Geum rivale (purple avens)	native	1.79	0.89%	0.00%	20.00%	4.38%
Geum spp. (avens)	unknown, not unique	0.47	0.50%	0.00%	0.50%	1.29%
Geum triflorum (three-flowered avens)	native	10.73	1.38%	0.00%	97.50%	9.26%
Glaux maritima (sea milkwort)	native	2.87	1.53%	0.00%	10.00%	3.45%
Glyceria borealis (northern manna grass)	native	0.00	0.50%	0.00%	0.50%	0.07%
Glyceria grandis (common tall manna grass)	native	146.89	3.20%	0.00%	40.00%	44.94%
Glyceria pulchella (graceful manna grass)	native	0.06	0.72%	0.00%	3.00%	0.50%
Glyceria spp. (manna grass)	unknown, not unique	0.01	0.50%	0.00%	0.50%	0.07%
Glyceria striata (fowl manna grass)	native	11.84	0.91%	0.00%	20.00%	16.01%
Glycyrrhiza lepidota (wild licorice)	native	224.39	4.19%	0.00%	60.00%	40.49%
Graminoid (Graminoid)	unknown, not unique	13.31	3.58%	0.00%	30.00%	2.66%
Grindelia squarrosa (gumweed)	native	18.03	0.64%	0.00%	10.00%	20.24%
Gutierrezia sarothrae (broomweed)	native, poisonous	3.82	0.71%	0.00%	3.00%	2.30%
Gymnocarpium dryopteris (oak fern)	native	0.23	2.13%	0.00%	3.00%	0.36%
Gypsophila paniculata (common baby's-breath)	introduced	0.01	0.50%	0.00%	0.50%	0.07%
Habenaria dilatata (tall white bog orchid)	native	0.04	0.50%	0.00%	0.50%	0.22%
Habenaria hyperborea (northern green bog orchid)	native	1.56	0.50%	0.00%	0.50%	2.80%
Habenaria spp. (bog orchid)	unknown, not unique	0.01	0.50%	0.00%	0.50%	0.14%
Habenaria viridis (bracted bog orchid)	native	0.21	0.50%	0.00%	0.50%	1.08%
Hackelia americana (nodding stickseed)	native	0.06	0.50%	0.00%	0.50%	0.22%
Hackelia floribunda (large-flowered stickseed)	native	0.01	0.50%	0.00%	0.50%	0.14%
Halogeton glomeratus (Halogeton)	introduced, poisonous	0.13	0.67%	0.00%	3.00%	0.36%
Hedysarum alpinum (alpine hedysarum)	native	6.50	0.84%	0.00%	10.00%	7.68%

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Hedysarum boreale (northern hedysarum)	native	0.33	0.50%	0.00%	3.00%	0.57%
Hedysarum spp. (hedysarum)	unknown, not unique	0.21	0.50%	0.00%	0.50%	0.93%
Hedysarum sulphurescens (yellow hedysarum)	native	0.05	0.50%	0.00%	0.50%	0.14%
Helenium autumnale (sneezeweed)	native, poisonous	5.91	0.79%	0.00%	10.00%	4.16%
Helianthus annuus (common annual sunflower)	native	2.94	0.64%	0.00%	3.00%	1.58%
Helianthus couplandii (Coupland's annual sunflower)	native	0.96	0.60%	0.00%	3.00%	0.72%
Helianthus maximilianii (narrow-leaved sunflower)	introduced	0.03	0.50%	0.00%	0.50%	0.22%
Helianthus nuttallii (common tall sunflower)	native	7.85	0.61%	0.00%	10.00%	10.77%
Helianthus spp. (Sunflower)	unknown, not unique	0.78	0.50%	0.00%	0.50%	0.57%
Helianthus subrhomboideus (rhombic-leaved sunflower)	native	1.52	0.52%	0.00%	10.00%	2.08%
Helictotrichon hookeri (Hooker's oat grass)	native	0.14	0.50%	0.00%	0.50%	0.14%
Heracleum lanatum (cow parsnip)	native	11.54	0.82%	0.00%	30.00%	21.75%
Hesperis matronalis (dame's rocket)	introduced	0.05	0.50%	0.00%	0.50%	0.14%
Heterotheca villosa (golden aster)	native	10.88	0.50%	0.00%	3.00%	9.69%
Heuchera richardsonii (Richardson's alumroot)	native	0.01	0.50%	0.00%	0.50%	0.14%
Hieracium spp. (hawkweed)	unknown, not unique	0.05	0.50%	0.00%	0.50%	0.14%
Hieracium triste (slender hawkweed)	native	0.04	0.50%	0.00%	0.50%	0.14%
Hieracium umbellatum (narrow-leaved hawkweed)	native	4.79	0.54%	0.00%	3.00%	8.40%
Hierochloe odorata (sweet grass)	native	3.95	0.64%	0.00%	3.00%	5.24%
Hippuris vulgaris (common mare's-tail)	native	3.44	0.50%	0.00%	0.50%	5.67%
Hordeum jubatum (foxtail barley)	disturbance, introduced	231.71	3.02%	0.00%	50.00%	62.96%
Hordeum spp. (barley)	unknown, not unique	0.09	0.50%	0.00%	0.50%	0.07%
Hordeum spp. (barley)	unknown, not unique	96.46	61.21%	0.00%	90.00%	0.86%
Hordeum vulgare (cultivated barley)	disturbance, introduced	0.68	0.66%	0.00%	30.00%	0.50%
Hylocomium splendens (stair-step moss)	native	0.01	0.50%	0.00%	0.50%	0.07%

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Hyoscyamus niger (black henbane)	introduced, poisonous	1.47	0.54%	0.00%	3.00%	1.65%
Impatiens capensis (spotted touch-me-not)	native	0.37	0.92%	0.00%	10.00%	0.93%
Impatiens noli-tangere (western jewelweed)	native	0.04	0.50%	0.00%	0.50%	0.22%
Iva axillaris (povertyweed)	native	0.11	1.71%	0.00%	3.00%	0.14%
Iva xanthifolia (false ragweed)	native	0.61	0.88%	0.00%	10.00%	0.86%
Juncus alpinoarticulatus (alpine rush)	native	1.18	0.51%	0.00%	3.00%	2.94%
Juncus balticus (wire rush)	native	157.25	2.60%	0.00%	70.00%	64.11%
Juncus bufonius (toad rush)	native	0.13	0.53%	0.00%	10.00%	0.50%
Juncus ensifolius (equitant-leaved rush)	native	0.12	0.50%	0.00%	0.50%	0.29%
Juncus longistylis (long-styled rush)	native	0.01	0.50%	0.00%	0.50%	0.07%
Juncus nevadensis (Nevada rush)	native	0.39	0.50%	0.00%	0.50%	0.14%
Juncus nodosus (knotted rush)	native	9.08	0.53%	0.00%	3.00%	11.20%
Juncus spp. (rush)	unknown, not unique	7.68	0.51%	0.00%	3.00%	8.18%
Juncus tenuis (slender rush)	native	1.18	1.02%	0.00%	10.00%	0.79%
Juncus tracyi (mud rush)	native	0.11	0.50%	0.00%	0.50%	0.07%
Juniperus communis (ground juniper)	native	9.72	0.76%	0.00%	10.00%	9.33%
Juniperus horizontalis (creeping juniper)	native	13.57	1.12%	0.00%	20.00%	9.05%
Juniperus scopulorum (Rocky Mountain juniper)	native	0.20	0.50%	0.00%	0.50%	0.07%
Kochia scoparia (summer-cypress)	native, poisonous	6.33	1.30%	0.00%	30.00%	3.95%
Koeleria macrantha (June grass)	native	30.33	1.04%	0.00%	20.00%	15.00%
Lactarius tatarica ()	native	0.08	0.50%	0.00%	0.50%	0.36%
Lactuca biennis (tall blue lettuce)	native	0.02	0.50%	0.00%	0.50%	0.07%
Lactuca pulchella (common blue lettuce)	native	1.24	0.59%	0.00%	3.00%	1.65%
Lactuca serriola (prickly lettuce)	introduced	1.18	0.50%	0.00%	0.50%	1.79%
Lappula occidentalis (western bluebur)	introduced	5.95	0.53%	0.00%	3.00%	10.70%
Lappula species (stickseed)	introduced, not unique	0.17	0.50%	0.00%	0.50%	1.22%
Lappula squarrosa (bluebur)	disturbance, introduced	10.11	0.63%	0.00%	3.00%	10.12%
Larix laricina (tamarack)	native	5.46	5.50%	0.00%	40.00%	1.01%

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			Constancy[4]
				Range		
		Hectares	Average[3]	Min	Max	
Larix occidentalis (western larch)	native	0.01	0.50%	0.00%	0.50%	0.07%
Larix spp. (larch)	unknown, not unique	0.01	0.50%	0.00%	0.50%	0.07%
Lathyrus ochroleucus (cream-colored vetchling)	native	3.37	0.50%	0.00%	0.50%	11.49%
Lathyrus spp. (Peavine)	unknown, not unique	0.01	0.50%	0.00%	0.50%	0.07%
Lathyrus venosus (purple peavine)	native	0.07	0.50%	0.00%	0.50%	0.65%
Ledum glandulosum (glandular Labrador tea)	native	0.03	0.50%	0.00%	0.50%	0.07%
Ledum groenlandicum (common Labrador tea)	native	0.41	2.56%	0.00%	3.00%	0.36%
Lemna minor (common duckweed)	native	0.43	0.50%	0.00%	0.50%	1.36%
Lepidium densiflorum (common pepper-grass)	introduced	9.36	0.56%	0.00%	10.00%	9.12%
Lesquerella arenosa (sand bladderpod)	native	0.04	0.50%	0.00%	0.50%	0.14%
Liatris punctata (dotted blazingstar)	native	4.49	0.50%	0.00%	0.50%	2.66%
Lilium philadelphicum (western wood lily)	native	0.29	0.50%	0.00%	0.50%	0.43%
Lilium spp. (lily)	unknown, not unique	0.01	0.50%	0.00%	0.50%	0.07%
Linaria dalmatica (broad-leaved toad-flax)	invasive, introduced	3.57	0.50%	0.00%	0.50%	2.37%
Linaria vulgaris (butter-and-eggs)	invasive, introduced	11.11	0.77%	0.00%	10.00%	7.32%
Linnaea borealis (twinflower)	native	0.25	0.56%	0.00%	3.00%	1.94%
Linum lewisii (wild blue flax)	native	12.43	0.50%	0.00%	0.50%	10.62%
Linum rigidum (yellow flax)	native	0.01	0.50%	0.00%	0.50%	0.07%
Lithospermum ruderale (woolly gromwell)	native	2.71	0.50%	0.00%	0.50%	5.74%
Lolium perenne (perennial ryegrass)	introduced	0.01	0.50%	0.00%	0.50%	0.07%
Lomatium dissectum (mountain wild parsnip)	native	0.09	0.50%	0.00%	0.50%	0.29%
Lomatium macrocarpum (long-fruited wild parsley)	native	0.10	0.50%	0.00%	0.50%	0.93%
Lomatium triternatum (western wild parsley)	native	0.08	0.50%	0.00%	0.50%	0.29%
Lonicera dioica (twining honeysuckle)	native	3.47	0.52%	0.00%	20.00%	5.24%
Lonicera involucrata (bracted honeysuckle)	native	4.54	0.87%	0.00%	30.00%	7.90%
Lonicera spp. (honeysuckle)	unknown, not unique	0.64	0.50%	0.00%	0.50%	0.43%

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			Constancy[4]
				Range		
		Hectares	Average[3]	Min	Max	
Lonicera tatarica (tatarian honeysuckle)	introduced	0.07	3.00%	0.00%	3.00%	0.07%
Lonicera utahensis (red twinberry)	native	0.13	0.61%	0.00%	3.00%	0.43%
Lotus corniculatus (bird's-foot trefoil)	introduced	0.01	0.50%	0.00%	0.50%	0.07%
Lupinus argenteus (silvery perennial lupine)	native, poisonous	5.26	0.67%	0.00%	3.00%	5.53%
Lupinus sericeus (silky perennial lupine)	native	9.04	0.95%	0.00%	3.00%	5.38%
Lupinus spp. (lupine)	unknown, not unique	0.56	0.61%	0.00%	3.00%	0.50%
Luzula parviflora (small-flowered wood-rush)	native	0.00	0.50%	0.00%	0.50%	0.14%
Luzula spp. (wood-rush)	unknown, not unique	0.01	0.50%	0.00%	0.50%	0.07%
Lycopus americanus (American water-horehound)	native	0.08	0.50%	0.00%	0.50%	0.50%
Lycopus asper (western water-horehound)	native	1.74	0.60%	0.00%	3.00%	1.51%
Lycopus uniflorus (northern water-horehound)	native	0.73	0.63%	0.00%	3.00%	1.72%
Lygodesmia juncea (skeletonweed)	native	0.83	0.50%	0.00%	0.50%	0.65%
Lysimachia ciliata (fringed loosestrife)	native	9.39	0.54%	0.00%	3.00%	11.20%
Lythrum salicaria (purple loosestrife)	invasive, introduced	0.02	0.50%	0.00%	0.50%	0.07%
Machaeranthera canescens (hoary aster)	native	0.30	0.50%	0.00%	0.50%	0.36%
Madia glomerata (tarweed)	native	0.02	0.50%	0.00%	0.50%	0.07%
Maianthemum canadense (wild lily-of-the-valley)	native	0.38	0.50%	0.00%	0.50%	1.65%
Malaxis monophylla (white adder's-mouth)	native	0.05	0.50%	0.00%	0.50%	0.14%
Malva parviflora (small-flowered mallow)	introduced	0.08	0.50%	0.00%	0.50%	0.07%
Malva rotundifolia (round-leaved mallow)	disturbance, introduced	0.04	0.50%	0.00%	0.50%	0.22%
Marasmius oreades (fairy ring mushroom)	native	0.04	0.50%	0.00%	0.50%	0.07%
Matricaria matricarioides (pineappleweed)	introduced	1.17	0.50%	0.00%	0.50%	2.44%
Matricaria perforata (scentless chamomile)	invasive, introduced	4.89	0.56%	0.00%	3.00%	5.74%
Medicago lupulina (black medick)	introduced	18.31	0.60%	0.00%	10.00%	19.53%
Medicago sativa (alfalfa)	introduced	26.06	1.00%	0.00%	50.00%	24.69%

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		Hectares	Average[3]	Min	Max	Constancy[4]
Medicago spp. (medick)	introduced, not unique	0.03	0.50%	0.00%	0.50%	0.07%
Melilotus alba (white sweet-clover)	disturbance, introduced	99.66	2.09%	0.00%	40.00%	30.87%
Melilotus officinalis (yellow sweet-clover)	disturbance, introduced	35.99	0.93%	0.00%	20.00%	28.86%
Melilotus spp. (sweet clover)	disturbance, introduced, not unique	0.71	0.50%	0.00%	0.50%	0.57%
Mentha arvensis (wild mint)	native	44.42	0.67%	0.00%	10.00%	63.10%
Mentha spp. (mint)	unknown, not unique	0.38	0.59%	0.00%	3.00%	1.08%
Mentzelia decapetala (sand-lily)	native	0.08	0.50%	0.00%	0.50%	0.29%
Menyanthes trifoliata (buck-bean)	native	0.00	0.50%	0.00%	0.50%	0.07%
Menziesia ferruginea (false azalea)	native	0.02	0.54%	0.00%	3.00%	0.43%
Mertensia lanceolata (lance-leaved lungwort)	native	0.00	0.50%	0.00%	0.50%	0.07%
Mertensia paniculata (tall lungwort)	native	1.11	0.73%	0.00%	3.00%	2.87%
Mimulus guttatus (yellow monkeyflower)	native	0.05	0.50%	0.00%	0.50%	0.36%
Mimulus lewisii (red monkeyflower)	native	0.00	0.50%	0.00%	0.50%	0.07%
Mitella nuda (bishop's-cap)	native	0.49	0.50%	0.00%	0.50%	1.87%
Moehringia lateriflora (blunt-leaved sandwort)	native	0.57	0.50%	0.00%	0.50%	2.08%
Monarda fistulosa (wild bergamot)	native	34.81	1.31%	0.00%	97.50%	15.79%
Moneses uniflora (one-flowered wintergreen)	native	0.03	0.50%	0.00%	0.50%	0.22%
Monolepis nuttalliana (spear-leaved goosefoot)	native	0.06	0.50%	0.00%	0.50%	0.29%
Moss spp. (moss)	unknown, not unique	0.00	40.00%	0.00%	40.00%	0.07%
Muhlenbergia asperifolia (scratch grass)	native	0.05	0.50%	0.00%	0.50%	0.07%
Muhlenbergia glomerata (bog muhly)	native	0.04	3.00%	0.00%	3.00%	0.07%
Muhlenbergia richardsonis (mat muhly)	native	0.20	0.50%	0.00%	0.50%	0.43%
Muhlenbergia spp. (muhly)	unknown, not unique	0.07	0.31%	0.00%	0.50%	0.22%
Musineon divaricatum (leafy musineon)	native	0.10	0.50%	0.00%	0.50%	0.36%
Myosotis alpestris (alpine forget-me-not)	native	0.07	0.50%	0.00%	0.50%	0.29%
Myosotis arvensis (field forget-me-not)	introduced	0.06	0.50%	0.00%	0.50%	0.22%

[1,2,3,4] - for note descriptions refer to Appendix J title page

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Myosotis spp. (forget-me-not)	unknown, not unique	0.01	0.50%	0.00%	0.50%	0.14%
Nasturtium officinale (water cress)	introduced	0.03	0.50%	0.00%	0.50%	0.07%
Neslia paniculata (ball mustard)	disturbance, introduced	0.43	0.50%	0.00%	0.50%	0.57%
Nuphar variegatum (yellow pond-lily)	native	0.00	0.50%	0.00%	0.50%	0.07%
Oenothera biennis (yellow evening-primrose)	native	12.94	0.50%	0.00%	0.50%	13.50%
Oenothera caespitosa (butte-primrose)	native	0.09	0.50%	0.00%	0.50%	0.29%
Oenothera nuttallii (white evening-primrose)	native	0.32	0.50%	0.00%	0.50%	0.36%
Oenothera spp. (evening primrose)	unknown, not unique	0.01	0.50%	0.00%	0.50%	0.07%
Onosmodium molle (western false gromwell)	native	0.74	0.68%	0.00%	3.00%	1.15%
Opuntia fragilis (brittle prickly-pear)	native	0.56	0.50%	0.00%	0.50%	0.29%
Opuntia polyacantha (prickly-pear)	native	4.95	0.62%	0.00%	10.00%	2.44%
Orchis rotundifolia (round-leaved orchid)	native	0.03	0.50%	0.00%	0.50%	0.07%
Orthilia secunda (one-sided wintergreen)	native	0.00	0.50%	0.00%	0.50%	0.07%
Orthocarpus luteus (owl-clover)	native	1.23	0.50%	0.00%	0.50%	0.79%
Oryzopsis asperifolia (white-grained mountain rice grass)	native	1.09	1.36%	0.00%	20.00%	1.44%
Oryzopsis hymenoides (Indian rice grass)	native	11.83	0.76%	0.00%	3.00%	4.88%
Oryzopsis pungens (northern rice grass)	native	0.00	0.50%	0.00%	0.50%	0.07%
Osmorhiza depauperata (spreading sweet cicely)	native	1.51	0.64%	0.00%	3.00%	4.95%
Osmorhiza occidentalis (western sweet cicely)	native	0.04	0.50%	0.00%	0.50%	0.07%
Osmorhiza purpurea (purple sweet cicely)	native	0.00	0.50%	0.00%	0.50%	0.07%
Oxytropis cusickii (alpine locoweed)	native, poisonous	0.33	0.50%	0.00%	0.50%	0.72%
Oxytropis deflexa (reflexed locoweed)	native, poisonous	0.03	0.50%	0.00%	0.50%	0.29%
Oxytropis monticola (late yellow locoweed)	native, poisonous	1.02	0.64%	0.00%	3.00%	1.22%

[1,2,3,4] - for note descriptions refer to Appendix J title page

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			Constancy[4]
				Range		
		Hectares	Average[3]	Min	Max	
Oxytropis sericea (early yellow locoweed)	native, poisonous	6.27	1.69%	0.00%	10.00%	3.16%
Oxytropis splendens (showy locoweed)	native, poisonous	5.02	0.52%	0.00%	3.00%	7.47%
Oxytropis spp. (locoweed)	unknown, not unique, poisonous	1.01	0.50%	0.00%	0.50%	1.44%
Panicum capillare (witch grass)	introduced	0.09	0.50%	0.00%	0.50%	0.22%
Parnassia fimbriata (fringed grass-of-parnassus)	native	0.03	0.50%	0.00%	0.50%	0.22%
Parnassia palustris (northern grass-of-parnassus)	native	1.86	0.50%	0.00%	0.50%	3.80%
Parnassia parviflora (small northern grass-of-parnassus)	native	0.02	0.50%	0.00%	0.50%	0.07%
Pastinaca sativa (parsnip)	introduced	0.11	1.17%	0.00%	3.00%	0.14%
Pedicularis bracteosa (western lousewort)	native	0.04	0.50%	0.00%	0.50%	0.29%
Pedicularis groenlandica (elephant's-head)	native	1.01	0.50%	0.00%	0.50%	2.73%
Pedicularis spp. (lousewort)	unknown, not unique	0.01	0.50%	0.00%	0.50%	0.14%
Penstemon albertinus (blue beardtongue)	native	0.10	0.50%	0.00%	0.50%	0.36%
Penstemon confertus (yellow beardtongue)	native	0.28	0.50%	0.00%	0.50%	0.93%
Penstemon gracilis (lilac-flowered beardtongue)	native	0.04	0.50%	0.00%	0.50%	0.22%
Penstemon nitidus (smooth blue beardtongue)	native	0.21	0.50%	0.00%	0.50%	0.50%
Penstemon procerus (slender blue beardtongue)	native	0.55	0.50%	0.00%	0.50%	2.01%
Penstemon spp. (beardtongue)	unknown, not unique	0.27	0.50%	0.00%	0.50%	0.43%
Perideridia gairdneri (squawroot)	native	0.11	0.50%	0.00%	0.50%	0.72%
Petalostemon candidum (white prairie-clover)	native	0.38	0.50%	0.00%	0.50%	0.07%
Petalostemon purpureum (purple prairie-clover)	native	0.76	0.50%	0.00%	0.50%	0.65%
Petasites palmatus (palmate-leaved coltsfoot)	native	3.48	0.54%	0.00%	3.00%	6.03%
Petasites sagittatus (arrow-leaved coltsfoot)	native	4.12	0.66%	0.00%	3.00%	6.82%
Phacelia hastata (silver-leaved scorpionweed)	native	0.01	0.50%	0.00%	0.50%	0.07%
Phacelia sericea (silky scorpionweed)	native	0.01	0.50%	0.00%	0.50%	0.07%

[1,2,3,4] - for note descriptions refer to Appendix J title page

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			Constancy[4]
				Range		
		Hectares	Average[3]	Min	Max	
Phalaris arundinacea (reed canary grass)	native	240.93	4.56%	0.00%	90.00%	46.88%
Phleum commutatum (mountain timothy)	native	0.02	0.50%	0.00%	0.50%	0.22%
Phleum pratense (timothy)	disturbance, introduced	383.41	6.82%	0.00%	80.00%	52.19%
Phlox hoodii (moss phlox)	native	0.13	0.50%	0.00%	0.50%	0.14%
Phragmites australis (reed)	native	1.16	2.32%	0.00%	10.00%	1.51%
Physostegia parviflora (false dragonhead)	native	0.20	0.50%	0.00%	0.50%	0.07%
Picea engelmannii (Engelmann spruce)	native	0.19	0.83%	0.00%	40.00%	0.29%
Picea glauca (white spruce)	native	417.53	14.92%	0.00%	90.00%	33.60%
Picea mariana (black spruce)	native	3.21	2.67%	0.00%	40.00%	1.15%
Picea pungens (blue spruce)	introduced	0.27	0.50%	0.00%	0.50%	0.50%
Picea spp. (spruce)	unknown, not unique	0.06	0.83%	0.00%	3.00%	0.22%
Pinguicula vulgaris (common butterwort)	native	0.03	0.50%	0.00%	0.50%	0.07%
Pinus banksiana (jack pine)	native	0.17	2.33%	0.00%	3.00%	0.22%
Pinus contorta (lodgepole pine)	native	12.20	4.89%	0.00%	60.00%	5.10%
Pinus flexilis (limber pine)	native	0.29	0.99%	0.00%	3.00%	0.43%
Plantago eriopoda (saline plantain)	disturbance, native	0.53	0.50%	0.00%	0.50%	0.43%
Plantago major (common plantain)	disturbance, introduced	41.79	0.61%	0.00%	20.00%	61.23%
Plantago patagonica (Pursh's plantain)	disturbance, native	0.13	3.00%	0.00%	3.00%	0.07%
Poa alpina (alpine bluegrass)	native	0.09	0.50%	0.00%	0.50%	0.50%
Poa annua (annual bluegrass)	introduced	0.05	0.50%	0.00%	0.50%	0.07%
Poa canbyi (Canby bluegrass)	native	0.02	0.50%	0.00%	0.50%	0.14%
Poa compressa (Canada bluegrass)	native	20.82	4.02%	0.00%	30.00%	4.24%
Poa interior (inland bluegrass)	native	2.49	16.53%	0.00%	30.00%	0.43%
Poa palustris (fowl bluegrass)	native	120.33	4.29%	0.00%	30.00%	31.37%
Poa pratensis (Kentucky bluegrass)	disturbance, introduced	1368.53	14.52%	0.00%	97.50%	90.38%
Poa sandbergii (Sandberg bluegrass)	native	0.16	3.00%	0.00%	3.00%	0.07%
Poa spp. (bluegrass)	unknown, not unique	150.06	18.70%	0.00%	70.00%	4.52%
Polemonium acutiflorum (tall Jacob's-ladder)	native	0.01	0.50%	0.00%	0.50%	0.07%
Polemonium pulcherrimum (showy Jacob's-ladder)	native	0.62	0.50%	0.00%	0.50%	0.14%
Polygonum amphibium (water smartweed)	native	12.20	0.58%	0.00%	10.00%	13.78%

[1,2,3,4] - for note descriptions refer to Appendix J title page

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Plant Species	Plant Status[1]		Percent Canopy Cover[2]			
		Area by Species		Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Polygonum arenastrum (common knotweed)	introduced	2.21	0.50%	0.00%	3.00%	4.24%
Polygonum bistortoides (western bistort)	native	0.48	0.50%	0.00%	0.50%	0.72%
Polygonum coccineum (water smartweed)	native	3.54	1.15%	0.00%	20.00%	5.60%
Polygonum convolvulus (wild buckwheat)	disturbance, introduced	0.30	0.50%	0.00%	0.50%	0.79%
Polygonum lapathifolium (pale persicaria)	native	0.31	0.55%	0.00%	3.00%	1.08%
Polygonum persicaria (lady's-thumb)	disturbance, introduced	0.21	0.50%	0.00%	0.50%	1.22%
Polygonum spp. (polygonum)	unknown, not unique	9.09	0.62%	0.00%	10.00%	10.34%
Polygonum viviparum (alpine bistort)	native	0.40	0.50%	0.00%	0.50%	0.79%
Polygonum watsonii (Watson's knotweed)	native	0.01	0.50%	0.00%	0.50%	0.14%
Polytrichum alpinum (hair cap moss)	native	0.02	0.50%	0.00%	0.50%	0.07%
Populus angustifolia (narrow-leaf cottonwood)	native	418.78	28.58%	0.00%	70.00%	5.60%
Populus balsamifera (balsam poplar)	native	1118.48	17.55%	0.00%	70.00%	56.35%
Populus deltoides (plains cottonwood)	native	210.44	15.16%	0.00%	60.00%	4.59%
Populus spp. (Cottonwood)	unknown, not unique	0.06	0.50%	0.00%	0.50%	0.36%
Populus tremuloides (aspen)	native	139.88	4.28%	0.00%	50.00%	35.53%
Portulaca oleracea (purslane)	introduced	0.23	0.50%	0.00%	0.50%	0.07%
Potentilla anserina (silverweed)	disturbance, native	69.40	1.11%	0.00%	20.00%	57.00%
Potentilla argentea (silvery cinquefoil)	introduced	0.18	0.50%	0.00%	0.50%	0.65%
Potentilla fruticosa (shrubby cinquefoil)	native	85.39	3.13%	0.00%	80.00%	29.43%
Potentilla gracilis (graceful cinquefoil)	native	9.99	0.70%	0.00%	10.00%	19.67%
Potentilla hippiana (woolly cinquefoil)	native	0.05	0.50%	0.00%	0.50%	0.07%
Potentilla macounii (cinquefoil)	native	0.15	0.50%	0.00%	0.50%	0.07%
Potentilla norvegica (rough cinquefoil)	disturbance, native	6.60	0.50%	0.00%	3.00%	8.26%
Potentilla palustris (marsh cinquefoil)	native	0.01	0.50%	0.00%	0.50%	0.14%
Potentilla pensylvanica (prairie cinquefoil)	native	0.56	0.50%	0.00%	0.50%	0.93%

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			Constancy[4]
				Range		
		Hectares	Average[3]	Min	Max	
Potentilla recta (rough-fruited cinquefoil)	disturbance, introduced	0.10	3.00%	0.00%	3.00%	0.07%
Potentilla rivalis (brook cinquefoil)	native	0.02	0.50%	0.00%	0.50%	0.43%
Potentilla spp. (cinquefoil)	unknown, not unique	0.88	0.50%	0.00%	0.50%	1.87%
Primula incana (mealy primrose)	native	0.11	0.50%	0.00%	0.50%	0.36%
Prunella vulgaris (heal-all)	native	0.62	0.50%	0.00%	0.50%	0.93%
Prunus pensylvanica (pin cherry)	native	2.34	1.59%	0.00%	20.00%	2.08%
Prunus virginiana (choke cherry)	native	421.06	8.58%	0.00%	40.00%	33.96%
Pseudotsuga menziesii (Douglas-fir)	native	4.77	6.56%	0.00%	50.00%	1.22%
Puccinellia nuttalliana (Nuttall's salt-meadow grass)	native	13.35	1.26%	0.00%	20.00%	8.90%
Pyrola asarifolia (common pink wintergreen)	native	0.65	0.53%	0.00%	3.00%	2.80%
Pyrola elliptica (white wintergreen)	native	0.03	0.50%	0.00%	0.50%	0.07%
Pyrola spp. (wintergreen)	unknown, not unique	0.04	0.50%	0.00%	0.50%	0.57%
Quercus macrocarpa (bur oak)	introduced	0.01	0.50%	0.00%	0.50%	0.07%
Quercus spp. (oak)	introduced, not unique	0.02	0.50%	0.00%	0.50%	0.22%
Ranunculus acris (tall buttercup)	invasive, introduced	22.25	1.56%	0.00%	30.00%	17.23%
Ranunculus aquatilis (large-leaved white water crowfoot)	native	0.03	0.50%	0.00%	0.50%	0.07%
Ranunculus cymbalaria (seaside buttercup)	native	12.08	0.53%	0.00%	3.00%	22.40%
Ranunculus gmelinii (yellow water crowfoot)	native	0.06	0.50%	0.00%	0.50%	0.36%
Ranunculus macounii (Macoun's buttercup)	native	3.47	0.51%	0.00%	3.00%	8.61%
Ranunculus occidentalis (western buttercup)	native	0.01	0.50%	0.00%	0.50%	0.14%
Ranunculus repens (creeping buttercup)	introduced	1.50	5.09%	0.00%	20.00%	0.72%
Ranunculus rhomboideus (prairie buttercup)	native	0.09	0.50%	0.00%	0.50%	0.07%
Ranunculus sceleratus (celery-leaved buttercup)	native	3.50	0.51%	0.00%	3.00%	7.61%
Ranunculus spp. (ranunculus)	unknown, not unique	0.96	0.52%	0.00%	3.00%	2.58%
Ratibida columnifera (prairie coneflower)	native	10.55	0.50%	0.00%	0.50%	11.49%
Rhinanthus minor (yellow rattle)	native	0.49	0.50%	0.00%	0.50%	1.08%

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Rhus radicans (poison ivy)	native	0.02	0.50%	0.00%	0.50%	0.22%
Rhus trilobata (skunkbush)	native	7.68	0.80%	0.00%	3.00%	2.80%
Ribes americanum (wild black currant)	native	1.77	0.82%	0.00%	3.00%	1.87%
Ribes aureum (golden currant)	native	12.35	1.10%	0.00%	10.00%	7.04%
Ribes glandulosum (skunk currant)	native	0.03	0.50%	0.00%	0.50%	0.07%
Ribes hudsonianum (northern black currant)	native	0.58	1.14%	0.00%	20.00%	1.08%
Ribes lacustre (bristly black currant)	native	4.16	0.81%	0.00%	10.00%	5.10%
Ribes oxyacanthoides (northern gooseberry)	native	46.33	1.02%	0.00%	20.00%	49.17%
Ribes spp. (currant)	unknown, not unique	6.61	1.30%	0.00%	10.00%	4.38%
Ribes triste (wild red currant)	native	11.58	1.39%	0.00%	20.00%	9.19%
Ribes viscosissimum (sticky currant)	native	0.03	0.50%	0.00%	0.50%	0.07%
Rorippa palustris (marsh yellow cress)	native	0.36	0.63%	0.00%	3.00%	0.29%
Rorippa sylvestris (creeping yellow cress)	introduced	0.05	0.50%	0.00%	0.50%	0.50%
Rosa acicularis (prickly rose)	native	152.66	4.57%	0.00%	50.00%	33.24%
Rosa arkansana (prairie rose)	native	0.54	10.00%	0.00%	10.00%	0.07%
Rosa spp. (rose)	unknown, not unique	3.69	15.44%	0.00%	40.00%	0.36%
Rosa woodsii (common wild rose)	native	364.45	5.31%	0.00%	50.00%	64.32%
Rubus arcticus (dwarf raspberry)	native	0.01	0.50%	0.00%	0.50%	0.14%
Rubus idaeus (wild red raspberry)	native	61.29	2.02%	0.00%	30.00%	35.10%
Rubus parviflorus (thimbleberry)	native	1.22	1.82%	0.00%	20.00%	0.93%
Rubus pubescens (dewberry)	native	3.84	0.90%	0.00%	20.00%	4.95%
Rubus spp. (raspberry)	unknown, not unique	0.03	0.50%	0.00%	0.50%	0.22%
Rudbeckia hirta (black-eyed Susan)	introduced	0.00	0.50%	0.00%	0.50%	0.07%
Rumex acetosa (green sorrel)	introduced	0.02	0.50%	0.00%	0.50%	0.14%
Rumex crispus (curled dock)	introduced	32.78	0.62%	0.00%	10.00%	50.47%
Rumex maritimus (golden dock)	native	6.94	0.69%	0.00%	20.00%	8.11%
Rumex occidentalis (western dock)	native	10.63	0.52%	0.00%	10.00%	24.41%
Rumex spp. (dock; sorrel)	unknown, not unique	0.40	0.50%	0.00%	0.50%	0.50%
Rumex triangulivalvis (narrow-leaved dock)	native	0.10	0.50%	0.00%	0.50%	0.14%

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Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Sagittaria cuneata (arum-leaved arrowhead)	native	6.09	0.81%	0.00%	10.00%	6.39%
Sagittaria latifolia (broad-leaved arrowhead)	native	0.17	0.50%	0.00%	0.50%	0.29%
Salix amygdaloides (peach-leaved willow)	native	84.57	4.09%	0.00%	20.00%	6.39%
Salix athabascensis (Athabasca willow)	native	0.03	0.50%	0.00%	0.50%	0.07%
Salix bebbiana (beaked willow)	native	363.50	5.73%	0.00%	70.00%	69.85%
Salix boothii (Booth's willow)	native	14.19	5.54%	0.00%	30.00%	3.95%
Salix candida (hoary willow)	native	5.28	1.04%	0.00%	20.00%	5.74%
Salix discolor (pussy willow)	native	13.51	2.49%	0.00%	30.00%	4.38%
Salix drummondiana (Drummond's willow)	native	15.86	6.48%	0.00%	40.00%	4.16%
Salix exigua (sandbar willow)	native	494.08	6.15%	0.00%	50.00%	58.08%
Salix farriae (Farr's willow)	native	0.25	1.36%	0.00%	3.00%	0.29%
Salix glauca (smooth willow)	native	3.91	10.45%	0.00%	30.00%	0.72%
Salix lanata (woolly willow)	native	0.04	0.50%	0.00%	0.50%	0.07%
Salix lucida (shining willow)	native	10.77	1.01%	0.00%	10.00%	6.39%
Salix lutea (yellow willow)	native	458.42	6.17%	0.00%	60.00%	59.37%
Salix maccalliana (velvet-fruited willow)	native	24.05	5.30%	0.00%	30.00%	4.81%
Salix myrtillifolia (myrtle-leaved willow)	native	17.48	9.48%	0.00%	30.00%	2.80%
Salix pedicellaris (bog willow)	native	0.00	0.50%	0.00%	0.50%	0.07%
Salix petiolaris (basket willow)	native	124.58	6.16%	0.00%	60.00%	21.61%
Salix planifolia (flat-leaved willow)	native	137.66	6.34%	0.00%	30.00%	19.02%
Salix prolixa (Mackenzie's willow)	native	17.45	12.82%	0.00%	20.00%	1.15%
Salix pseudomonticola (false mountain willow)	native	57.89	3.12%	0.00%	70.00%	18.88%
Salix pyrifolia (balsam willow)	native	0.02	0.50%	0.00%	0.50%	0.29%
Salix scouleriana (Scouler's willow)	native	2.37	7.41%	0.00%	20.00%	0.72%
Salix serissima (autumn willow)	native	2.24	2.02%	0.00%	30.00%	2.44%
Salix spp. (willow)	unknown, not unique	22.31	3.64%	0.00%	40.00%	7.18%
Salsola kali (Russian-thistle)	disturbance, introduced	17.02	1.02%	0.00%	10.00%	4.95%
Sambucus racemosa (red elderberry)	native	0.40	0.68%	0.00%	3.00%	0.72%
Sanicula marilandica (snakeroot)	native	1.26	0.50%	0.00%	0.50%	2.37%

[1,2,3,4] - for note descriptions refer to Appendix J title page

APPENDIX J
Provincial Riparian Plant Species List for Alberta 1997-2006

Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Sarcobatus vermiculatus (greasewood)	native	2.24	0.55%	0.00%	3.00%	1.22%
Schedonnardus paniculatus (tumble grass)	native	0.02	0.50%	0.00%	0.50%	0.07%
Schizachne purpurascens (purple oat grass)	native	0.10	0.50%	0.00%	0.50%	0.57%
Scirpus acutus (great bulrush)	native	14.54	5.79%	0.00%	50.00%	2.37%
Scirpus microcarpus (small-fruited bulrush)	native	106.84	1.70%	0.00%	30.00%	54.06%
Scirpus pallidus (pale bulrush)	native	0.76	0.97%	0.00%	20.00%	0.79%
Scirpus pungens (three-square rush)	native	46.69	2.05%	0.00%	70.00%	18.52%
Scirpus spp. (bulrush)	unknown, not unique	1.47	0.73%	0.00%	20.00%	1.36%
Scirpus validus (common great bulrush)	native	70.76	2.27%	0.00%	40.00%	25.56%
Scleranthus annuus (knawel)	disturbance, introduced	0.16	0.50%	0.00%	0.50%	0.07%
Scolochloa festucacea (spangletop)	native	1.43	7.09%	0.00%	30.00%	0.29%
Scutellaria galericulata (marsh skullcap)	native	1.82	0.68%	0.00%	3.00%	5.10%
Sedum lanceolatum (lance-leaved stonecrop)	native	0.12	0.50%	0.00%	0.50%	0.86%
Sedum spp. (stonecrop)	unknown, not unique	0.19	0.50%	0.00%	0.50%	0.29%
Senecio canus (prairie groundsel)	native	0.09	0.50%	0.00%	0.50%	0.29%
Senecio congestus (marsh ragwort)	native	0.33	2.10%	0.00%	10.00%	0.43%
Senecio conterminus (Arctic butterweed)	native	0.74	0.52%	0.00%	3.00%	1.65%
Senecio eremophilus (cut-leaved ragwort)	native	2.38	0.53%	0.00%	3.00%	3.59%
Senecio integerrimus (entire-leaved groundsel)	native	1.53	0.77%	0.00%	3.00%	1.72%
Senecio pauciflorus (few-flowered ragwort)	native	0.48	0.50%	0.00%	0.50%	0.79%
Senecio pseudaureus (thin-leaved ragwort)	native	0.06	0.50%	0.00%	0.50%	0.57%
Senecio spp. (senecio)	unknown, not unique	3.41	0.51%	0.00%	3.00%	4.95%
Senecio triangularis (brook ragwort)	native	0.05	0.50%	0.00%	0.50%	0.93%
Senecio vulgaris (common groundsel)	introduced	0.63	0.50%	0.00%	0.50%	1.29%
Setaria glauca (yellow foxtail)	introduced	0.11	0.50%	0.00%	0.50%	0.14%
Setaria viridis (green foxtail)	disturbance, introduced	1.89	1.43%	0.00%	40.00%	0.79%

[1,2,3,4] - for note descriptions refer to Appendix J title page

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Plant Species	Plant Status[1]		Percent Canopy Cover[2]			
		Area by Species		Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Shepherdia argentea (thorny buffaloberry)	native	280.77	11.29%	0.00%	50.00%	9.33%
Shepherdia canadensis (Canada buffaloberry)	native	63.23	2.49%	0.00%	30.00%	25.70%
Shrub (Shrub)	unknown, not unique	6.21	2.28%	0.00%	97.50%	1.87%
Silene cserei (smooth catchfly)	disturbance, introduced	0.04	0.50%	0.00%	0.50%	0.07%
Silene cucubalus (bladder campion)	invasive, introduced	3.48	0.51%	0.00%	3.00%	2.87%
Silene noctiflora (night-flowering catchfly)	disturbance, introduced	0.03	0.50%	0.00%	0.50%	0.07%
Silene pratensis (white cockle)	invasive, introduced	1.61	0.50%	0.00%	0.50%	3.88%
Sisymbrium altissimum (tumbling mustard)	introduced	0.19	0.50%	0.00%	0.50%	0.72%
Sisymbrium loeselii (tall hedge mustard)	introduced	0.43	0.50%	0.00%	0.50%	0.50%
Sisymbrium spp. (tumblemustard)	introduced, not unique	0.01	0.50%	0.00%	0.50%	0.07%
Sisyrinchium montanum (common blue-eyed grass)	native	2.07	0.50%	0.00%	0.50%	4.38%
Sisyrinchium septentrionale (pale blue-eyed grass)	native	0.01	0.50%	0.00%	0.50%	0.07%
Sium suave (water parsnip)	native	11.96	0.53%	0.00%	10.00%	19.45%
Smilacina racemosa (false Solomon's-seal)	native	0.78	0.51%	0.00%	3.00%	1.72%
Smilacina stellata (star-flowered Solomon's-seal)	native	21.92	0.51%	0.00%	10.00%	36.90%
Smilacina trifolia (three-leaved Solomon's-seal)	native	0.01	0.64%	0.00%	3.00%	0.22%
Solanum triflorum (wild tomato)	native	0.15	0.50%	0.00%	0.50%	0.14%
Solidago canadensis (Canada goldenrod)	native	162.80	2.11%	0.00%	50.00%	68.56%
Solidago gigantea (late goldenrod)	native	0.56	1.05%	0.00%	10.00%	1.29%
Solidago graminifolia (flat-topped goldenrod)	native	0.51	0.57%	0.00%	3.00%	0.72%
Solidago missouriensis (low goldenrod)	native	22.19	1.03%	0.00%	10.00%	13.28%
Solidago mollis (velvety goldenrod)	native	0.20	2.61%	0.00%	3.00%	0.14%
Solidago multiradiata (alpine goldenrod)	native	0.16	0.50%	0.00%	0.50%	0.22%
Solidago rigida (stiff goldenrod)	native	1.70	1.01%	0.00%	10.00%	2.51%

[1,2,3,4] - for note descriptions refer to Appendix J title page

APPENDIX J
Provincial Riparian Plant Species List for Alberta 1997-2006

Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Solidago spathulata (mountain goldenrod)	native	4.31	2.44%	0.00%	10.00%	1.94%
Solidago spp. (goldenrod)	unknown, not unique	17.69	4.56%	0.00%	10.00%	4.59%
Sonchus arvensis (perennial sow-thistle)	invasive, introduced	97.84	1.17%	0.00%	50.00%	69.71%
Sonchus asper (prickly annual sow-thistle)	introduced	1.09	0.63%	0.00%	3.00%	1.51%
Sonchus oleraceus (annual sow-thistle)	disturbance, introduced	0.56	0.63%	0.00%	3.00%	0.86%
Sonchus uliginosus (smooth perennial sow-thistle)	native	0.04	0.50%	0.00%	0.50%	0.14%
Sorbus aucuparia (European mountain-ash)	introduced	0.01	0.50%	0.00%	0.50%	0.07%
Sorbus scopulina (western mountain-ash)	native	0.06	0.50%	0.00%	0.50%	0.29%
Sorbus sitchensis (Sitka mountain-ash)	native	0.00	0.50%	0.00%	0.50%	0.07%
Sparganium angustifolium (narrow-leaved bur-reed)	native	0.15	0.50%	0.00%	0.50%	0.29%
Sparganium eurycarpum (giant bur-reed)	native	10.17	3.60%	0.00%	20.00%	2.87%
Spartina gracilis (alkali cord grass)	native	16.05	0.84%	0.00%	10.00%	10.91%
Spartina pectinata (prairie cord grass)	native	0.10	0.50%	0.00%	0.50%	0.29%
Sphaeralcea coccinea (scarlet mallow)	native	0.25	0.50%	0.00%	0.50%	0.86%
Spiraea alba (narrow-leaved meadowsweet)	native	5.18	0.92%	0.00%	3.00%	3.59%
Spiraea betulifolia (white meadowsweet)	native	0.14	0.50%	0.00%	0.50%	0.93%
Spiraea spp. (meadowsweet)	unknown, not unique	0.09	0.50%	0.00%	0.50%	0.07%
Spiranthes romanzoffiana (hooded ladies'-tresses)	native	0.03	0.50%	0.00%	0.50%	0.29%
Sporobolus cryptandrus (sand dropseed)	native	1.11	0.50%	0.00%	0.50%	0.93%
Stachys palustris (marsh hedge-nettle)	native	25.53	0.77%	0.00%	20.00%	32.95%
Stellaria calycantha (northern stitchwort)	native	0.02	0.50%	0.00%	0.50%	0.22%
Stellaria longifolia (long-leaved chickweed)	native	1.22	0.50%	0.00%	0.50%	3.16%
Stellaria media (common chickweed)	disturbance, introduced	0.14	0.50%	0.00%	0.50%	0.36%
Stellaria spp. (stellaria)	unknown, not unique	0.05	0.50%	0.00%	0.50%	0.07%

[1,2,3,4] - for note descriptions refer to Appendix J title page

APPENDIX J
Provincial Riparian Plant Species List for Alberta 1997-2006

Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Stenanthium occidentale (bronzebells)	native	0.01	0.50%	0.00%	0.50%	0.22%
Stipa columbiana (Columbia needle grass)	native	0.00	0.50%	0.00%	0.50%	0.07%
Stipa comata (needle-and-thread)	native	232.82	8.30%	0.00%	50.00%	11.27%
Stipa curtiseta (western porcupine grass)	native	2.98	2.12%	0.00%	10.00%	1.22%
Stipa richardsonii (Richardson needle grass)	native	6.28	1.49%	0.00%	10.00%	2.66%
Stipa spartea (porcupine grass)	native	3.74	23.97%	0.00%	30.00%	0.14%
Stipa spp. (needle grass)	unknown, not unique	23.62	7.37%	0.00%	40.00%	1.51%
Stipa viridula (green needle grass)	native	164.73	4.27%	0.00%	40.00%	23.83%
Streptopus amplexifolius (clasping leaved twisted-stalk)	native	0.89	1.23%	0.00%	20.00%	2.73%
Streptopus spp. (Twisted Stalk)	unknown, not unique	0.03	0.50%	0.00%	0.50%	0.07%
Symphoricarpos albus (snowberry)	native	0.00	0.50%	0.00%	0.50%	0.07%
Symphoricarpos occidentalis (buckbrush/snowberry)	native	999.09	11.24%	0.00%	60.00%	82.99%
Syringa spp. (lilac)	introduced	0.02	0.50%	0.00%	0.50%	0.14%
Tanacetum vulgare (common tansy)	invasive, introduced, poisonous	8.43	0.91%	0.00%	20.00%	5.03%
Taraxacum officinale (common dandelion)	disturbance, introduced	159.56	2.13%	0.00%	40.00%	76.74%
Thalictrum occidentale (western meadow rue)	native	0.44	0.57%	0.00%	3.00%	1.29%
Thalictrum sparsiflorum (flat-fruited meadow rue)	native	0.01	0.50%	0.00%	0.50%	0.07%
Thalictrum venulosum (veiny meadow rue)	native	22.10	0.54%	0.00%	10.00%	38.33%
Thermopsis rhombifolia (golden bean)	native	26.17	0.77%	0.00%	20.00%	22.83%
Thlaspi arvense (stinkweed)	disturbance, introduced	19.23	0.58%	0.00%	10.00%	35.03%
Tofieldia glutinosa (sticky false asphodel)	native	0.40	0.50%	0.00%	0.50%	0.43%
Tofieldia pusilla (dwarf false asphodel)	native	0.03	0.50%	0.00%	0.50%	0.07%
Tragopogon dubius (common goat's-beard)	introduced	37.82	1.13%	0.00%	97.50%	20.24%
Tree (Tree)	unknown, not unique	20.82	12.82%	0.00%	20.00%	0.36%
Trifolium hybridum (alsike clover)	disturbance, introduced	76.81	2.20%	0.00%	20.00%	38.48%

[1,2,3,4] - for note descriptions refer to Appendix J title page

APPENDIX J
Provincial Riparian Plant Species List for Alberta 1997-2006

Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			
				Range		
		Hectares	Average[3]	Min	Max	Constancy[4]
Trifolium pratense (red clover)	disturbance, introduced	20.93	1.02%	0.00%	10.00%	22.18%
Trifolium repens (white clover)	disturbance, introduced	98.92	2.63%	0.00%	97.50%	39.12%
Trifolium spp. (clover)	disturbance, introduced, not unique	0.03	0.50%	0.00%	0.50%	0.14%
Triglochin maritima (seaside arrow-grass)	native, poisonous	6.47	0.70%	0.00%	10.00%	11.06%
Triglochin palustris (slender arrow-grass)	native, poisonous	0.29	0.50%	0.00%	0.50%	0.65%
Trisetum spicatum (spike trisetum)	native	0.02	0.50%	0.00%	0.50%	0.14%
Triticum aestivum (common wheat)	native	0.44	2.56%	0.00%	10.00%	0.36%
Typha latifolia (common cattail)	native	126.37	5.07%	0.00%	70.00%	23.98%
Typha spp. (cattail)	unknown, not unique	0.02	0.50%	0.00%	0.50%	0.07%
Ulmus americana (White Elm)	introduced	0.11	1.73%	0.00%	3.00%	0.14%
Urtica dioica (common nettle)	native	52.29	1.33%	0.00%	30.00%	43.58%
Vaccinium myrtilloides (common blueberry)	native	0.11	1.28%	0.00%	3.00%	0.29%
Vaccinium scoparium (grouseberry)	native	0.00	0.50%	0.00%	0.50%	0.07%
Valeriana dioica (northern valerian)	native	0.05	0.50%	0.00%	0.50%	0.14%
Valeriana sitchensis (mountain valerian)	native	0.00	0.50%	0.00%	0.50%	0.07%
Veratrum eschscholtzii (green false hellebore)	native	0.02	0.50%	0.00%	0.50%	0.22%
Verbascum thapsus (common mullein)	introduced	3.19	0.50%	0.00%	0.50%	1.87%
Veronica americana (American brooklime)	native	0.83	0.52%	0.00%	3.00%	2.01%
Verrucaria virens ()	native	0.01	0.50%	0.00%	0.50%	0.29%
Viburnum edule (low-bush cranberry)	native	5.90	1.44%	0.00%	10.00%	4.59%
Viburnum opulus (high-bush cranberry)	native	7.11	2.06%	0.00%	10.00%	2.80%
Vicia americana (wild vetch)	native	35.82	0.61%	0.00%	10.00%	57.72%
Vicia cracca (tufted vetch)	introduced	4.29	0.85%	0.00%	20.00%	2.66%
Vicia spp. (vetch)	unknown, not unique	2.00	3.00%	0.00%	3.00%	0.22%
Viola adunca (early blue violet)	native	0.71	0.50%	0.00%	0.50%	2.44%
Viola canadensis (western Canada violet)	native	2.37	0.56%	0.00%	3.00%	7.32%

[1,2,3,4] - for note descriptions refer to Appendix J title page

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Provincial Riparian Plant Species List for Alberta 1997-2006

Plant Species	Plant Status[1]	Area by Species	Percent Canopy Cover[2]			Constancy[4]
				Range		
		Hectares	Average[3]	Min	Max	
Viola nephrophylla (bog violet)	native	2.55	0.59%	0.00%	10.00%	6.89%
Viola orbiculata (evergreen violet)	native	0.03	0.50%	0.00%	0.50%	0.14%
Viola spp. (violet)	unknown, not unique	6.06	2.80%	0.00%	97.50%	2.08%
Xanthium strumarium (cocklebur)	native	9.82	0.55%	0.00%	10.00%	8.47%
Yucca glauca (soapweed)	native	0.02	0.50%	0.00%	0.50%	0.07%
Zigadenus elegans (white camas)	native, poisonous	3.69	0.66%	0.00%	3.00%	4.45%
Zigadenus venenosus (death camas)	native, poisonous	0.37	0.50%	0.00%	0.50%	0.93%
Zizia aptera (heart-leaved Alexanders)	native	5.15	0.54%	0.00%	3.00%	13.85%

[1,2,3,4] - for note descriptions refer to Appendix J title page

APPENDIX K
Riparian Health Parameter Rating Descriptions

Table K-1. Riparian health rating descriptions for parameters out of 3 points.

Average Health Rating	**Unhealthy**			**Healthy but with Problems**		**Healthy**		
Average Health Percent Range	0%	1-32%	33-59%	60-63%	64-79%	80-99%	100%	
Actual Health Score Range	0	0.1-0.9	1-1.7	1.8-1.9	2-2.3	2.4-2.9	3	
Health Parameter Assessed	**Scoring Category**							**Scoring Description**
Regeneration of Other Tree Species	0%	<1%	<1%	<1-5%	1-5%	1 to >5 %	>5%	% of canopy cover that is seedlings/saplings
Preferred Shrub Regeneration	0%	<1%	<1%	<1-5%	1-5%	1 to >5 %	>5%	% of canopy cover that is seedlings/saplings
Preferred Tree/Shrub Utilisation	>50%	>50%	25-50%	5-50%	5-25%	0-25%	0-5%	% utilised
Dead/decadent Woody Material	>45%	>45%	25-45%	5-45%	5-25%	<25%	<5%	% of woody material that is dead/decadent
Total Canopy Cover of Woody Plants	<5%	<5%	5-25%	5-50%	25-50%	25 to >50%	>50%	% of site covered
Disturbance Plants	>45%	>45%	25-45%	5-45%	5-25%	<25%	<5%	% of site covered
Presence of Native Graminoids	<5%	<5%	5-25%	5-50%	25-50%	25 to >50%	>50%	% of site covered
Exotic Undesirable Woody species	>50%	>50%	25-50%	5-50%	5-25%	<25%	<5%	% of site covered
Human-Caused Physical Alterations to Rest of Site	>25%	>25%	15-25%	5-25%	5-15%	<15%	<5%	% of area physically altered

Table K-2. Riparian health rating descriptions for parameters out of 6 points.

Average Health Rating	**Unhealthy**			**Healthy but with Problems**		**Healthy**		
Average Health Percent Range	0%	1-32%	33-59%	60-66%	67- 79%	80-99%	100%	
Average Actual Health Score Range	0	0.1-1.9	2-3.5	3.6-3.9	4 - 4.7	4.8 - 5.9	6	
Health Parameter Assessed	**Scoring Category**							**Scoring Description**
Vegetative Cover	<75%	<75%	75-85%	75-95%	85-95%	>85%	>95%	% of site vegetated
Cottonwood and Poplar Regeneration	None	<5%	<5%	<5-15%	5-15%	>5%	>15%	% canopy cover seedling/sapling
Preferred Tree/ Shrub Regeneration	None	<5%	<5%	<5-15%	5-15%	>5%	>15%	% canopy cover as seedlings/saplings
Invasive Plants	>15% cc and/or DD >8	>15% cc and/or DD >8	1-15% cc and DD 4,-7	1-15% cc and DD 1-7	<1% cc and DD 1-3	<1% cc and DD 1-3	None	% canopy cover and density distribution class
Human-Caused Alteration to Site Vegetation	>35%	>35%	15-35%	5-35%	5-15%	<15%	<5%	% of vegetation altered by human activities
Root Mass Protection	<35%	<35%	35-65%	35-85%	65-85%	>85%	>95%	% of bank length with deep binding root mass
Human-Caused Bank Alterations (except Large River Survey)	>35%	>35%	15-35%	5-35%	5-15%	<15%	<5%	% of bank length with alterations due to human activities
Human-Caused Bare Ground (Streams and Small Rivers & Lakes and Wetland Survey, Large River Survey)	>15%, >50%	>15%, >50%	5-15%, 25-50%	1-15%, 5-50%	1-5%, 5-25%	<5%, <25%	<1%, <5%	% of site that is human-caused bare ground
Floodplain Accessibility	<35%	35%	35-65%	35-85%	65-85%	>65%	>85%	% of floodplain that is accessible

Table K-3. Riparian health rating descriptions for parameters out of 9 points.

Average Health Rating	**Unhealthy**			**Healthy but with Problems**		**Healthy**		
Average Health Percent Range	0%	1-32%	33-59%	60-66%	67-79%	80-99%	100%	
Actual Health Score Range	0	0.1-2.9	3-5.3	5.4-5.9	6-7.1	7.2-8.9	9	
Health Parameter Assessed	**Scoring Categories**							**Scoring Description**
Human-Caused Bank Alteration (Large River Survey)	>50%	>50%	25-50%	10-50%	10-25%	<25%	<10%	% of bank length with alterations due to human activities
*Channel Incisement (category)	D	D/C	C/B	B	B/A	A/B	A	channel type
Artificial Water Level Change	extreme	extreme	moderate	minor or moderate	minor	minor or no	not subjected	artificial water level change
Dewatering of the River System	>50%	>50%	25-50%	10-50%	10-25%	<25%	<10%	% of annual discharge removed
Control of Flood Peak/Timing by Dam(s)	>50%	>50%	25-50%	10-50%	10-25%	<25%	<10%	% of watershed dammed

*Channel incisement categories: A. Vertically stable, no incisement and 1-2 year high flows access appropriate floodplain; B. Slight incisement, in either an improving or degrading phase, with 1-2 year flows only accessing a narrow floodplain less than or slightly wider than twice bankfull width; C. A deep healing incisement or a phase with active signs of headcuts; flows less than a 5-10 year event access a floodplain less than twice bankfull channel width; D. Deep incisement resembling a ditch or gully and only extreme floods access a floodplain.

Table K-4. Riparian health rating descriptions for parameters out of 12 points.

Average Health Rating	**Unhealthy**			**Healthy but with Problems**		**Healthy**		
Average Health Percent	0%	1-32%	33-59%	60-66%	67-79%	80-99%	100%	
Actual Health Score Range	0	0.1-3.9	4-7.1	7.2-7.9	8-9.5	9.6-11.9	12	
Health Parameter Assessed	**Scoring Categories**							**Scoring Description**
Human-Caused Alterations to Physical Site	>35%	>35%	15-35%	5-35%	5-15%	<15%	<5%	% of site physically altered

APPENDIX L
Details for Analysis and Interpretation of Parameters: Dewatering of the River System and Control of Flood Peak and Timing by Upstream Dam(s)

Dewatering of the River System
The following details on determination of level of dewatering are provided by Alberta Environment (Fraser 2008), who analysed and provided the data. The basis of analysis for this parameter is from methods used in a previous riparian health study of the South Saskatchewan River basin completed by Cows and Fish in 2005. The analysis and data for that report was also provided by Alberta Environment. The following description of the process is much more detailed than in that report.

The level of dewatering was calculated as the average percentage difference between the natural flow and recorded flow for a specific location. Natural flows were considered to be the reconstructed flows that occur at a location on a river where the effects from stream diversion, storage, import, export, return flow, or change in consumptive use are removed from the flow record. In contrast to this, recorded flows are the flows actually recorded at an established river gauging stations.

Percentage difference calculations were calculated for the growing season (defined as the May through September period) – a period of time widely recognized as being critical to the overall health of riparian vegetation. In the South Saskatchewan River basin this baseline was selected for three reasons: availability of natural flow datasets for the relevant tributaries in the South Saskatchewan River Basin; to incorporate inter-annual variability in the level of dewatering calculation; as well as serving as a recent analog for the flow regime that shaped the riparian sites considered in the analysis.

For sites that were examined previously within the SSRB tributaries and ten new riparian sites that were characterized in the previous study of the riparian areas in the SSRB, no new mapping and hydrology analyses were completed. Mapping analysis for level of dewatering and the summary hydrology tables from data derived for that report were used to characterize these sites.

For sites not examined previously within the SSRB work or not falling within those reaches, level of dewatering was calculated in one of two ways:

1) For the Milk and North Milk Rivers, Battle River and other rivers in the South Saskatchewan River Basin (Elbow, Highwood, Sheep, Medicine, Little Red Deer), published natural flow studies and related databases were used in conjunction with Water Survey of Canada recorded flow datasets to determine level of dewatering for the appropriate time periods. Key natural flow studies and references include: AENV 1989; AENV 2002; AENV 2003; AENV 2004. The level of dewatering and subsequent riparian health scoring for approximately 85% of sites outside of the original SSRB work was determined using this approach.

2) Where natural flow studies and related databases were not available for a study river (i.e. Owl and Driftpile Rivers), water use and water allocation data was used to estimate level of dewatering for riparian sites. Total allowable diversions (i.e. licensed allocation volumes) for all water uses on the river were summed and then compared to Water Survey of Canada recorded flow volumes for the appropriate time periods. This approach was used for about 15% of sites outside the original SSRB work.

Independent of the approach used to calculate level of dewatering, final scores were back-checked against actual water use and demand data where available to ensure values were reasonable (e.g. USGS, 2004; AENV 2007).

Control of Flood Peak and Timing by Upstream Dam(s)
The following details on determination of control of flood peak and timing by upstream dams are provided by Alberta Environment (Fraser 2008), who analysed and provided the data. The basis of analysis for this parameter is from methods used in a previous riparian health study of the South Saskatchewan River basin completed by Cows and Fish in 2005. The analysis and data for that report was also provided by Alberta Environment. The following description of the process is much more detailed than in that report.

Dams and diversions were selected based on a number of criteria, including: their identified importance in natural flow studies for those river reaches (AENV 1989, AENV 2002, AENV 2003, AENV 2004); their location on or directly adjacent to the main stem of the study river; the design of the water regulating structure (i.e. fully cross-sect the river and fully or partially impound water behind the structure); and classification of the water regulating structure as a dam or major dam in provincial hydrology and water operations databases. These criteria are consistent with methods used for previous reporting of riparian health for the SSRB.

In addition to the main stem rivers within the South Saskatchewan River basin, the damming analysis was extended from the SSRB report to a number of rivers including: the Owl River, Driftpile River, Medicine River, Little Red Deer River, Elbow River, Sheep River, Highwood River, Milk River, North Milk River and the Battle River.

Watershed boundaries for the sites not previously determined for the SSRB report were delineated using a 100 m resolution digital elevation model (DEM) of Alberta, provincial hydrography, and GIS mapping software (Alberta Research Council, 2006). Watershed areas upstream of the 10 major dams and diversion in the SSRB were calculated previously for the Cows and Fish report in 2005 and used directly in calculations for the 10 newest sites on these reaches. For calculation of percentage area controlled by dams and final damming scores, dammed areas upstream of riparian sites were compared to watershed areas upstream of riparian sites and converted to a percentage.

Although the effects on the damming analysis were hypothesized to be small, a number of dams on the rivers' tributaries and tributaries to these tributaries were included in the damming analysis for new riparian sites to test the sensitivity of the scoring indicator to such dams. Therefore, the effects of dams in the headwaters of the Medicine River, Milk River, Little Red Deer River, Elbow River, and the Highwood River were also considered in the analysis.

With the exception of the Battle River (North Saskatchewan River Basin), no major dams were identified on the main stems of the new study rivers considered. Although the Glenmore Dam on the Elbow River was characterized as a major dam based on the defining criteria, it was not considered in this study since all riparian sites falling on the Elbow River were upstream of the water regulating structure. In addition, although the diversions on the Highwood River at Women's Coulee and Little Bow Canal influence the level of dewatering on the river, these sites were not considered in the damming analysis because that they do not impound river flows at the point of diversion.

Based on previous work, the dams considered important within the South Saskatchewan River basin included: the Dickson Dam, Horseshoe Dam, Kananaskis Falls Dam, Ghost Dam, Bearspaw Dam, Bassano Dam, Waterton Dam, St Mary Dam, Oldman Dam, and Carseland Weir.

Note riparian health ratings are defined as:

- *Healthy (Score Range 80-100%) – Little or no impairment to riparian functions;*
- *Healthy but with Problems (Score Range 60-79%) – Some impairment to riparian functions due to human or natural causes; and*
- *Unhealthy (Score Range <60%) – Impairment to many riparian functions due to human or natural causes.*

APPENDIX M
Alberta Lotic Wetland Inventory Form (7/11/2006)

ALBERTA LOTIC WETLAND INVENTORY FORM

Polygon number: ________ Record ID No: ________

ADMINISTRATIVE DATA

A1. Field data collected by (Organisation): ________

A2. Funding Agency/Organisation: ________

A3a. Indian or Metis Reserve? (Yes; No): ____ If **Yes**, Reserve Name: ________

A3b. National or Provincial Park, Preserve, or Sanctuary? (Yes; No): ____

If **Yes**, Name: ________

A3c. Ecological, Environmental and/or Municipal Reserve (Exclude national or provincial reserves)? (Yes; No): ____

If **Yes**, Name: ________

A3d. Private or Deeded Land? (Yes; No): ____ **A4.** Observers: ________

A5a. Date field data collected: ________ **A5b.** Year: ____ **A6a.** Grazing lease or grazing reserve? (Yes; No): ____

If **Yes**, **A6b.** Grazing disposition No.: GRL: ________ GRP: ________

FGL: ________ Other: ________

A6c. Other Grazing Name (e.g. Community Pasture): ________

A7a. Is this the latest inventory for this polygon? (Yes; No): ____

A7b. At least some part of this polygon has been inventoried more than once (resampled)? (Yes; No): ____

If **No**, Go to item **A8a.** **A7c.** This polygon coincides exactly with another inventoried polygon? (Yes; No): ____

If **No**, Go to item **A7f.**, **A7d.** Other years sampled: ________

A7e. ID No.(s) of other inventories of this exact polygon: ____ , ____ , ____ , ____ , ____

A7f. This polygon shares common area with other inventoried polygon(s), but is not exact? (Yes; No): ____

A7g. Other years: ________

A7h. ID No.(s) of other records sharing area with this polygon: ____ , ____ , ____ , ____ , ____

A8a. Has a change in management occurred? (Yes; No, Unknown): ____ **A8b.** Year changed occurred: ____

A8c. Type of management change applied: ________

LOCATION DATA

B1. Province: ____ **B2a.** Natural Region: ____ **B2b.** Natural Sub-Region: ____

B3. County/Municipal District: ____ **B4a.** City/Town/Village: ____

B4b. Subdivision Plan No.: ____ **B4c.** Block No.: ____ **B4d.** Lot No.: ____

B5. Allotment/Range Unit/Landowner/Lessee Name: ________

B6. Waterbody/Area Name: ________ **B7.** Polygon number: ____

B8a. Location: 1/4 1/4 Sec: ____ 1/4 Sec: ____ Sec: ____ **B8b.** Side of Waterbody: ____

Township (NS): ____ Range (EW): ____ Meridian: ____ **B9.** Elev. (ft): ____ ; (m): ____

B10a. Major Watershed (e.g. North Saskatchewan River): ________

B10b. Minor Watershed (e.g. Battle River): ________

B10c. Minor Watershed Area (km^2): ____ ; (hect): ____ **B10d.** Minor Watershed Perimeter (km): ____

B10e. Sub-basin (e.g. Iron Creek): ________

B11a. UTM coordinates of polygon UPPER END: Easting: ____ Northing: ____ Zone: ____

B11b. UTM coordinates of polygon LOWER END: Easting: ____ Northing: ____ Zone: ____

B11c. UTM coordinates of any other point of interest in the polygon: East: ____ North: ____; Zone: ____

B11d. GPS Unit #: ____ WPt Upper: ____ WPt Lower: ____ WPt Other: ____

B11e. Comments: ________

B12a. Map Title(s): ________

B12b. Map Scale: ____ **B12c.** Map Year: ____

B13. Aerial Photo Info: Scale: ____ Date: ____ Job#: ____ Line#: ____

AS#: ____ Photo#: ____ Other Info: ____

SELECTED SUMMARY DATA Polygon number: ________ Record ID No: ________

C1. Water body type: ________ C2. Polygon size (acres): ________ ; (hect): ________

C3a. Is the entire polygon an upland? (Yes; No): ________ If No, C3b. Does the polygon consist entirely of functional wetland types? (Yes; No): ____ C3c. Functional wetland (acres): ________ ; (hect): ________ C3d. Percent of total polygon: ________

C4. Does the polygon contain a defined streambank or channel? (Yes; No; NC): ________

C5. Channel length (mi): ________ ; (km): ________ C6. Number of river miles the polygon represents: (mi) ________ ; (km): ________

C7a. Average polygon width (usually same as width of the riparian zone) (ft): ________ ; (m): ________

C7b. Riparian zone width range (ft): ________ to ________ ; (m): ________ to ________

Health Assessment Summary

C8. Polygon Health:

	Rating Percent (%)	Descriptive Category:
Vegetation:	________	________
Soil / Hydrology:	________	________
Overall:	________	________

Rating Percent Range	*Descriptive Category*
80-100	*Proper Functioning Condition (Healthy)*
60-79	*Functional At Risk (Healthy, but with problems)*
<60	*Nonfunctional (Unhealthy)*

VEGETATION DATA

D1a. Wetland prevalence index: ________

D1b. Vegetation structural diversity: ________

Trees

D2a. Are trees present? (Yes; No): ________ D2b. Tree species by canopy cover (%) and percent age group (%)

SPECIES	COV (%)	SDLG/DEC	SPLG/DEC	POLE/DEC	MAT/DEC	DEAD

SPECIES	D3. Regeneration Category	D4. Age Group Distribution Category	D5. Seedling/Sapling Utilization

Shrubs Polygon number: ______________ Record ID No: ____________

D6a. Are shrubs present? (Yes; No): ______

D6b. Is there potential for preferred shrubs? (Yes; No): ______

D6c. Shrub species canopy cover (%), age/size groups (%), and utilization

SPECIES	COV (%)	SDLG-SPLG/UTIL	MATURE/UTIL	DEC-DEAD/UTIL	**D6c.** Shrub Growth Form (N,F,U)

D7. Graminoids

Graminoids present?
(Yes; No): _______

SPECIES	COV (%)

D8. Forbs

Forbs present?
(Yes; No): _______

SPECIES	COV (%)

Polygon number: ____________ Record ID No: ____________

D9. Plant Group by Canopy Cover (%)

Layer	Trees	Shrubs	Graminoids	Forbs
3 (>6.0 ft):				
2 (>1.5 - 6.0 ft):				
1 (0 - 1.5 ft):				

D10. Total canopy cover (%) by lifeform:

Trees: __________ Shrubs: __________

Graminoids: __________ Forbs: __________

D11. Total canopy cover (%) by woody species: ________

D12. Total canopy cover (%) by all plant lifeforms: ______

Weed Data

D13a. Are invasive species present ? (Yes; No; NC): ______

If **Yes, D13b.** Enter the Canopy Cover and the Density/Distribution Class for each of the following invasive species:

	Canopy Cover	Density/Distribution Class
Bladder Campion:		
Blueweed:		
Canada Thistle:		
Caraganna:		
Common Hound's-tongue:		
Common Tansy:		
Dalmatian Toadflax:		
Diffuse Knapweed:		
European Buckthorne:		
Leafy Spurge:		
Ox-eye Daisy:		
Perennial Sowthistle:		
Purple Loosestrife:		
Russian Knapweed:		
Russian Olive:		
Scentless Chamomile:		
Spotted Knapweed:		
Tall Buttercup:		
Tamarisk:		
Yellow Toadflax:		
Others: __________		
Others: __________		
Others: __________		
Others: __________		
Others: __________		
Others: __________		

D13c. Cumulative totals for all invasive species:

Canopy Cover: _______ Density/Distribution Class: ______

D14a. Are undesirable herbaceous species present?
(Yes; No; NC): ______

If **Yes, D15b.** Record the combined canopy cover (%) of all undesirable herbaceous species observed: ______

D15. Habitat Types and Community Types

Polygon number: ______________ Record ID No: ______________

Classification Type Name	Phase	Percent of Polygon	Successional Stage or Comments

D16. Polygon trend: Improving, Degrading, Static, or Status Unknown? ________________________

D17. Explain trend description and give other vegetation comments:

WATER QUALITY DATA Polygon number: ____________ Record ID No: ____________

E1. Waterbody number (FMIS/Hydro code): ______________

E2a. Is water quality data available on this waterbody? (Yes, No, Unknown, NA): ______

If **Yes, E2b.** Describe the reference for that data (name, year, etc.): ______________

PHYSICAL SITE DATA

F1. Does the polygon contain a stream bank or channel bottom? (Yes; No; NC): ______ If **No,** go to item **F15a.**

F2a. Is the channel bottom visible? (Yes; No; NC): ______

If **Yes, F2b.** Give the percent breakdown of particle sizes (must approx. 100%):

______ >20 inches (Medium Boulders +) ______ 0.6 - 2.5 inches (Coarse Gravel)

______ 10 - 20 inches (Small Boulders) ______ 0.08 inches - 0.6 inches (Fine Gravel)

______ 5 - 10 inches (Large Cobbles) ______ 0.062 mm - 2 mm (Sand)

______ 2.5 - 5 inches (Small Cobbles) ______ <0.062 mm (Silt and Clay)

F3a. Is the channel bank material visible? (Yes; No; NC): ______

If **Yes, F3b.** Give the percent breakdown of particle sizes (must approx. 100%):

______ >20 inches (Medium Boulders +) ______ 0.6 - 2.5 inches (Coarse Gravel)

______ 10 - 20 inches (Small Boulders) ______ 0.08 inches - 0.6 inches (Fine Gravel)

______ 5 - 10 inches (Large Cobbles) ______ 0.062 mm - 2 mm (Sand)

______ 2.5 - 5 inches (Small Cobbles) ______ <0.062 mm (Silt and Clay)

F4a. Is there active lateral cutting of stream? (Yes; No; NC): ______

If **Yes, F4b.** How much of the stream length displays active lateral cutting (%): ______

F5. Percent of the total bank length unstable (0-5%; 6–25%; 26–45%; over 45%; NC): ______

F6a. Is the streambank altered by on-site human activities? (Yes; No; NC): ______

If **Yes, F6b.** Percent (%) of the bank length that has human-caused alterations? ______

F6c. Of this, how much resulted from these causes: (must approx. 100%)

______ Grazing ______ Mining ______ Construction ______ Railroads

______ Cultivation ______ Logging ______ Recreation ______ Other

Explain "other": ______________

F6d. Distribute the total streambank alteration among these kinds: (must approximate 100%)

______ Hoof shear/trampling ______ Roads ______ Berms

______ Vegetation Removal: ______ Trails ______ Riprap ______ Other

Explain "other": ______________

F7. Percent of the streambanks with deep, binding root mass (0-35%; 36–65%; 66–85%; over 85%; NC): ______

F8. Percent of polygon with sufficient fine material to hold water and act as a rooting medium (0-35%; 36–65%; 66–85%; over 85%; NC): ______

F9. Average non-vegetated stream channel width: (ft) ______ ; (m): ______ **F10.** Stream gradient (percent): ______

F11a. Active downcutting of the stream? (Yes; No; NC): ______ If **Yes, F11b.** Percent of stream actively downcutting: ______

F12a. Headcuts present? (Yes; No; NC): ______ If **Yes, F12b.** No. of headcuts: ______ **F12c.** Average headcut height (ft): ______

F12d. Location of headcut(s): ______________

F13a. Is the stream channel braided (has multiple active channels during normal flows)? (Yes; No; NC): ______

If **Yes, F13b.** Percent of the stream channel that is braided: ______

F14. Indicate the best description of channel incisement (A; B; C; D): ____

F15a. Is there exposed soil surface (bare ground)? (Yes; No; NC): ______ If **No** or **NC,** go to item **F17.**

F15b. Percent (%) of the polygon which is exposed soil surface (bare ground): ______

F15c. Of this, how much is due to Natural Processes: ______ Human-caused disturbance: ______ (must approx. 100%)

F15d. Within ***each*** category (natural & human-caused), how much resulted from the listed processes?

NATURAL PROCESSES *(must approx. 100%)*

______ Erosional ______ Type Dependent

______ Depositional ______ Saline/Alkaline

______ Wildlife Use ______ Within Veg. Channel Bottoms

______ Other Explain "Other": ______________

HUMAN-CAUSED PROCESSES *(must approx. 100%)*

______ Grazing ______ Construction

______ Logging ______ Mine tailings

______ Recreation ______ Other

Polygon number: ________ Record ID No: ________

F16. Non-vegetated ground cover. **(Note:** Bare ground and vascular plant cover recorded above.)

Rocks (>2.5 in.): ______ Moss: ______ Litter and Duff: ______ Wood: ______ Human Imperv. Surf: ______ Other: ______

F17. Are channel point bars revegetating? (Yes; No; NA; NC): ______

F18. Is there a nearby source ***on the system*** for large woody debris to enter the stream? (Yes; No; NA; NC): ______

F19a. Is the polygon away from the streambank physically altered? (Yes; No; NC): ______ If **Yes, F19b.** WhatPercent ?: ______

F19c. Of this, how much resulted from these causes: (must approx. 100%)

______ Grazing ______ Recreation ______ Mining ______ Railroads

______ Cultivation ______ Construction ______ Logging ______ Other

Explain "other": ______

F19d. Distribute the total streambank alteration among these kinds: (must approximate 100%)

______ SoilCompaction ______ Hydrologic chan______ Landscaping (altering topography

______ Plowing/Tilling ______ Roads ______ Impervious surfaces (Roofs, Pavement, etc. ______ Other

Explain "other": ______

F20a. Animal caused pugging and/or hummocks present? (Yes; No; NC): ______

F20b. Percent of the polygon affected by animal-caused pugging and/or hummocks ______

F20c. Distribution of hummocks/pugging: Within streambanks: ______ Remainder of polygon: ______ (must approx. 100%)

F21a. Are seeps or springs present? (Yes; No; NC): ______ If **Yes, F21b.** Number of seeps and springs: ______

F21c. How many springs and seeps had hummocks and/or pugging in 25% or more of the wetted area? ______

F21d. Location of the springs and seeps: ______

F22 ı. Is wetland type a pooled channel of an intermittent stream (item C1)? (Yes; No; NC): ______

If **Yes, F22b.** Percent of the channel length with pooled water: ______

F22c. Is this pooled water expected to remain at the surface through the remainder of the growing season? (Yes; No): ______

F22d. Location of the pools: ______

F23a. Is there evidence of beaver in the polygon? (Yes; No; NC) ______

If **Yes, F23b.** (Active; Inactive): ______ **F23c.** Describe the type and amounts of beaver activity observed:

______

______

F23d. Number of beaver dams and lodges observed: ______

F23e. Level of beaver activity (number of stems chewed) (1-25; 26-100; over 100; NC): ______

F23f. How many beavers were observed? ______

Where? ______

F23. Comments (Summarize unique characteristics or problems not evident from the data collected. Include topics related to any of the optional data. Consider current and historic attributes resulting from human-caused and natural processes.):

______

F24. Detailed description of upper and lower ends and width (lateral boundaries) of the polygon:

______

PHOTOGRAPH DATA Polygon number: ____________ Record ID No: ____________

G1. Identification of photos (taken at the ***upstream*** end of polygon): Photographer: ______________________

Roll #: Photo #: Description: Camera Number: __________

_________ (Roll # for polygons prior to 2001)

Upstream views: _________ _________ ____

Downstream views: _________ _________ ____

Other views: _________ _________ ____

G2. Is there an adjacent polygon ***upstream*** of this polygon? (Yes; No): _______

G3. Is there an adjacent polygon ***downstream*** of this polygon? (Yes; No): _______

G4. Identification of photos (taken at the ***downstream*** end of polygon): Photographer: ______________________

Upstream Roll #: Photo #: Description: Camera Number: __________

views: _________ _________ ____

Downstream views: _________ _________ ____

Other views: _________ _________ ____

G5. Identification of additional photos taken outside of polygon (i.e., non-polygon photos):

Roll #:	Photo #:	Description:

G6. Film and Camera Specs: Film brand: ____________ Film speed (ASA): ____ Lens dia. (mm): _____

Lens foc. len. (mm): _______ Lens filter used: ______________________

OPTIONAL DATA Polygon number: ______ Record ID No: ______

H1. Vegetative use by animals (0-25%; 26-50%; 51-75%; 76-100%): ______

H2. Adjacent uplands (Agriculture; Grassland; Shrubland; Forest; or Other): ______ ______

H3. Break down the polygon into percentages of the area in the land uses listed (must total to approx. 100%):

No land use apparent: ______
Turf grass (lawn): ______
Tame pasture (grazing): ______
Native pasture (grazing): ______
Recreation (ATV paths, campsites, etc.): ______
Development (buildings, corrals, paved lots, etc.): ______
Tilled Cropping: ______
Perennial forage (e.g., alfalfa hayland): ______
Roads: ______
Logging: ______
Mining: ______
Railroads: ______
Other: ______

Description of Other Usage Noted:

______
______

H4. Break down the area adjacent to the polygon into the land uses listed (must total to approx. 100%):

No land use apparent: ______
Turf grass (lawn): ______
Tame pasture (grazing): ______
Native pasture (grazing): ______
Recreation (ATV paths, campsites, etc.): ______
Development (buildings, corrals, paved lots, etc.): ______
Tilled Cropping: ______
Perennial forage (e.g., alfalfa hayland): ______
Roads: ______
Logging: ______
Mining: ______
Railroads: ______
Other: ______

Description of Other Usage Noted:

______
______

H5a. Do available maps accurately represent the sinuosity of the stream? (Yes; No; NA; NC): ______

If **No, H6b.** Determine sinuosity in the field; If **Yes,** determine sinuosity in the office from topo map: ___

H6. Percent of streambank physically accessible to large animals: ______

H7a. Has the bank configuration or channel profile been modified by construction? (Yes; No; NC): ______

If **Yes, H7b.** How much of the bank or channel length is modified (%)? ______

H7c. What part resulted from the various sources: (must approx. 100%)

Dikes	______	Road Construction	______	Railroads	______
Berns	______	Water Diversion Structures	______	Mining	______
Dams	______	Vegetation Removal	______	Bridges	______
Rip-rap	______	Channelization	______	Logging	______
Other	______	Explain "Other":	______		

H7d. Location(s): ______

______
______

H7e. If human-caused channel modifications are present, are they stable? (Stable; Unstable): ______

H7f. What is the effect of the modifications on the immediate and downstream channel?

______
______
______

H8. Rosgen stream types recorded and the percent of the stream length accounted for by each:

Rosgen 1: ______ / ______ Rosgen 2: ______ / ______ Rosgen 3: ______ / ______ Rosgen 4: ______ / ______

Waterfowl Data Polygon number: ____________ Record ID No: ____________

H9a. Were waterfowl nests or broods observed? (Yes; No): ________

If **Yes, H9b.** Describe: ____________________

Fishery Data

H10a. Does the polygon contain a fishery? (Yes; No; Unknown): ________

If **Yes, H10b.** Is it a sport fishery, non-sport fishery, or unknown: ____________

H10c. Fish types present, if known (use common names or descriptions): ____________________

H10d. How many fish were observed? (0; 1-10; 11-50; >50): ____________

H10e. If the polygon does not contain a fishery, is there potential for one? (Yes; No; Unknown): ________

Explain: ____________________

Amphibian and Reptile Data

H11a. Were amphibians observed? (Yes; No): ______

If **Yes, H11b.** Number observed: Frogs: ______ Toads: ______ Salamanders: ______

H12a. Were reptiles observed? (Yes; No): ______

If **Yes, H12b.** Number observed: Snakes: ______ Turtles: ______ Lizards: ______

H13. List amphibian or reptile species and the quantity of each identified in the polygon.

Spp. #1: ____________ No.: ____ Loc.: ____________

Spp. #2: ____________ No.: ____ Loc.: ____________

Spp. #3: ____________ No.: ____ Loc.: ____________

Spp. #4: ____________ No.: ____ Loc.: ____________

Threatened and Endangered Species Data

H14a. Were Threatened and Endangered animal species observed? (Yes; No): ______

If **Yes, H16b.** What species? Peregrine Falcon: ____ Bald Eagle: ____ Bull Trout: ____

Peregrine Falcon Nest: ____ Bald Eagle Nest: ____

H16c. Other species observed?

Species	Number
________	____
________	____
________	____
________	____

H14d. Location in polygon where Threatened and Endangered animals or nests were sighted:

____

____

APPENDIX N
Alberta Lotic Wetland Inventory User Manual (5/25/2006)

This user manual is intended to accompany the Alberta Lotic Wetland Inventory Form for the inventory of riparian wetlands associated with systems having flowing water and (usually) a defined channel. Use this form for a detailed inventory on any size stream. This document serves as the field reference to assist data collectors in answering each item on the form. It can also serve as an aid to the database user in the interpretation of data presented in the Alberta Lotic Wetland Inventory Form format. Another form entitled the Alberta Lentic Wetland Inventory Form, with a different set of user guidelines, is to be used for lentic (still water) wetlands.

ACKNOWLEDGEMENT

Development of these assessment tools has been a collaborative and reiterative process. Many people from many agencies and organizations have contributed greatly their time, effort, funding, and moral support for the creation of these documents, as well as to the general idea of devising a way for people to look critically at wetlands and riparian areas in a systematic and consistent way. Some individuals and the agencies/organizations they represent who have been instrumental in enabling this work are Dan Hinckley, Tim Bozorth, and Jim Roscoe of the USDI Bureau of Land Management in Montana; Karen Rice and Karl Gebhardt of the USDI Bureau of Land Management in Idaho; Bill Haglan of the USDI Fish and Wildlife Service in Montana; Barry Adams and Gerry Ehlert of Alberta Public Lands Division; Lorne Fitch of Alberta Environmental Protection; and Greg Hale and Norine Ambrose of the Alberta Cows and Fish Program.

BACKGROUND INFORMATION

Flowing Water (Lotic) Wetlands vs. Still Water (Lentic) Wetlands

Cowardin and others (1979) point out that no single, correct definition for wetlands exists, primarily due to the nearly unlimited variation in hydrology, soil, and vegetative types. Wetlands are lands transitional between aquatic (water) and terrestrial (upland) ecosystems. Windell and others (1986) state, “wetlands are part of a continuous landscape that grades from wet to dry. In many cases, it is not easy to determine precisely where they begin and where they end.”

In the semi-arid and arid portions of western North America, a useful distinction has been made between wetland types based on association with different aquatic ecosystems. Several authors have used ***lotic*** and ***lentic*** to separate wetlands associated with flowing water from those associated with still water. The following definitions represent a synthesis and refinement of terminology from Shaw and Fredine (1956), Stewart and Kantrud (1972), Boldt and others (1978), Cowardin and others (1979), American Fisheries Society (1980), Johnson and Carothers (1980), Cooperrider and others (1986), Windell and others (1986), Kovalchik (1987), Federal Interagency Committee for Wetland Delineation (1989), Mitsch and Gosselink (1993), and Kent (1994).

Lotic wetlands are associated with rivers, streams, and drainage ways. Such wetlands contain a defined channel and floodplain. The channel is an open conduit, which periodically or continuously carries flowing water, dissolved and suspended material. Beaver ponds, seeps, springs, and wet meadows on the floodplain of, or associated with, a river or stream are part of the lotic wetland.

Lentic wetlands are associated with still water systems. These wetlands occur in basins and lack a defined channel and floodplain. Included are permanent (i.e., perennial) or intermittent bodies of water such as lakes, reservoirs, potholes, marshes, ponds, and stockponds. Other examples include fens, bogs, wet meadows, and seeps not associated with a defined channel.

Functional vs. Jurisdictional Wetland Criteria

Defining wetlands has become more difficult as greater economic stakes have increased the potential for conflict between politics and science. A universally accepted wetland definition satisfactory to all users has not yet been developed because the definition depends on the objectives and the field of interest. However, scientists generally agree that wetlands are characterized by one or more of the following features: 1) ***wetland hydrology,*** the driving force creating all wetlands, 2) ***hydric soils,*** an indicator of the absence of oxygen, and 3) ***hydrophytic vegetation,*** an indicator of wetland site conditions. The problem is how to define and obtain consensus on thresholds for these three criteria and various combinations of them.

Wetlands are not easily identified and delineated for jurisdictional purposes. Functional definitions have generally been difficult to apply to the regulation of wetland dredging or filling. Although the intent of legislation is to protect wetland functions, delineation of jurisdictional wetlands has relied largely on structural features or attributes. The prevailing view among many wetland scientists is that functional wetlands need to meet only one of the three criteria as outlined by Cowardin and others (1979) (e.g., hydric soils, hydrophytic plants, and wetland hydrology). On the other hand, jurisdictional wetlands need to meet all three criteria, except in limited situations. Even though functional wetlands may not meet jurisdictional wetland requirements, they certainly perform wetland functions resulting from the greater amount of water that accumulates on or near the soil surface relative to the adjacent uplands. Examples include some woody draws occupied by the *Acer negundo/Prunus virginiana* (Manitoba maple/choke cherry) habitat type (Thompson and Hansen 2002) and some floodplain sites occupied by the *Artemisia cana/Agropyron smithii* (silver sagebrush/western wheatgrass) habitat type or the *Populus tremuloides/Cornus stolonifera* (aspen/red-osier dogwood) habitat type. Currently, many of these sites fail to meet jurisdictional wetland criteria. Nevertheless, these functional wetlands provide important wetland functions vital to wetland dependent species and may warrant special managerial consideration. The current interpretation is that not all functional wetlands are jurisdictional wetlands, but that all jurisdictional wetlands are functional wetlands.

Polygon Delineation

The lotic inventory process incorporates data on a wide range of biological and physical categories. The basic unit of delineation within which this data is collected is referred to as a ***polygon.*** A polygon is the area upon which one set of data is collected. One inventory form is completed (i.e., one set of data is collected) for each polygon. One or more (usually several) polygons constitute a project. A lotic (riparian) polygon is an area adjacent to a waterway (stream or river). Polygons are delineated on 7.5-minute topographic (topo) maps by marking the upper and lower ends before observers go to the field. (The widths of most riparian wetland zones are unknown before the inventory and cannot be pre-marked.) On 7.5-minute topo maps, most polygons are usually drawn as a single line following the stream or river and are numbered sequentially proceeding downstream. It is important to clearly mark and number the polygons on the topo map. Polygons are numbered pre-field (in the office) with consecutive integers (1, 2, 3 . . .). In cases where field inspection shows the need to change the delineation or to subdivide the pre-drawn polygons, additional polygons should be numbered using alpha-numerics (e.g., 1a, 1b, 2a, 2b, etc.). Combinations of delineated polygons will be field identified as the hyphenated tags of both combined parts (e.g., 1-2, 2-3, etc.).

If aerial photos are available, pre-field polygon delineations may be based on vegetation differences, geologic features, or other observable characteristics. On larger systems with wide riparian wetland areas, aerial photos may allow the pre-field drawing of multiple polygons away from the channel. In these cases, where polygons can be drawn as enclosed units (instead of just as a line), a minimum mapping unit of 5 or 10 acres (2 to 4 ha) should be used. The size of the minimum mapping unit should be based on factors such as management capabilities and the costs and capabilities of data collection.

Once in the field, observers are to verify (ground truth) the office-delineated polygon boundaries. If the pre-assigned numbers are used, be sure the inventoried polygons correspond exactly as drawn originally. Observers are allowed to move polygon boundaries, create new polygons, or consolidate polygons if the vegetation, geography, location of fences, or width of the wetland zone warrant. If polygon boundaries are changed, the changes must be clearly marked on the field copies of the 7.5- minute topographic maps. The original polygon numbers should be retained on the map for cross-reference. ***Polygons should not cross fences between areas with different management.***

Upper and lower polygon boundaries are placed at distinct locations such as fences, stream confluences, or stream meanders that can be recognized in the field. Polygons should not cross fences between areas with different management. In most cases, polygons are delineated one quarter to three quarters of a mile long. On smaller streams, polygons include the land on both sides of the stream. On large rivers, or if property ownership or access differs, polygons may include only one side of a stream.

The outer boundaries of riparian polygons are at the wetland vegetative type outer edges. These boundaries are sometimes clearly defined by abrupt changes in the geography and/or vegetation, but proper determination often depends on experienced interpretation of more subtle differences. The area to be assessed includes any terraces dominated by facultative wetland and wetter plant species (Reed 1988), the active floodplain, streambanks, and areas in the channel with emergent vegetation. Reference to Reed's list of plants found in wetlands should not be necessary to determine the area for evaluation. The evaluator should simply focus on that area which is obviously more lush, dense, or greener by virtue of proximity to the stream.

The location of the inner (or streamside) polygon boundary is also required, even on polygons that span the stream. This allows data to be collected on the riparian area while excluding the aquatic zone of the stream. The aquatic zone is the area covered by surface water and lacking persistent emergent vegetation. Persistent emergent vegetation consists of wetland species that normally remain standing at least until the beginning of next growing season, e.g., *Typha* species (cattails) or *Scirpus* species (bulrushes).
Stream channels that go dry during the growing season can create problems for polygon delineation. Some stream channels remain unvegetated after the water is gone. If the total vegetative cover of the channel is no more than 15%, it is considered a non-vegetated stream channel. The average width of the non-vegetated stream channel is recorded, and its area is ***excluded*** from the polygon**.** Exceptions to this minimum of 15% canopy cover include channels with the vegetation removed by human-causes (such as grazing, logging, and construction). These are considered exposed soil surface (bare ground). Those channels that do contain more than 15% vegetative cover are included as part of the riparian vegetation.

INVENTORY FORM CODES AND INSTRUCTIONS

Class Codes

Field observers will use class codes to represent ranges of percent wherever percent data is recorded. The class codes are defined below. These codes and range classes are from the USDA Forest Service Northern Regions ECODATA (1989) program.

T = 0.1<1%	**2** = 15<25%	**5** = 45<55%	**8** = 75<85%
P = 1<5%	**3** = 25<35%	**6** = 55<65%	**9** = 85<95%
1 = 5<15%	**4** = 35<45%	**7** = 65<75%	**F** = 95<100%

The class codes are converted to class midpoints in the office. The class midpoints are: **T** = 0.5%; **P** = 3.0%; **1** = 10.0%; **2** = 20.0%; **3** = 30.0%; **4** = 40.0%; **5** = 50.0%; **6** = 60.0%; **7** = 70.0%; **8** = 80.0%; **9** = 90.0%; **F** = 97.5%. These class midpoints are used in data reporting and in all calculations throughout the data analysis process.

Polygon Data

The following are the codes and instructions for the individual data items on the form. All data items are to be recorded in the field unless otherwise noted. Numbering corresponds to that of items on the form. Also included are comments about the data, how it is collected, and its meaning. When the inventory methodology follows a published source, that source is cited. However, in many instances, due to the lack of pre-existing guidelines, we have developed our own methodologies.
Field data collection may be done using field forms customized by deleting certain items from the Lotic Wetland Inventory Data Form, which need not be completed while in the field. ***Fill in all blanks on the Field Form.*** Enter “0” for any item to indicate the absence of value. Do not use “—” and do not leave items blank, except for the following: 1) items that logically would not be answered because they follow an answer of “No” in a leading “Yes/No” question, and 2) lines in a species list below the last species observed. An answer of “**0**” means the observer looked and saw none, whereas a blank line means the observer did not look, either by negligence or because the point was moot. ***NA*** means the item is not applicable to a particular polygon. ***NC*** means data was not collected for that item in a particular polygon. Observers must write legibly and should limit use of abbreviations throughout to prevent confusion.

Record ID No. This is the unique identifier allocated to each polygon. This number will be assigned in the office when the form is entered into a database.

ADMINISTRATIVE DATA

A1. Identify what organisation is doing the evaluation field work.

A2. Identify what organisation is paying for the work.

A3a. Identify any Indian or Métis Reserve on which work is being done.

A3b. Identify any National or Provincial Park, Preserve, or Sanctuary on which work is being done.

A3c. Identify any local Environmental, Ecological or Municipal Reserve (Exclude national or provincial reserves) on which work is being done. If yes, identify which applicable reserve is established and its number.

Ecological Reserves are areas of Crown land (Provincial and Federal Government), which have the potential to contain representative, rare and fragile landscapes, plants, animals and geological features. The intent is for the preservation of natural ecosystems, habitats and features associated with biodiversity. Public access to ecological reserves is by foot only; public roads and other facilities do not normally exist and will not be developed.

Environmental reserve generally are those lands that are considered undevelopable and may consist of a swamp, gully, ravine, coulee or natural drainage course, flood prone areas, steep slopes or land immediately adjacent to lakes, rivers, stream or other bodies of water. Governed by *The Municipal Government Act (Alberta).*

Municipal reserve may also be known, in part, as reserve, park reserve, park or community reserve. Municipal reserves are lands that have been given to the municipality by the developer of a subdivision as part of the subdivision approval process. Governed by *The Municipal Government Act (Alberta).*

A3d. Was the work done on Private or Deeded Land? Simply answer “Yes” or “No.”

A4. Observers: Name the evaluators recording the data in the field.

A5a. Date that the field data was collected**:** Use the format: month/day/year

A5b. Record the year that the field data was collected**.**

A6a. Identify any grazing lease or grazing reserve on which work is being done.

A6b. Give any grazing disposition identifying number.

A6c. Give any other grazing name (e.g. Community Pasture) to identify where the work is being done.

***Note:* Items A7a-h are completed in the office; field evaluators need not complete these items.**

A7. The several parts of this item identify various ways in which a data record may represent a resampling of a polygon that may have been inventoried again at some other time. The data in this record may have been collected on an area that coincides precisely with an area inventoried at another time and recorded as another record in the database. It may also represent the resampling of only a part of an area previously sampled. This would include the case where this polygon overlaps, but does not precisely and entirely coincide with one inventoried at another time. One other case is where more than one polygon inventoried one year coincides with a single polygon inventoried another year. All of these cases are represented in the database, and all have some value for monitoring purposes, in that they give some information on how the status on a site changes over time.

A7a. Does this record represent the latest data recorded for this polygon?

A7b. Has any part of the area within this polygon been inventoried previously, or subsequently, as represented by another data record in the Lotic Wetland database? Such other records would logically carry different dates.

A7c. Does the area extent of this polygon exactly coincide with that of any other inventory represented in the Lotic Wetland database? In many cases, subsequent inventories only partially overlap spatially. The purpose of this question is to identify those records that can be compared as representing exactly the same ground area.

A7d. If A7c is answered “Yes,” then enter the years of any inventories of this exact polygon.

A7e. If A7c is answered “Yes,” also enter the record ID number(s) of any other previous or subsequent reinventories (resamplings) of this exact polygon for purposes of cross-reference in the database.

A7f. Even though this polygon is not a re-inventory of the exact same area as any other polygon, does it share at least some common area with one or more polygons inventoried at another time?

A7g. If A7f is answered "Yes," enter the years of any other inventories of polygons sharing common area with this one.

A7h. If A7f is answered "Yes," also enter the record ID number(s) of any other polygon(s) sharing common area with this one.

A8a. Has a management change been implemented on this polygon?

A8b. If A8a is answered "Yes," in what year was the management change implemented?

A8c. If A8a is answered "Yes," describe the management change implemented.

LOCATION DATA

B1. Province in which the field work is being done.

B2a, b. Identify the Natural Region and Sub-Region in which the field work is being done. Use the Natural Regions and Subregions of Alberta (Alberta Natural Heritage Information Centre (1999).

B3. County or municipal district in which the field work is being done.

B4a. The city, town, or village in which the fieldwork is being done.

B4b. The subdivision plan number in which the fieldwork is being done.

B4c. The block number in which the fieldwork is being done.

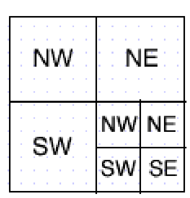
B4d. The lot number in which the fieldwork is being done.

B5. Identify the allotment, range unit, or landowner where the field work is being done.

B6. Name the waterbody or area on which the field work is being done.

B7. Polygon number is a sequential identifier of the actual piece of land being surveyed. This is referenced to the map delineations.

B8a. The location of the polygon is presented as a legal land description: 1/4,1/4 section, 1/4 section, Township, Range, and Meridian are read from smallest to largest unit.



B8b. Identify the side of the polygon that the Assessment is completed for by using "North, South, East or West", if assessment includes both sides enter "Both"

B9. Elevation (feet or meters) of the polygon ***centroid.*** Elevation is usually interpolated from a topographic map

B10a. Name the major watershed (e.g. North Saskatchewan River) of which the site being surveyed is a part.

B10b. Name the minor watershed (e.g. Battle River) of which the site being surveyed is a part. This is normally subordinate to the major watershed named above in #B10a.

B10c, d. The minor watershed area (km2) and perimeter (km) are obtained from the map in the office.

B10e. Name the sub-basin in which you are working (e.g. Iron Creek). This is the third level down from the largest (major watershed) (e.g., North Saskatchewan River—Battle River—***Iron Creek***; or South Saskatchewan River—Red Deer River— ***Little Red Deer River***), although you may be working on an even lower level tributary. The sub-basin is the local watershed of which the site being surveyed is a part. It is subordinate to the minor watershed named above in #B10b.

B11a-c. Universal Transverse Mercator (UTM) coordinates are recorded for the upper and lower ends of the polygon using GPS units in the field. Other locations of special interest may be recorded using the GPS unit. These coordinates are considered accurate to within approximately 50 m. Field observers are to use GPS units to obtain these coordinates following standard protocol. Record UTM coordinates at each end of the long axis of the polygon.

Enter the UTM coordinate data, including the UTM zone and the identifying waypoint number, on the form for each point collected. Save the data in the GPS unit for downloading to the computer later. When starting work in a new location, always check the GPS receiving unit against a known point by using the UTM grid and map.
B11d, e. Identify the GPS unit used, and the name or number designator of the waypoints saved for the upper and lower ends of the polygon and for other locations. Describe any comments worth noting about the waypoints (i.e., monument referenced or general location descriptions).

B12a-c. Record the name(s), scale, and publication year of the quadrangle map(s) or any other map(s) locating the polygon. Use precisely the name listed on the map sheet. Provision is made for listing two maps in case the polygon crosses between two maps.

B13. Record identifying data for any aerial photos used on this polygon.

SELECTED SUMMARY DATA
C1. Wetland type is a categorical description of the predominant polygon character. Select from the following list of categories that may occur within a lotic system the one that best characterizes the majority of the polygon. Observers will ***select only one category*** as representative of the entire polygon. If significant amounts of other categories are present, indicate this in Vegetation Comments (item D17) or consider dividing the original polygon into two or more polygons.

Category	***Description***

Perennial Stream A stream or stretch of stream that flows continuously for most of most years. Perennial streams are generally fed in part by springs or discharge from groundwater. Perennial streams are distinguished from larger rivers by size. Streams wider than 50 ft (15m) are considered rivers for the purpose of this inventory (see below).

Intermittent Stream A stream or stretch of stream which flows only at certain periods of the year when it receives water from springs, discharge from groundwater, or melting snow in mountainous areas. These streams generally flow continuously at least one month most years.

Ephemeral Stream A stream or stretch of stream that flows in normal water years only in direct response to precipitation. In normal years, it receives no water from springs and no extended supply from melting snow or other surface source. Ephemeral streams are not in contact with groundwater and normally do not flow continuously for as long as one month. Not all ephemeral streams support riparian plant communities.

Subterranean Stream A stream that flows underground for part of the stream reach. This occurs on systems composed of oarse textured, porous substrates. Surface flow may disappear and re-emerge farther downstream.

Pooled Channel Stream An intermittent stream that has significant channel pools after surface flow ceases. Pools are generally at meander curves and are usually considerably deeper than the rest of the channel bottom. Water sources for the pools may be springs or contact with subsurface groundwater. This stream type is typical of fine textured sedimentary plains in semi-arid regions where headwater drainages lack the extended runoff of deep mountain snowpack. This stream type may not be apparent early in the season when flow is continuous.

River Rivers are generally larger than streams. They flow year around, in years of normal precipitation and when significant amounts of water are not being diverted out of them. Those watercourses called rivers on USGS 7.5 minute topo quads and/or those having bankfull channel widths greater than 50 ft (15 m) will be classified as rivers for the purpose of this inventory.

Beaver Dams A system that is predominantly characterized by beaver dams that change the character of the system from a regular flowing channel to a "stepped" system of ponds where water is spread wide and flow velocity is apparent only at each dam outlet before it enters the next pond. Water is still flowing through the riparian system.

Wet Meadow This type of wetland may occur in either running water (lotic) or in still water (lentic) systems. A lotic wet meadow has a defined channel or flowing surface water nearby, but is typically much wider than the riparian zone associated with the classes described above. This is often the result of the influence of lateral groundwater not associated with the stream flow. Lotic and lentic wet meadows may occur in proximity (e.g., when enough groundwater emerges to begin to flow from a mountain meadow, the system goes from lentic to lotic). Such communities are typically dominated by herbaceous hydrophytic vegetation that requires saturated soils near the surface, but tolerates no standing water for most of the year. This type of wetland typically occurs as the filled-in basin of old beaver ponds, lakes, and potholes.

Spring/Seep Groundwater discharge areas. In general, springs have more flow than seeps. This wetland type may occur in a running water (lotic) or still water (lentic) system.

Irrigation Canal Includes all types of canals and ditches associated with irrigation systems.

Other Describe the water source (e.g., irrigation return flow, industrial discharge, etc.).

Nonriparian (Upland) This designation is for those areas which are included in the inventoried polygon, but which do not support functional wetland vegetation communities. Such areas may be undisturbed inclusions of naturally occurring high ground or such disturbed high ground as roadways and other elevated sites of human activity.

C2. The size (acres/hectares) of polygons large enough to be drawn as enclosed units on 1:20,000 or 1:50,000 scale maps is determined in the office using a planimeter, dot grid, or GIS. For polygons too small to be accurately drawn as enclosed units on the maps, and which are represented by line segments on the map along the drainage bottom, polygon size is calculated using polygon length and average polygon width (items C5 and C7a).

C3a-d. Evaluators may be asked to survey some areas that have not been determined to be wetlands for the purpose of making such a determination. Other polygons include areas supporting non-wetland vegetation types. A "Yes" answer here indicates that no part of the polygon keys to a riparian habitat type or community type (HT/CT). Areas classified in item D15 as any vegetation type described in a riparian and/or wetland classification document for the region in which you are working are counted as functional wetlands. Areas listed as UNCLASSIFIED WETLAND TYPE are also counted as functional wetlands. Other areas are counted as non-wetlands, or uplands. The functional wetland fraction of the polygon area is listed in item C3c in acres and as a percentage of the entire polygon area in item C3d.

C4. Some riparian areas do not contain an unvegetated, defined stream channel. In some cases, these polygons are in ephemeral systems which may flow infrequently, but which do support riparian plant communities. In other cases, these polygons may be associated with larger river systems that have wide floodplains where polygons may be delineated in areas not adjacent to the channel.

C5. Channel length—the length of channel contained within or adjacent to the polygon—is measured by scaling from the map. This data is considered accurate to the nearest 0.1 mile (0.16 km).

C6. In some cases, the polygon record is used to characterize, or represent, a larger portion of a stream system. The length represented by the polygon is given here. For example, a 0.5-mile polygon may be used to represent 4 miles of a stream. In the case, 0.5 is the channel length of the polygon (item C5), and 4 miles is entered in item C6.

C7a. Record average width of the polygon, which on smaller streams corresponds to the width of the riparian zone. To determine this width, subtract the width of the non-vegetated stream channel (item F9) from the distance between the two opposite riparian/upland boundaries. In the case of very wide systems where the polygon inventoried does not extend across the full width of the riparian zone (e.g., area with riparian vegetation communities lies outside the polygon), record the average width of the polygon inventoried and make note of the situation in the narrative comments.

C7b. Record the range of width (ft/m), narrowest to widest, of the riparian zone in the polygon.

Health Assessment Summary

C8. Polygon Health (PFC) Score is an ecological function rating for the polygon derived by computer using data from several items in this polygon inventory. For detailed discussion of this process, see the companion document *Lotic Wetland Health Assessment* (derived from the *Lotic Wetland Inventory Form*). The techniques used to obtain the data do not allow ratings to be interpreted with a fine degree of precision. For example, two polygons rating 76% and 78% should not be interpreted as functionally different from each other, but they both are more likely to differ functionally from a third polygon that rates 61%. Therefore, use of the descriptive categories may be more useful than referring to the specific numerical figures.

The health ratings are presented both as an overall polygon score and in two subsections (vegetation and soil/hydrology) to give a broad indication of what part of the system may be in need of more management attention.

Vegetation Data

D1a. The wetland prevalence index is compiled by the computer from the U.S. National Wetland Inventory wetland status classes for plant species recorded on the site (Reed 1988) and weighted by species abundance measured in terms of canopy cover. The range of index values is from 1.0 to 5.0. Lower value indicates a wetter site.

D1b. The vegetation structural diversity category is automatically calculated in the office by the computer using plant group and height layer data (item D9). Trees and shrubs are considered major components of structural diversity. These terms are used to describe vegetation height: tall = > 6.0 ft (layer 3); medium = >1.5-6.0 ft (layer 2); short = 0-1.5 ft (layer 1). Graminoids and forbs are combined as the "herbaceous" lifeform. Trees and shrubs in layer 2 are also combined as "medium trees/shrubs." A polygon is assigned the highest structural diversity category it can meet. To meet a category, each lifeform (by height) named in the description must have a canopy cover of at least 15% in the polygon. Combination groups (i.e., medium trees/shrubs; and short, medium, and tall herbaceous) must have at least 5% cover of both components or at least 15% cover of one component. ***Note:*** Structural diversity on a site can change as succession proceeds or if management changes.

Category Description
Tall trees; tall shrubs; medium trees/shrubs; herbaceous understory present1
Tall trees; tall shrubs; herbaceous understory present1
Tall trees; medium trees/shrubs; herbaceous understory present1
Tall trees; herbaceous understory present1
Tall shrubs; medium trees/shrubs; herbaceous understory present1
Tall shrubs; herbaceous understory present1
Medium trees/shrubs; herbaceous understory present1
Tall herbaceous
Medium herbaceous
Short herbaceous
Sparsely vegetated2

[1]The herbaceous understory present does not need to have a minimum canopy cover.
[2]Sparsely vegetated refers to polygons in which the minimum canopy cover by the various lifeforms is not met.

D2a, b. If present, record the species code and the canopy cover in the two left-most columns for ***all*** tree species observed. Canopy cover is evaluated using ocular estimation following the Daubenmire (1959) method. (For all plant species in this inventory, observers will use the preferred six-letter codes in the United States and seven-letters codes in Canada.) Within the total canopy cover of each species, estimate the proportion of each of five groups (seedling, sapling, pole, mature, and dead trees). The canopy covers of the five groups of each species must total approximately 100%. If some individuals in an age group have at least 30% of the upper canopy dead (are decadent), record the decadence as a percentage of that group. Record the total group cover to the left of the slash (/) and the decadent portion to the right.

Example:

Species	Cover	Sdlg	Splg/Dec	Pole/Dec	Mat/Dec	Dead
POPUBAL	3	T / 0	P / 0	1 / P	8 / 1	P

Note: 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, not restricted to the over-mature. We count decadent plants, both trees and shrubs, as those with 30% or more dead wood in the upper canopy.

Tree Age Groups

Age Group	**Conifers**1 **and Cottonwoods**	**Other Broadleaf Species** 2
Seedling	<4.5 ft tall **OR** <1.0 inch dbh	<3.0 ft tall
Sapling	4.5 ft tall **AND** 1.0 inch to 4.9 inch dbh	>3.0 ft tall **AND** <3.0 inch dbh
Pole	5.0 inch to 8.9 inch dbh	>6.0 ft tall **AND** 3.0 inch to 5.0 inch dbh
Mature	>9.0 inch dbh	>5.0 inch dbh
Dead	100% of canopy is dead	100% of canopy is dead

[1]Species such as *Juniperus scopulorum* (Rocky Mountain juniper) are exceptions to the specifications given because they lack typical coniferous size, age, and growth form relationships. Assign age classes to individuals of these two species based on relative size, reproductive ability, and overall appearance.
2Other broadleaf species may include species such as *Fraxinus pennsylvanica* (green ash), *Acer negundo* (box-elder), *Populus tremuloides* (quaking aspen), *Betula papyrifera* (paper birch), and *Ulmus americana* (American elm).

D3. The tree regeneration category is automatically calculated in the office by the computer using the age group data collected with the species' canopy cover as described in item D2b. The canopy covers of the seedling and sapling age groups are combined to quantify tree regeneration. The categories represent actual, and not potential, tree regeneration.

Code	***Description***
1	No seedlings or saplings were observed in the polygon.
2	Seedlings and/or saplings were observed; individually, or in combination, these age groups have less than 5% of the species canopy cover.
3	Seedlings and/or saplings were observed; individually, or in combination, these age groups have 5% or more of the species canopy cover, but less than 15%.
4	Seedlings and/or saplings were observed; individually, or in combination, these age groups have 15% or more of the species canopy cover, but less than 25%.
4	Seedlings and/or saplings were observed; individually, or in combination, these age groups have 25% or more of the species canopy cover.

D4. The tree age group distribution category is automatically calculated in the office by the computer using age group canopy covers recorded in item D2b. In classifying tree age group distribution, the seedling and sapling groups are combined. Three resulting age groups (seedlings/saplings, pole, and mature), ***and*** the percent of the mature individuals which are decadent, determine age group distribution categories.

Tree Age Group Categories (An “X” under an age group indicates presence in that category.)

Category Code	Sdlg1/Splg2 (CC > 1%)	Pole (CC > 5%)	Mature (Decadent3) (CC>5%)	Description
1	X			seedling/sapling only
2		X		pole age only
3	X	X		seedling/sapling and pole
4	X		X	seedling/sapling and mature (<75% dec.)
5		X	X	pole and mature (<75% dec.)
6	X	X	X	seedling/sapling, pole, and mature (<75% dec.)
7			X	mature only (<75% dec.)
8	X		X	seedling/sapling and mature (≥75% dec.)
9		X	X	pole and mature (≥75% dec.)
10	X	X	X	seedling/sapling, pole, and mature (≥75% dec.)
11			X	mature only (≥75% dec.)

[1]Sdlg indicates seedlings, Splg indicates saplings, Decadent indicates percent of mature trees, which are decadent

Decadence of younger age groups is ignored in this calculation. Younger decadent trees are assumed to have the capacity to grow out of any current condition caused by injury, disease, or other non-age related factors. A species with decadent mature individuals may fall into one of two classes: those having 75% or more of mature individuals decadent and those having less than 75% of mature individuals decadent. The age distribution category of a tree species on a polygon is defined by the presence of certain age groups. To be present, age groups must have minimum canopy covers in the polygon: seedlings/saplings must have a combined total canopy cover of at least 1%; pole and mature are treated separately and must have at least 5% cover.

D5. Record the appropriate category, which best describes the amount of utilisation (Utl) of the combined seedling (Sdlg) and sapling (Splg) age groups for each tree species. Include all herbivore use by livestock and wildlife, including beaver. ***Note:*** If a plant is entirely mushroom/umbrella shaped by long term heavy browse or rubbing use, count this as heavy utilisation. Be sure to include physical and mechanical damage or cutting by humans, as well as consumptive use by animals.

Category	Description
None	0 to 5% of the available second year and older leaders are clipped (browsed).
Light	>5 to 25% of the available second year and older leaders are clipped (browsed).
Moderate	>25 to 50% of the available second year and older leaders are clipped (browsed).
Heavy	More than 50% of the available second year and older leaders are clipped (browsed).
Unavailable	Woody plants provide no browsed or unbrowsed material below 1.5 m, or are inaccessible due to location or protection by other plants.
NA	Neither seedlings nor saplings of tree species are present.

D6a, b. Are there shrubs present on the polygon, and does the polygon have potential for woody species such as tall shrubs and trees? Some riparian and wetland sites are marshes, wet meadows, or other wetland types that lack potential for woody species. Such sites should not be penalized on health assessment rating for this lack of potential. Other sites lacking these species do have the potential, but lack the plants due to disturbance. Observers are to answer D6b on the basis of species noted on similar, nearby, less disturbed sites, or other indications. On polygons where the observer can not find sufficient evidence to make a confident determination, enter NC and explain in the comment field at the end of the Vegetation Section.

D6c. Record the species code and canopy cover for ***every*** shrub species observed on the polygon. Determine the portion of the species cover represented by each of three groups: seedling/saplings, mature, or decadent/dead. (***Note:*** For shrubs, all decadent individuals are included in one group with dead individuals. This contrasts to the method of recording tree decadence, where the decadence within each age group is recorded.) As with trees, decadent shrubs are individuals having 30% or more dead material in the canopy. The canopy covers of the three age/size groups for a species must total approximately 100%.

In general, shrub seedling/saplings can be distinguished from mature plants on the following basis: For normally tall shrubs, which have an average mature height of over 6.0 ft, seedlings and saplings will be plants reaching only into the first and second vegetation layers (shorter than 6.0 ft). For shrub species having normal mature height between 1.6 and 6.0 ft, seedlings and saplings are individuals reaching only into the first vegetation layer (below 1.5 ft). For short shrub species, whose mature height is 1.5 ft or less, observers must judge individual plants for height, reproductive structures, and other characteristics that indicate relative age. Refer to reference manuals on the regional flora for information of normal sizes for unfamiliar species. Remember that browsing may have shortened the stature of mature specimens.

Record to the right of the slash (/) the ***one category*** that best describes shrub utilisation for each age group (using the five categories in item D5).

Example:	Species	Cover	Sdlg-Splg/Util	Mature/Util	Dec-Dead/Util	Shrub Growth Form
	ALNUTEN	2	P / Moderate	7 / Light	3 / Unavail.	N

D6d. Record the category best describing the dominant appearance of each shrub species in the polygon.

Code	Description
N	***Normal Growth Form.*** No apparent deviation from the normal appearance of the lifeform.
F	***Flat-Topped Growth Form.*** Shrubs with the tallest leaders hedged (e.g., hedging from the top down). (Moose during winter in deep snow browse exposed branches of shorter plants.)
U	***Umbrella-shaped/Heavily-hedged/High-lined.*** Shrubs that have most of the branches (up to 1.5 m in height) removed by browsing.

D7 and **D8.** Record the species code and the percent canopy cover for graminoid and forb species observed in the polygon. ***As a minimum,*** include all species having at least 5% cover on the polygon. This inventory is not intended to be comprehensive. It is not necessary to search for obscure species, just record all species readily seen. Observers should especially look, however, for hydrophytic (wetland) species that may be reduced to trace representation by site disturbance.
Herbaceous species other than invasive species (see item D13) with minor presence may be overlooked without serious compromise to the inventory value.

D9. The purpose of this item is to describe the vegetation structure in terms of height layers and plant lifeforms on the polygon. (Think of the layering as a GIS file with 12 layers, each one representing one of four lifeforms [trees, shrubs, graminoids, and forbs] in one of three height layers.) Include the canopy cover on the polygon that is provided by all standing, rooted plants (live or dead). Do not include fallen wood or other plant litter.

Record the percent canopy cover of each plant lifeform in each of the three height layers. Consider each group in each layer separately. For example, shrubs in layer 2 will be the canopy cover of all plants of all shrubs in the polygon between >1.5 and 6.0 ft tall (roughly knee high to head high). In estimating this value, ignore all plants taller and shorter than this range.
Similarly estimate the cover separately of those taller and those shorter shrubs. Proceed in this way through each lifeform andlayer. As a check, refer to your species/canopy lists to help remember what all you have seen on the site. ***Leave no field blank;*** enter “0” to indicate absence of a value. See further discussion in the note for item D10.

D10. Record the total percent of the polygon area occupied by canopy cover of each plant lifeform. Include the canopy cover on the polygon that is provided by all standing, rooted plants (live or dead). Do not include fallen wood or other plant litter. Avoid counting overlapping areas more than once for one group. (For example, an area is not counted twice for total tree cover if seedlings cover all ground under mature trees.) However, the same piece of ground may occur under the canopy of more than one group. (For example, areas covered by grass which are also under trees would be counted for both tree and grass lifeforms.) On the other hand, when estimating total cover of all plants (item D12), the area covered by both trees and grass would only be counted once—trees and grass in this case being part of the same group (“all four plant groups”).

D11. Record the percent of the polygon area covered by tree and shrub (woody species) canopy considered as a group in the sense described above. Include the canopy cover on the polygon that is provided by all standing, rooted plants (live or dead). Do not include fallen wood.

D12. Record the percent of the polygon area covered by the canopy of all four plant groups together. Include the canopy cover on the polygon that is provided by all standing, rooted plants (live or dead). Do not include fallen wood or other plant litter. Do not consider the polygon area covered by water (such as between emergent plants).

D13a, b. Invasive plants (noxious weeds) are alien species whose introduction does or is likely to cause economic or environmental harm. Without regard to 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 impacted by the presence of noxious weeds. The severity of the weed problem on a site is a function of density/distribution (pattern of occurrence), as well as abundance of the weeds. A weed list should be used that is standard for the region (i.e., *Weeds and Disturbance Species Fact Sheet* [Cows and Fish 2001]).

Record the combined percent canopy cover and the overall density distribution class of all invasive plants on the polygon. Common invasive species in Alberta 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 species. For each weed species observed record canopy cover as a percentage of the polygon (area being evaluated) and density/distribution class. Choose a density/distribution class from the chart (Figure 2) below that best represents each species' pattern of presence on the site.

NOTE: Prior to the 2001 season, weed infestation was assessed with a single numerical value representing the part of the polygon on which a weed species had a well-established population of individuals (i.e., the area it infested).

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 2. Weed density distribution class guidelines

D13c. Record total presence of all invasive species on the polygon. Use the same method described above without consideration of individual species, but instead by considering all weed species together. Enter the total canopy cover of all invasive species and the density/distribution class of all invasive species considered together.

D14a, b. Areas with historically heavy grazing often have large canopy cover of undesirable herbaceous species which tend to be less productive and which contribute less to ecological functions. 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.

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)	____________________________	______________________________

D15. List the riparian habitat type(s) and/or community type(s) found in the polygon using a manual for identifying types in the region in which you are working, such as *Classification and Management of Riparian and Wetland Sites of Alberta's Grassland Natural Region* (Thompson and Hansen 2002). If the habitat type cannot be determined for a portion of the polygon, then list the appropriate community type(s) of that portion. If neither the habitat type nor community type can be determined for any portion of the polygon (or in areas [outside of Montana] where the habitat and community types have not been named and described), list the area in question as "unclassified wetland type" and give the dominant species present.

Indicate with the appropriate abbreviation if these are habitat types (HT), community types (CT), or dominance types (DT), for example, POPUTRE/CORNSTO HT. For each type listed, estimate the percent of the polygon represented. If known, record the successional stage (i.e., early seral, mid-seral, late seral, and climax), or give other comments about the type. As a minimum, list all types that cover 5% or more of the polygon. The total must approximate 100%. Slight deviations due to use of class codes or to omission of types covering less than 5% of the polygon are allowed. ***Note:*** For any area designated as an "unclassified wetland type," it is important to list any species present that can indicate the wetness or dryness of the site.

D16. Select the ***one category*** (Improving, Degrading, Static, or Status Unknown) which best indicates the current trend of the vegetative community on the polygon to the extent possible. Trend refers, in the sense used here, not specifically to successional pathway change, but in a more general sense of apparent community health. By definition, trend implies change over time. Accordingly, a precise trend analysis would require comparison of repeated observations over time. However, some insights into trend can be observed in a single visit. For example, the observer may notice healing (revegetating) of a degraded streambank and recent establishment of woody seedlings and saplings. This would indicate changing conditions that suggest an improving trend. If such indicators are not apparent, select the category "status unknown."

D17. Add any necessary commentary to explain or amplify the vegetation data recorded. ***Do not leave this space blank.*** Describe any unique characteristics of the site and other observations relating to the vegetation. This space is the place for general commentary to help the reader understand the larger context of the data. Such things as landscape setting and local land use history are appropriate here.

STOP and Check the Vegetation Data for Completeness.

WATER QUALITY DATA

E1. Give the waterbody number (FMIS/Hydro code).

E2a, b. If water quality data is available on this waterbody, list the reference where the data can be found.

PHYSICAL SITE DATA

F1. Record whether or not the polygon contains a defined bank or channel bottom. A defined channel will have an unvegetated bottom and evidence of at least ephemeral flow. If no defined channel with banks is found in the polygon, skip the channel/bank related items down to the bare ground item F15.

F2a, b. If the channel bottom is visible (water depth or turbidity or depth does not obscure the bottom), record the percent of channel bottom materials in each size group. (Category sizes are based on the measurement of the middle length axis of the particle. This is the dimension that would limit the screen size the particle could pass through.) The sum of these values must approximate 100%. Consider the area within the generally flatter bottom that lies between the left and right bank toes. The goal here is to characterize the bed load or materials already entrained in the stream. Of course, some systems lacking stored bed load may be flowing on non-alluvial parent material or native bedrock.

F3a, b. Some streambanks are completely vegetated, so do not disrupt the vegetation to examine the substrates. However, if the bank substrate is visible, record the percent of each size category of materials. Consider the generally sloped area above the bank toes bounding both sides of the channel bottom up to the point at which the bank slope levels off or reaches the first terrace top. The goal is to characterize the materials with the most potential to be eroded into the stream by lateral shear forces of flows up to bankfull, or flood, stage. The bank may have very shallow slope and be indistinct, as is often the case on point bars along inside curves, however every channel must have a bank on each side to contained it.

F4a, b. Record the percent of stream length that displays active lateral cutting. Lateral cutting is indicated by new streamcaused bank disruption along the outside of curves and, much less commonly, along straight reaches. Any lateral cutting occurring during the past year is considered active**.** Cut banks with vegetation establishing are considered healing and the cutting no longer active. Since lateral cutting is usually restricted to one side of the channel at any point, this item (unlike others) considers ***only one bank in determining the total stream length*** which displays active lateral cutting. Thus, a 100 ft (30 m) length of stream with 10 ft (3 m) of lateral cutting would have 10% lateral cutting. In contrast, a 100 ft (30 m) length of stream with 10 ft (3 m) of bank alteration (item F6a) would have 5% bank alteration, as both banks (200 ft [60 m] in this case) are equally subject to alteration. If a significant amount of lateral cutting is occurring on exactly opposite banks, describe this unusual situation in the Physical Site Data comment section.

F5. Record the range category estimated to best characterize the degree of polygon streambank instability. There are several types of streambank instability. Unstable banks can be described as follows. ***Undercut banks*** most often indicate a binding root mass which will allow upper streambank layers to persist for some time without support underneath. Highly cohesive soils in the upper banks may also persist above an undercut lower layer without a binding root mass, but this is less common. Not all undercut banks should be called unstable. Some cuts under large trees or shrubs are more stable than banks not undercut held by strongly rooted herbaceous plants. Therefore, consider the timeframe for expected failure in making this call. ***Vertically eroded banks*** are usually composed of cohesive soils (silts and clays), but lack a root mass to significantly increase resistance to erosion. As the stream erodes the bottom of the bank, the top almost immediately collapses. ***Slumping banks*** usually represent the most unstable situation (no cohesive soils or binding root mass). Upper banks crack and give way, often in large chunks, back from the bank top with the material falling toward the stream in mass. The degree of instability in all three cases increases with further disturbance. ***NOTE:*** Assess both sides of the stream, so the total bank length evaluated will be approximately twice the stream reach length.

F6a-d. The banks of a stream are formed to contain the channel flow in a delicate balance of forces that can be destabilized by alteration by many human activities. 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. For smaller streams (see the table below) the portion of the bank to be considered is 18 inches (50 cm) back from the top (or from the normal high water mark in cases where the top of the bank is not obvious). On larger rivers assess a wider bank area of 3 m (10 ft).

This question seeks to assess the amount of alteration, its causes, and its kind; so that remedy can be effectively sought. 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 rip rap) may be stabilized at the immediate location, but are likely to disrupt normal flow dynamics and cause erosion of banks downstream.

Stream Size (Bankfull Channel Width)	Width of Band to Assess for Bank Alteration
Large Rivers (over. 15 m [50 ft])	3 m (10 ft)
Smaller Rivers and Streams (under 15 m [50 ft])	0.5 m (1.5 ft)

If the streambank has not been altered by on-site human activities, answer “No.” to **F6a**. Otherwise, in **F6b,** record the total percent of the polygon streambank that is altered. Then, in **F6c,** break down the total streambank alteration into a distribution among the listed potential agents of cause, so that these add to 100 percent.

In **F6d,** break down the total streambank alteration among the listed potential kinds, so that these also add to 100 percent. ***NOTE:*** A particular kind of alteration may derive from more than one cause (i.e., there may not be a one-to-one relationship between cause and kind. Leave no line blank. Enter “0” if there is none.

F7. Vegetation along streambanks performs the primary physical functions of stabilizing 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 generalizations 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* spp. (sedges) are excellent bank stabilizers. Others, such as *Poa pratensis* (Kentucky bluegrass), have only shallow roots and are poor bank stabilizers. Still others, such as *Juncus balticus* (Baltic rush), are intermediate in their ability to stabilize 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 rootmass.

Since the kind and amount of deep, binding roots needed is stream size dependent. Use the following table as a general guide to determine width of a band along the banks to assess for deep, binding roots.

Stream Size for Deep, binding Roots	(Bankfull Channel Width)	Width of Band to Assess
Small rivers	approx. 10-15 m (33-50 ft)	10 m (33 ft)
Large streams	approx. 5-10 m (16-33 ft)	5 m (17 ft)
Medium streams	approx. 3-5 m (10-16 ft)	3 m (10 ft)
Small streams	up to approx. 3 m (10 ft)	1 m (3 ft)

F8. Two basic functions of substrate materials (or soil) in riparian areas are to act as a sponge in the storage of water and to support vegetation by serving as rooting medium. The kind and amount of soil materials present determine how well these functions can be fulfilled. For example, soils composed of clays, silts, and, to a lesser degree, sands (particle sizes less than 2 mm) will act as a sponge, while coarser substrates such as gravels, cobbles, and boulders will not. Substrate particle size also plays an important role in a site's quality as a plant rooting medium. Substrates dominated by bedrock, exposed boulders (>10 inches [25 cm]), or large cobbles (>5 inches [12.5 cm]) provide a poor rooting medium for plant growth. Record the percent range to represent the portion of the polygon having sufficient fine materials to perform these functions.

F9. Record the average non-vegetated stream channel width through the entire polygon. This is the portion of the stream channel which remains unvegetated due to the scouring action of the stream or due to the presence of continual water. Describe in the blank for physical site comment any discontinuous unvegetated channel.

F10. Record the stream channel gradient percent. A clinometer may be used to measure gradient of the water surface over a distance of at least two full meander cycles or 50 meters (165 feet) (whichever is greater) or the maximum distance practicable. If the stream is large enough, gradient may be determined in a gross manner from a topographic map.

F11a, b. Record the percent of channel length showing active downcutting. Active downcutting of a stream may be hard to recognize. 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. Wetland vegetation perched on pedestals above degraded (eroded) surrounding areas can indicate downcutting. The lack of distinct channel bottom materials different from materials comprising the adjacent banks can also indicate downcutting. Channels in equilibrium with their flow regime and sediment supply usually have bottoms composed of entrained fluvial materials that differ from the bank material. If the stream has removed this bedload and is flowing on material similar to the banks, this can indicate that the stream has destabilized and is downcutting. Look also for headcuts and exposed bedrock on the bottom to indicate downcutting.

F12a-d. Record the presence, number, average height, and location of erosional headcuts in the polygon. Do not count headcuts less than one foot high. These smaller headcuts are taken into account in item F11.

F13a, b. Record the percent of braided stream reach (the stream has more than two active channels) in the polygon. A braided channel is more complex and divided than an occasional island and results most often from excess sediment in the system and/or severe disturbance.

F14. Stream channel incisement is vertical downcutting of the channel bed. It can lower the water table enough to change vegetation site potential. It can also increase stream energy by reducing sinuosity, reduce water retention/ storage, and increase erosion. A stream becomes critically incised when downcutting lowers the channel bed so that the two-year flood event cannot overflow the banks. Four typical downcutting indicators are: a) headcuts; b) exposed cultural features (pipelines, bridge footings, culverts, etc.); c) lack of sediment deposits; d) exposed bedrock; and e) a low, vertical scarp at the bank toe on the inside of a channel bend. Channel incisement can be found in any of several stages (Figure 2). A severe disturbance can initiate downcutting, transforming the system from a steady state of high water table, appropriate floodplain, and high productivity to one of degraded water table, narrow [or no] active floodplain, and low productivity. (These stages of incisement can be categorized in terms of Rosgen Level I channel types [Rosgen 1996].)

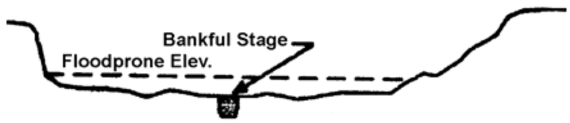
A top rating is given to unincised channels from which the 1-2 year high flow can access a well formed floodplain. These can be meandering meadow streams (Rosgen E-type) and wide valley bottom streams (Rosgen C-type) which access floodplains much wider than the stream channel, or they may be mountain and foothill streams in V-shaped valleys which have floodplains limited by topography or bedrock. 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-types) 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 that are not yet downcut so badly that some flood stages still cannot access the floodplain, or they may be old incisements that are now healing and rebuilding new floodplain in the bottom of the ravine.

Code	Categories of Channel Incisement
A	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 characterized by a broad floodplain inside which perennial riparian plant communities are well established. This condition is illustrated in Figure 2 by the following three stages. **Stage A-1.** A stable, unincised meandering meadow channel (Rosgen E-type). Flows greater than bankfull (1-2 year event) spread over a floodplain more than twice the bankfull channel width. **Stage A-2.** A fairly stable, unincised wide valley bottom stream with broad curves and point bars (Rosgen C-type). Although these streams typically cut laterally on the outside of curves and deposit sediment on inside point bars, bankfull flows (1-2 year events) have access to a floodplain more than twice bankfull channel width. **Stage A-3.** A stable, unincised mountain (Rosgen A-type) or foothill (Rosgen B-type) channel with limited sinuosity and slopes greater than 2%. Although bankfull flow stage is reached every 1-2 years, the adjacent floodplain is often narrower than twice the bankfull channel width. Consequently, overflow conditions are not so obvious as in Stages A-1 and A-2 systems.
B	Either of two incisement phases: (a) an improving phase with a sinuous curve/point bar system (Rosgen C-type) or a narrow, meandering stream (E-type) establishing in an old incisement which now represents the new floodplain, although this may be much narrower than it will become;(b) an early degrading phase in which a narrow, meandering meadow stream (E-type) is degrading into a curve/point bar type (C-type) or a wide, shallow channel (Rosgen F-type). In either case, the 1-2 year high flow event can access only a narrow floodplain less than or only slightly wider than twice the bankfull channel width. Perennial riparian vegetation is well established along much of the reach. These conditions are represented in **Stage B** of Figure 2.
C	Two phases of incisement fit this rating. (a) A deep incisement that is starting to heal. In this phase new floodplain development, though very limited, is key. This phase is characterized by a wide, shallow channel unable to access a floodplain (Rosgen F-type) evolving into a curve/point bar system (C-type) through sediment deposition and lateral cutting. Pioneer perennial plants are beginning to establish on the new depositional surfaces. (b) An intermediate phase with downcutting and headcuts probable. Flows less than a 5-10 year event can access a narrow floodplain less than twice bankfull channel width. These conditions are represented in **Stage C** of Figure 2.

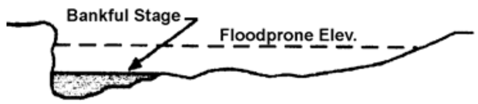
D The channel is deeply incised to resemble a ditch or a gully. Downcutting is likely ongoing. Only extreme floods overtop the banks, and no floodplain development has begun. Both **Stages D-1** and **D-2** of Figure 2 fall into this rating.

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

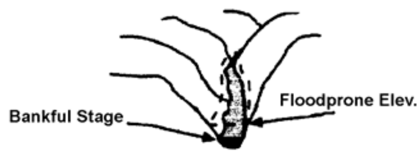
Stage D-2. A narrow, deep "gully" system (Rosgen G-type) downcut to the point that only extreme floods can overtop the banks. Distinguished from narrow mountain streams (A-type) by the presence of a flat floodplain through which the stream has downcut and by banks consisting of fine materials rather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



Stage A-1 (9 points)

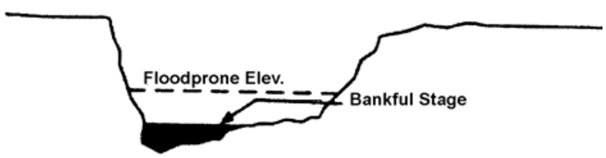


Stage A-2 (9 points)

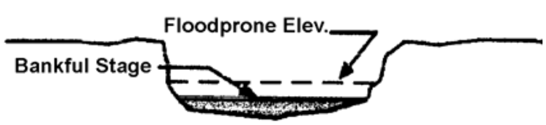


Stage A-3 (9 points)

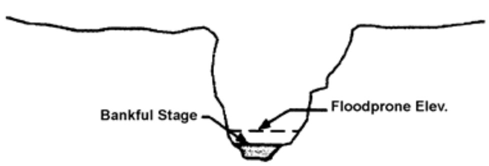
Stage B (6 points)



Stage C (3 points)



Stage D-1 (0 points)



Stage D-2 (0 points)

Figure 2. Guides for estimating stage of channel incisement

F15a, b. Record the portion of the polygon with exposed soil surface (bare ground). Exposed soil surfaces are those surfaces not protected from erosional forces by plants, litter or duff, downed woody materials, rocks of cobble size or larger (>2.5 in [6.25 cm]), or hardened impervious surfaces. Hardened, impervious surfaces (e.g., asphalt, concrete, etc.) are not bare ground (i.e., do not erode nor allow weeds to invade).

F15c. Separate the exposed soil surface into two categories: that resulting from natural and human causes. (These must total approximately 100%. Examples of human causes include livestock wallows and trails, hiking tails, ATV trails, roads, timber harvesting skid trails, mining, and construction activities.

F15d. Within both the natural and human-caused categories, record the proportions of exposed soil surface (bare ground) resulting from the listed causes. Within each category, the portions assigned to the individual causes must total approximately 100%. Explain whatever is put in the "other" category.

F16. Record how much of the polygon is covered by the items listed, which are not already taken into account as live vegetative cover, exposed soil surface, or open water (under the habitat type/community type question). Include areas covered only by litter or duff, downed woody materials, rocks of cobble size or larger (>2.5 in [6.25 cm]), or man-made impervious surface (concrete, asphalt, roofed structure, etc.). These are ground covers not accounted for by exposed soil surface (bare ground) and standing trees or shrubs or herbaceous vascular plant canopy of the season, which are recorded elsewhere. Although they do not support vegetation, they are not erodible. ***NOTE:*** Animal dung and dead, non-rooted, plant material that is not considered "wood" are all considered "litter and duff."

F17. Answer "Yes" if these bars are being colonized by perennial plant species and "No" if channel point bars older than the current season are not becoming vegetated by perennial plant species.

F18. Check whether there are forested areas nearby upstream or up slope with potential to deliver significant amounts of large woody debris to the stream channel. Consider scale of the system in this item, but large woody debris is generally understood to mean tree trunks.

F19a, b. Apart from the streambank, the remaining polygon area is naturally formed to perform riparian functions that may be disrupted by a variety of human-caused disturbances. If the non-streambank area of the polygon has been physically altered by human causes (**F19a**), estimate the total amount of all kinds of physical site alteration to this area (**F19b**).

F19c. Break down the total non-streambank alteration among the listed potential agents of cause, so that these add to 100 percent.

F19d. Break down the total non-streambank alteration among the listed kinds, so that these add to 100 percent. Kinds of human-caused alterations to the physical site include: cultivation, logging, mining, housing development, and the various effects of trampling by livestock or the abnormal concentrations of wildlife that result from human management. Count such things as: animal or human hummocking, pugging, and trampling, trailing, etc.; changes to the soil surface that impede water infiltration (i.e., impervious covers, compacted paths, trails, roads, etc.); hydrologic changes (i.e., draining, ditching, berming, etc.); disturbance to the natural soil surface caused by farming (plowing/tilling) or any other human activity.

F19e. Record the distribution of the pugging/hummocks between area within the streambanks and area outside the banks in **F19f**. ***Pugging*** is tracking depressions left by large animals (typically hooved animals, but occasionally humans) left in fine textured soil. Moist clay or silt usually has a consistency to hold tracks. Upon drying, pugged areas will have a hard, irregular surface, difficult to walk across. Bare soil may or may not be present. ***Hummocking*** is a form of micro-topographic relief characterized by raised pedicels of vegetated soil as much as 2 ft higher than the surrounding ground which results from long term large animal trampling and tracking in soft soil. Vegetation on the pedicels usually differs from that on the surrounding lower area due to moisture difference between the two levels.

F20a, b. If pugging and/or hummocking is present in the polygon, record the percent of polygon area affected in

F21a, b. Record the number of springs or seeps observed in the polygon. ***For this item, the non-vegetated stream channel bottom is included in the inventoried area.*** This inclusion allows the recording of springs or seeps found in the bottom or lower banks of commonly dry channels.

F21c. Of those springs and seeps recorded in item F26b, record the number having livestock-caused pugging and/or hummocks on at least 25% of the wet area associated with the spring or seep.

F21d. Record the general position within the polygon of springs and seeps (e.g., "upper 1/4 of polygon," middle 1/3 of polygon").

F22a-d. If the wetland type is a "pooled channel stream," record the percent of channel length with pooled water. Indicate whether a portion of this water is expected to remain through the growing season. Describe location of pools in the polygon relative to boundaries or other mapped or described features.

F23a-f. Record evidence of beaver activity in the polygon. Record whether the beaver sign appears current (active) or old (inactive). Describe the types and amounts of beaver evidence observed.

F24. Record comments, observations, and/or conclusions as instructed on the form.

F25. Describe the boundaries of the polygon, especially the location of the upper and lower ends, as well as the lateral boundaries. On smaller streams the polygon usually includes the entire width of the riparian zone. Describe what you use as the indicators of the wetland-upland boundary. Use localized geologic, physical, or vegetation information to identify these boundaries of the polygon for future polygon relocation.

PHOTOGRAPH DATA

Note: Take at least one photo upstream and one downstream at each end of every polygon. This applies even to situations where the polygon is at one end of an inventoried reach and one of the photos is taken into a non-inventoried area, as well as situations in which another polygon is adjacent to the one being inventoried.

G1. Identify the film roll number, photo (frame) number, and description of each photograph taken at the upper end of the polygon. List them in the order of upper views, then lower views, and then each other shot taken to show features of interest. Also, identify the photographer and camera used.

G2. Indicate if there is adjacent polygon upstream of this one.

G3. Same as G1 above for shots taken at the lower end of the polygon.

G4. Indicate if there is adjacent polygon downstream of this one.

G5. Identify all additional photos taken outside of polygon (i.e., non-polygon photos) by giving roll number, frame number, and description of view.

G6. Record the brand of film, film speed, camera lens size, and lens focal length or magnification.
STOP and Check the Physical Site data and Photograph data for completeness.

ADDITIONAL DATA ITEMS

H1. Record the rating category that best describes the vegetation use by animals (Platts and others 1987). This is intended as a measure of herbivore utilisation of available forage. However, it may be extended to include human removal of this same forage by mowing or other means. Although Platts and others (1987) state that this available forage is mainly herbaceous, the concept here is extended to also include normally utilized and available woody species. Record the category, not a precise value.

Code	Category Description
0 to 25%	Vegetation use is light or none. Almost all plant biomass at current development stage remains. Vegetation cover is close to that which would occur without use. Unvegetated areas (such as bedrock) are not a result of land uses.
26 to 50%	Vegetation use is moderate. At least half the potential plant biomass remains. Average stubble height is more than half its potential at the present stage of development.
51 to 75%	Vegetation use is high. Less than half the potential plant biomass remains. Plant stubble height is usually more than 2 inches (on many ranges).
76 to 100%	Vegetation use is very high. Only short stubble remains (usually less than 2 inches on many ranges). Almost all plant biomass has been removed. Only the root systems and parts of the stems remain.

H2. Record the type(s) of uplands adjacent to the lotic wetland; if "other" is selected, describe.

H3. Break down the polygon area into percentages of the land uses listed. Name any "others" observed.

H4. Break down the area adjacent to the polygon into the land uses listed. Name any "others" observed.

H5a, b. On many small streams the sinuosity (river length divided by the valley length) is not accurately represented on available topo maps due to limitations of map scale. Field observers are to examine the 7.5-minute map to determine if sinuosity is accurately shown. If the answer is "Yes," the field observer will leave blank item F10b, and sinuosity will be determined from the map in the office to the nearest tenth (i.e., 1.1, 1.2, etc.). If the answer is "No," the observer will measure sinuosity in the field and enter it into item F10b.

Field measurement of sinuosity is done by pacing the channel length along one edge for at least two meander cycles and dividing this value by the valley length between the same two points. (All sinuosities are at least 1.0, in which case the stream would exactly follow the valley bottom with no meandering whatsoever.)

H6. Record the percent of streambank length accessible to livestock. In general, only consider topography (steep banks, deep water, etc.) and dense vegetation as restricting access. Fences, unless part of an exclosure, do not necessarily restrict livestock access, even though they may appear to be doing so at the time.

H7a-d. Note the types and locations of any of the listed human constructed channel or streambank modifications observed within the polygon. Use "other" to note channel modifications observed but not included in this list.

H7e, f. Many channel modifications alter flow regimes and natural channel dynamics. Rate the stability of any channel modification according to your perception of probable high flow effects in the stream reach. Describe any apparent effects of the modifications on the immediate and downstream channel and banks.

H8. Record the Rosgen stream channel geomorphology type(s) observed in the polygon and the percent of total stream reach of each type representing at least 5% of the total reach, with the exception of stream types G, F, and D, which are considered degraded (Rosgen 1996). Degraded streams of these Rosgen types should be noted regardless of length. Stream reaches with sediment loads that appear higher than natural should also be noted in the comment section (item F29). (***Note:*** These observations are generally based on ocular estimates rather than quantitative measurements.)

WILDLIFE DATA (These wildlife data represent incidental observations only.)

H9a, b. If waterfowl nests or young broods were observed, describe location, type, and whether the nest was in use, of the year, or old.

H10a-e. Respond to the fishery questions based on observations.

H11a, b. Record the type and number of any amphibians observed.

H12a, b. Record the type and number of any reptiles observed.

H13. If possible, record the species name, number of individuals, and sighting locations of amphibians and reptiles (e.g., "lower 1/3 of polygon," "throughout polygon," "upper 1/4 of polygon").

H14a-d. List threatened and endangered animal species observed in the polygon along with any nesting sites. Space is provided to list species observed. Consult relevant documents to determine appropriate species. Record the location in the polygon where animals or nests were sighted.

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APPENDIX O
Alberta Lotic Wetland Health Assessment for Streams and Small Rivers (Survey) Form (7/11/2006)

ALBERTA LOTIC WETLAND HEALTH ASSESSMENT FOR STREAMS AND SMALL RIVERS (survey)

Record ID No: ______

ADMINISTRATIVE DATA

A1. Field data collected by (Organisation): ______

A2. Funding Agency/Organisation: ______

A3a. Indian or Metis Reserve? (Yes; No): ______ If **Yes**, Reserve Name: ______

A3b. National or Provincial Park, Preserve, or Sanctuary? (Yes; No): ______

If **Yes**, Name: ______

A3c. Ecological, Environmental and/or Municipal Reserve (Exclude national or provincial reserves)? (Yes; No): ______

If **Yes**, Name: ______

A3d. Private or Deeded Land? (Yes; No): ______ **A4.** Observers: ______

A5a. Date field data collected: ______ **A5b.** Year: ______ **A6a.** Grazing lease or grazing reserve? (Yes; No): ______

If **Yes**, **A6b.** Grazing disposition No.: GRL: ______ GRP: ______

FGL: ______ Other: ______

A6c. Other Grazing Name (e.g. Community Pasture): ______

A7a. Is this the latest inventory for this polygon? (Yes; No): ______

A7b. At least some part of this polygon has been inventoried more than once (resampled)? (Yes; No): ______

If **No**, Go to item A8a. **A7c.** This polygon coincides exactly with another inventoried polygon? (Yes; No): ______

If **No**, Go to item **A7f.**, **A7d.** Other years sampled: ______

A7e. ID No.(s) of other inventories of this exact polygon: ______ , ______ , ______ , ______ , ______

A7f. This polygon shares common area with other inventoried polygon(s), but is not exact? (Yes; No): ______

A7g. Other years: ______

A7h. ID No.(s) of other records sharing area with this polygon: ______ , ______ , ______ , ______ , ______

A8a. Has a change in management occurred? (Yes; No, Unknown): ______ **A8b.** Year changed occurred: ______

A8c. Type of management change applied: ______

LOCATION DATA

B1. Province: ______ **B2a.** Natural Region: ______ **B2b.** Natural Sub-Region: ______

B3. County/Municipal District: ______ **B4a.** City/Town/Village: ______

B4b. Subdivision Plan No.: ______ **B4c.** Block No.: ______ **B4d.** Lot No.: ______

B5. Allotment/Range Unit/Landowner/Lessee Name: ______

B6. Waterbody/Area Name: ______ **B7.** Polygon number: ______

B8a. Location: 1/4 1/4 Sec: ______ 1/4 Sec: ______ Sec: ______ **B8b.** Side of Waterbody: ______

Township (NS): ______ Range (EW): ______ Meridian: ______ **B9.** Elev. (ft): ______ ; (m): ______

B10a. Major Watershed (e.g. North Saskatchewan River): ______

B10b. Minor Watershed (e.g. Battle River): ______

B10c. Minor Watershed Area (km^2): ______ ; (hect): ______ **B10d.** Minor Watershed Perimeter (km): ______

B10e. Sub-basin (e.g. Iron Creek): ______

B11a. UTM coordinates of polygon UPPER END: Easting: ______ ; Northing: ______ ; Zone: ______

B11b. UTM coordinates of polygon LOWER END: Easting: ______ ; Northing: ______ ; Zone: ______

B11c. UTM coordinates of any other point of interest in the polygon: East: ______ ; North: ______ ; Zone: ______

B11d. GPS Unit #: ______ WPt Upper: ______ WPt Lower: ______ WPt Other: ______

B11e. Comments: ______

B12a. Map Title(s): ______ ______

B12b. Map Scale: ______ **B12c.** Map Year: ______

B13. Aerial Photo Info: Scale: ______ Date: ______ Job#: ______ Line#: ______

AS#: ______ Photo#: ______ Other Info: ______

Record ID No: ____________

SELECTED SUMMARY DATA

C1. Water body type: ________________________ C2. Polygon size (acres): ________ ; (hect): ________

C3a. Is the entire polygon an upland? (Yes; No): ______ If No, C3b. Does the polygon consist entirely of functional wetland types? (Yes; No): ____ C3c. Functional wetland (acres): ______ ; (hect): ______ C3d. Percent of total polygon: ______

C4. Does the polygon contain a defined streambank or channel? (Yes; No; NC): ______

C5. Polygon length (river miles, usually the same as channel length) (mi): ______ ; (km): ______

C6. Number of river miles the polygon represents: ______ ; (km): ______

C7. Average polygon width (usually same as width of the riparian zone) (ft): ______ ; (m): ______

C8. Habitat Types And Community Types

Classification Type Name	Phase	Pct of Poly	Successional Stage or Comments

ADDITIONAL SITE CHARACTERISTICS

D1a. The polygon has potential for tall woody type(s) (Yes, No): ______ D1b. Polygon has tall woody type(s) (Yes, No): ______

D2. Waterbody number (FMIS/Hydro code): ______________

D3a. Is water quality data available on this waterbody? (Yes, No, Unknown, NA): ______

If Yes, D3b. Describe the reference for that data (name, year, etc.): ________________________

D4. Detailed description of upper and lower ends and width (lateral boundaries) of the polygon:

PHOTOGRAPH DATA

E1. Identification of photos (taken at the *upstream* end of polygon): Photographer: ________

Camera Number: ________

Upstream views: Roll #: ____ Photo #: ____ Description: ________

Downstream views: ____ ____ ________

Other views ____ ____ ________

E2. Is there an adjacent polygon *upstream* of this polygon? (Yes; No): ____

E3. Identification of photos (taken at the downstream end of polygon): Photographer: ________

Camera Number: ________

Upstream views: Roll #: ____ Photo #: ____ Description: ________

Downstream views: ____ ____ ________

Other views: ____ ____ ________

E4. Is there an adjacent polygon *downstream* end of this polygon? (Yes; No): ____

E5. Identification of additional photos taken outside of polygon (i.e., non-polygon photos):

Roll #:	Photo #:	Description:

E6. Film and Camera Specs: Film brand: ________ Film speed (ASA): ____ Lens dia. (mm): ____

Lens foc. len. (mm): ____

LOTIC HEALTH ASSESSMENT SCORE SHEET

	Actual Score	Possible Score	Comment
1. Vegetative Cover of Floodplain and Streambanks	____	____	____
2a. Invasive Plant Species Canopy Cover	____	____	____
2b. Invasive Plant Species Density Distribution	____	____	____

List Invasive Plant Species present, including Percent Canopy Cover and Density Distribution Class:

	Species	Can.Cov.	Dens.Dist.
1.	____	____	____
2.	____	____	____
3.	____	____	____
4.	____	____	____
5.	____	____	____

	Actual Score	Possible Score	Comment
3. Disturbance-increaser Undesirable Herbaceous Species	____	____	____
4. Preferred Tree and Shrub Species Establishment and Regeneration	____	____	____
5. Utilization of Preferred Tree and Shrub Species	____	____	____
6. Standing Decadent and Dead Woody Material	____	____	____
Vegetation Subtotal:	____	____	
7. Streambank Root Mass Protection	____	____	____
8. Human-Caused Bare Ground	____	____	____
9. Streambank Structurally Altered	____	____	____
10. Human Physical Alteration to the Rest of the Polygon	____	____	____
11. Stream Channel Incisement	____	____	____
Soil/Hydrology Subtotal:	____	____	
Overall Polygon Total:	____	____	

12. Comments and Observations:

____

RATING CALCULATION

(Actual Score/Possible Score) X 100 = Rating Percent — Descriptive Category

	Actual		Possible		Rating Percent	Descriptive Category
Vegetation Rating:	____	/	____	00 =	____	____
Soil / Hydrology:	____	/	____	00 =	____	____
Total Rating:	____	/	____	00 =	____	____

Rating Percent Range	*Descriptive Category*
80-100	*Proper Functioning Condition (Healthy)*
60-79	*Functional At Risk (Healthy, but with Problems)*
<60	*Nonfunctional (Unhealthy)*

ADDITIONAL MANAGEMENT CONCERNS (OPTIONAL)

The following items do not contribute to a site's score. Rather they help to quantify inherent physical site characteristics or assess the direction of change on a site. These data can be useful for planning future site management.

13a. Streambank rock volume: ____________________

13b. Streambank rock size: ____________________

14. Vegetation use by animals: ____________________

15. Susceptibility of parent material to erosion: ____________________

16. Percent of streambank accessible to livestock: ________

17. Polygon trend (Is the polygon: Improving, Degrading, Static, or Status Unknown?): ____________________

18. Break Down the Polygon Area Into the Land Uses listed (must total to approx. 100%):

No land use apparent: ________

Turf grass (lawn): ________

Tame pasture (grazing): ________

Native pasture (grazing): ________

Recreation (ATV paths, campsites, etc.): ________

Development (buildings, corrals, paved lots, etc.): ________

Tilled Cropping: ________

Perennial forage (e.g., alfalfa hayland): ________

Roads: ________

Logging: ________

Mining: ________

Railroads: ________

Other: ________

Description of Other Usage Noted:

____

____

19. Break Down the Area Adjacent to the Polygon Into the Land Uses listed (must total to approx. 100%):

No land use apparent: ________

Turf grass (lawn): ________

Tame pasture (grazing): ________

Native pasture (grazing): ________

Recreation (ATV paths, campsites, etc.): ________

Development (buildings, corrals, paved lots, etc.): ________

Tilled Cropping: ________

Perennial forage (e.g., alfalfa hayland): ________

Roads: ________

Logging: ________

Mining: ________

Railroads: ________

Other: ________

Description of Other Usage Noted:

____

____

APPENDIX P
Alberta Lotic Wetland Health Assessment for Streams and Small Rivers (Survey) User Manual (5/15/2006)

The user manual is intended to accompany the Alberta Lotic Wetland Health Assessment For Streams and Small Rivers (survey) Form for the rapid evaluation of lotic (riparian) wetlands. Another form entitled the Alberta Lentic Wetland Health Assessment (survey) Form, with a different set of codes and instructions, is available for lentic (still water) wetlands.

ACKNOWLEDGEMENT

Development of these assessment tools has been a collaborative and reiterative process. Many people from many agencies and organizations have contributed greatly their time, effort, funding, and moral support for the creation of these documents, as well as to the general idea of devising a way for people to look critically at wetlands and riparian areas in a systematic and consistent way. Some individuals and the agencies/organizations they represent who have been instrumental in enabling this work are Dan Hinckley, Tim Bozorth, and Jim Roscoe of the USDI Bureau of Land Management in Montana; Karen Rice and Karl Gebhardt of the USDI Bureau of Land Management in Idaho; Bill Haglan of the USDI Fish and Wildlife Service in Montana; Barry Adams and Gerry Ehlert of Alberta Public Lands Division; Lorne Fitch of Alberta Environmental Protection; and Greg Hale and Norine Ambrose of the Alberta Cows and Fish Program.

BACKGROUND INFORMATION

Introduction

Public and private land managers are being asked to improve or maintain lotic (riparian) habitat and stream water quality on lands throughout western North America. Three questions that are generally asked about a wetland site are:

1) What is the potential of the site (e.g., climax or potential natural community)?
2) What plant communities currently occupy the site?
3) What is the overall health (condition) of the site?

For a lotic (flowing water) site, the first two questions can be answered by using the Alberta Lotic Wetland Inventory Form along with *Classification and management of riparian and wetland sites of Alberta's Grassland Natural Region* (Thompson and Hansen 2002) or a similar publication written for the region in which you are working. The health assessment survey is a method for rapidly addressing the third question above: What is the site's overall health (condition)? It provides a site rating useful for setting management priorities and stratifying riparian sites for remedial action or more rigorous analytical attention. It is intended to serve as a first approximation, or "coarse filter," by which to identify lotic wetlands in need of closer attention so that managers can more efficiently concentrate effort. We use the term "riparian health" to mean the ability of a riparian reach (including the riparian area and its channel) to perform certain functions. These functions include sediment trapping, bank building and maintenance, water storage, aquifer recharge, flow energy dissipation, maintenance of biotic diversity, and primary production. Excellent sources of practical ideas and tips on good management of these streamside wetland sites are found in *Caring for the Green Zone* (Adams and Fitch 1995), *Riparian Areas: A User's Guide to Health* (Fitch and Ambrose 2003), and *Riparian Health Assessment for Streams and Small Rivers* (Fitch and others 2001). In Saskatchewan some excellent resources are *Streambank Stewardship, Your Guide to Caring For Riparian Areas in Saskatchewan* (Huel 1998) and *Managing Saskatchewan Wetlands—A Landowner's Guide* (Huel 2000).

Flowing Water (Lotic) Wetlands vs. Still Water (Lentic) Wetlands

Cowardin and others (1979) point out that no single, correct definition for wetlands exists, primarily due to the nearly unlimited variation in hydrology, soil, and vegetative types. Wetlands are lands transitional between aquatic (water) and terrestrial (upland) ecosystems. Windell and others (1986) state that "wetlands are part of a continuous landscape that grades from wet to dry. In many cases, it is not easy to determine precisely where they begin and where they end."

In the semi-arid and arid portions of western North America, a useful distinction has been made between wetland types based on association with different aquatic ecosystems. Several authors have used ***lotic*** and ***lentic*** to separate wetlands associated with flowing water from those associated with still water. The following definitions represent a synthesis and refinement of terminology from Shaw and Fredine (1956), Stewart and Kantrud (1972), Boldt and others (1978), Cowardin and others (1979), American Fisheries Society (1980), Johnson and Carothers (1980), Cooperrider and others (1986), Windell and others (1986), Kovalchik (1987), Federal Interagency Committee for Wetland Delineation (1989), Mitsch and Gosselink (1993), and Kent (1994).

Lotic wetlands are associated with rivers, streams, and drainageways. Such wetlands, also referred to as riparian wetlands, contain a defined channel and floodplain. The channel is an open conduit which periodically or continuously carries flowing water and dissolved and suspended material. Beaver ponds, seeps, springs, and wet meadows on the floodplain of, or associated with, a river or stream are part of the lotic wetland.

Lentic wetlands are associated with still water systems. These wetlands occur in basins and lack a defined channel and floodplain. Included are permanent (i.e., perennial) or intermittent bodies of water such as lakes, reservoirs, potholes, marshes, ponds, and stockponds. Other examples include fens, bogs, wet meadows, and seeps not associated with a defined channel.

Functional vs. Jurisdictional Wetland Criteria

Defining wetlands has become more difficult as greater economic stakes have increased the potential for conflict between politics and science. A universally accepted wetland definition satisfactory to all users has not yet been developed because the definition depends on the objectives and the field of interest. However, scientists generally agree that wetlands are characterized by one or more of the following features:

1) **wetland hydrology,** the driving force creating all wetlands,
2) **hydric soils,** an indicator of the absence of oxygen, and
3) **hydrophytic vegetation,** an indicator of wetland site conditions.

The problem is how to define and obtain consensus on thresholds for these three criteria and various combinations of them. Wetlands are not easily identified and delineated for jurisdictional purposes. Functional definitions have generally been difficult to apply to the regulation of wetland dredging or filling. Although the intent of legislation is to protect wetland functions, the current delineation of jurisdictional wetland still relies upon structural features or attributes. The hydrogeomorphic (HGM) approach being developed by the US Corps of Engineers is intended to focus more specifically on wetland functions.

The prevailing view among many wetland scientists is that functional wetlands need to meet only one of the three criteria as outlined by Cowardin and others (1979) (e.g., hydric soils, hydrophytic plants, and wetland hydrology). On the other hand, jurisdictional wetlands need to meet all three criteria, except in limited situations. Even though functional wetlands may not meet jurisdictional wetland requirements, they certainly perform wetland functions resulting from the greater amount of water that accumulates on or near the soil surface relative to the adjacent uplands. Examples include some woody draws occupied by the *Acer negundo/Prunus virginiana* (Manitoba maple/choke cherry) habitat type (Thompson and Hansen 2002) and some floodplain sites occupied by the *Artemisia cana/Agropyron smithii* (silver sagebrush/western wheatgrass) habitat type or the *Populus tremuloides/Cornus stolonifera* (aspen/red-osier dogwood) habitat type. Currently, many of these sites fail to meet jurisdictional wetland criteria. Nevertheless, these functional wetlands provide important wetland functions vital to wetland dependent species and may warrant special managerial consideration. The current interpretation is that not all functional wetlands are jurisdictional wetlands, but that all jurisdictional wetlands are functional wetlands.

Lotic (Riparian) Health

As noted above, the health of a lotic site (a wetland, or riparian area, adjacent to flowing water) may be defined as the ability of that system to perform certain wetland functions. These functions include sediment trapping, bank building and maintenance, water storage, aquifer recharge, flow energy dissipation, maintenance of biotic diversity, and primary biotic production. A site's health rating may also reflect management considerations. For example, although *Cirsium arvense* (Canada thistle) or *Euphorbia esula* (leafy spurge) may help to trap sediment and provide soil-binding properties, other functions (i.e., productivity and wildlife habitat) will be impaired; and their presence should be a management concern.

No single factor or characteristic of a wetland site can provide a complete picture of either site health or the direction of trend. The lotic health assessment is based on consideration of physical, hydrologic, and vegetation factors. It relies heavily on vegetative characteristics as integrators of factors operating on the landscape. Because they are more visible than soil or hydrologic characteristics, plants may provide early indications of riparian health as well as successional trend. These are reflected not only in the types of plants present, but also by the effectiveness with which the vegetation carries out its wetland functions of stabilizing the soil, trapping sediments, and providing wildlife habitat. Furthermore, the utilisation of certain types of vegetation by animals may indicate the current condition of the wetland and may indicate trend toward or away from potential natural community (PNC).

In addition to vegetation factors, an analysis of site health and its susceptibility to degradation must consider physical factors (soils and hydrology) for both ecologic and management reasons. Changes in soil or hydrologic conditions obviously affect functioning of a wetland ecosystem. Moreover, changes in physical characteristics are often (but not always) more difficult to remedy than vegetative changes. For example, extensive incisement (down-cutting) of a stream channel may lower the water table and thus change site potential from a *Salix lutea/Cornus stolonifera* (yellow willow/red-osier dogwood) habitat type to an *Bromus inermis* (smooth brome) community type or even to an upland (non-riparian) type. Sites experiencing significant hydrologic, edaphic (soil), or climatic changes will likely also have a change in plant community potential.

This assessment method attempts to balance the need for a simple, quick index of health against the reality of an infinite variety of wetland situations. Although this approach will not always work perfectly, we believe in most cases it will yield a usefully accurate rating of riparian health. Some more rigorous methods to determine status of a stream's channel morphology are Dunne and Leopold (1978), Pfankuch (1975), and Rosgen (1996). These relate their ratings to degree of channel degradation, but do not integrate other riparian functions into the rating. Other methods are available for determining condition from perspectives that also include vegetation, most notably the USDI Bureau of Land Management (BLM) proper functioning condition (PFC) methodology (1998).

This rapid assessment procedure has been tested in Montana, surrounding states, and western Canada since 1992. Some potential uses for this rating are:

1) for stratifying streams or stream reaches by degree of ecologic dysfunction,
2) for identifying ecologic problems, and
3) when repeated over time, for monitoring to detect functional change.

A less direct, but also important, value of an environmental assessment of this kind is its educational potential. By getting land managers to focus on individual riparian functions and ecologic processes, they may come to better understand how the parts work together and are affected by human activities.

This method is not designed for an in-depth and comprehensive analysis of ecologic processes. Such analysis may be warranted on a site and can be done after this evaluation has identified areas of concern. Nor does this approach yield an absolute rating to be used in comparison with streams in other areas or of other types. Comparisons using this rating with streams of different types (Rosgen 1996), different orders (size class), or from outside the immediate locality should be avoided. Appropriate comparisons using this rating can be made between segments of one stream, between neighboring streams of similar size and type, and between subsequent assessments of the same site.

A single evaluation provides a rating at only one point in time. Due to the range of variation possible on a riparian site, a single evaluation cannot define absolute status of site health or reliably indicate trend (whether the site is improving, degrading, or stable). To monitor trend, health assessments should be repeated in subsequent years during the same time of year. Evaluation should be conducted when most plants can be identified in the field and when hydrologic conditions are most nearly normal (e.g., not during peak spring runoff or immediately after a major storm). Management regime should influence assessment timing. For example, in assessing trend on rotational grazing systems, one should avoid comparing a rating after a season of use one year to a rating another year after a season of rest.

There are some visible changes to riparian area health which we have no simple way to measure. An obvious and commonly encountered example is excess entrained sediment. This may indicate serious degradation, but we leave it out of the assessment due to difficulty in knowing how much is normal. Instead, we address on-site causes of sediment production: bare ground, banks with poor root mass protection, and human-caused structural damage to the banks. Another potentially serious degrading factor for which we have no simple measurement yet is dewatering of the system by irrigation diversion/pumping and by upper drainage retention dams.

Pre-Assessment Preparation

The lotic wetland health assessment process incorporates data on a wide range of biological and physical categories. The basic unit of delineation upon which an assessment is made is referred to as a ***polygon.*** Polygons are delineated on 7.5- minute topographic (topo) maps by marking the upper and lower ends before observers go to the field. (The widths of most riparian zones are unknown before the inventory and cannot be pre-marked.) On 7.5-minute topo maps, most polygons are usually drawn as a single line following the stream or river and are numbered sequentially proceeding downstream. It is important to clearly mark and number the polygons on the topo map. Polygons are numbered pre-field (in the office) with consecutive integers (1, 2, 3 . . .). In cases where field inspection shows the need to change the delineation or to subdivide the pre-drawn polygons, additional polygons should be numbered using alpha-numerics (e.g., 1a, 1b, 2a, 2b, etc.). Combinations of delineated polygons will be field identified as the hyphenated tags of both combined parts (e.g., 1-2, 2-3, etc.).

If aerial photos are available, pre-field polygon delineations may be based on vegetation differences, geologic features, or other observable characteristics. On larger systems with wide riparian areas, aerial photos may allow the pre-field drawing of multiple polygons away from the river. In these cases, where polygons can be drawn as enclosed units (instead of just as a line), a minimum mapping unit of 5 to 10 acres (2 to 4 ha) should be used. The size of the minimum mapping unit should be based on factors such as management capabilities and the costs and capabilities of data collection.

Upper and lower polygon boundaries are placed at distinct locations such as fences, stream confluences, or stream meanders that can be recognized in the field. Polygons should not cross fences between areas with different management. In most cases, polygons are delineated one quarter to three quarters of a mile (0.4 km to 1.2 km) long. On smaller streams, polygons include the land on both sides of the stream. On large rivers, or if property ownership or access differs, polygons may include only one side of a stream.

Once in the field, observers will verify (ground truth) the office-delineated polygon boundaries. If the pre-assigned numbers are used, be sure the inventoried polygons correspond exactly as drawn originally. Observers are allowed to move polygon boundaries, create new polygons, or consolidate polygons if the vegetation, geography, location of fences, or width of the wetland zone warrant. If polygon boundaries are changed, the changes must be clearly marked on the field copies of the 7.5- minute topographic maps. The original polygon numbers should be retained on the map for cross-reference.

Selection of a Reach to Evaluate

If time is available, or the length of stream in question is short, the entire stream can be assessed. If not, then one or more reaches may represent the whole. The evaluator may choose either a ***critical*** reach (an especially sensitive spot) or one ***representing*** (typical of) the larger area. It may be wise to assess both critical and representative reaches. To determine what is actually representative, observers must become familiar with the entire length of the designated stream and adjacent riparian area. This will require walking the entire length.

Identification of plant communities by vegetation type (such as Thompson and Hansen 2002) will be useful both in site selection and, later, in determining appropriate management. These communities may be in a mosaic difficult to map. An area may have a mix of herbaceous communities, shrubs, and forest. These communities have diverse resource values and may respond differently to a management action, but it is seldom practical to manage such communities separately. Community composition can be described as percentages of component types. Management actions can then be keyed to the higher priority types present.

We recommend the length of reach be at least one channel meander cycle, although two is preferable. Streambank problems will be overestimated if the reach is located mostly on an outside curve and underestimated if it is mostly on an inside curve. A complete meander cycle has equal inside and outside curvature (Figure 1)

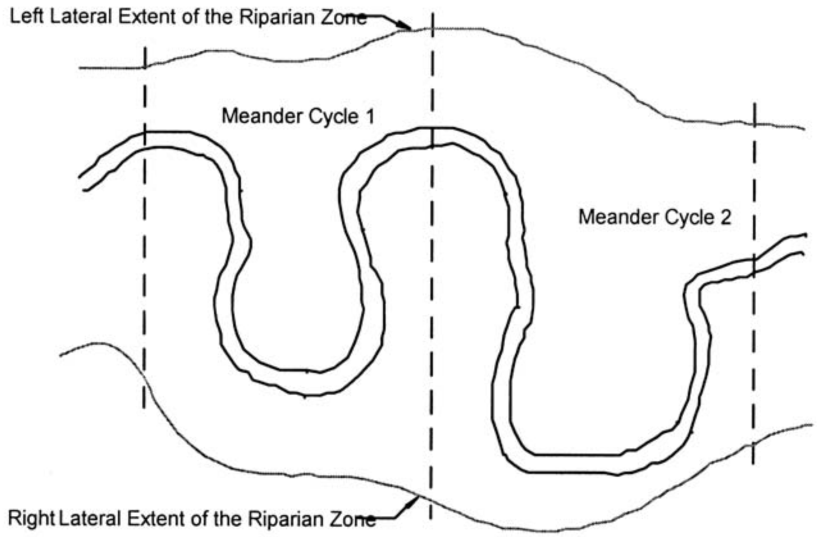

Figure 1. A schematic example of meander cycle delineation showing two cycles

Scale should be considered in determining reach length. Whereas a 600 ft (180 m) reach length may include two meander cycles on smaller streams, such a length would be inadequate on a river 100 ft (30 m) wide. If the reach to be assessed must be shorter than a full meander cycle, the evaluator should look beyond the delineated reach to include a full meander cycle when rating channel morphology and streambank factors. If it is impractical to assess a full meander cycle, we recommend a 600 ft (180 m) minimum length.

In addition to reach length, riparian zone width must be considered. The outer boundaries of riparian polygons are at the wetland vegetative type outer edges. These boundaries are sometimes clearly defined by abrupt changes in the geography and/or vegetation, but proper determination often depends on experienced interpretation of more subtle differences. The area to be assessed includes any terraces dominated by facultative wetland and wetter plant species (Reed 1988), the active floodplain, streambanks, and areas in the channel with emergent vegetation (Figure 2). Reference to Reed's list of plants found in wetlands should not be necessary to determine the area for evaluation. The evaluator should simply focus on that area which is obviously more lush, dense, or greener by virtue of proximity to the stream.

The location of the inner (or streamside) polygon boundary is also required, even on polygons that span the stream. This allows data to be collected on the riparian area while excluding the aquatic zone of the stream. The aquatic zone is the area covered by surface water and lacking persistent emergent vegetation. Persistent emergent vegetation consists of wetland species that normally remain standing at least until the beginning of the next growing season, e.g., *Typha* spp. (cattails) or *Scirpus* spp. (bulrushes) (Cowardin and others 1979).

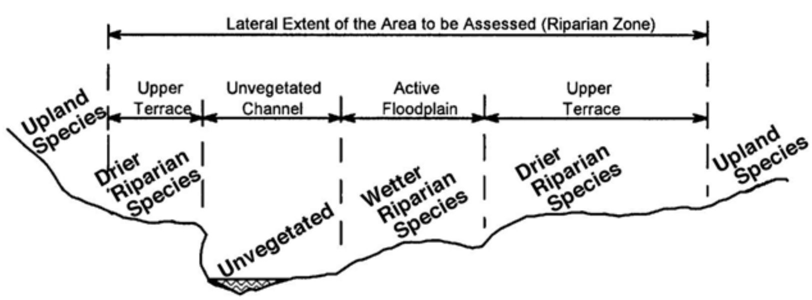

Figure 2. A schematic example of a typical riparian zone cross section showing near-channel landform features.

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

Assessments should not cross fences between areas with different management.
If the stream to be rated crosses more than one management unit, at least one reach should be assessed in each unit. Fences exert a strong influence on livestock movement and grazing patterns; therefore, assessed reaches should be located at least 250 ft (75 m) from any fence. The evaluation should include the riparian zone on both sides of the stream if both are under the same management. Along a large stream, the same operator may not manage both sides. The channel may be so large that livestock (or evaluators) cannot easily cross. In such cases it may not be feasible to evaluate both sides at once.

DATA FORM ITEMS

Record ID No. This is the unique identifier allocated to each polygon. This number will be assigned in the office when the form is entered into the database.

ADMINISTRATIVE DATA

A1. Identify what organisation is doing the evaluation field work.

A2. Identify what organisation is paying for the work.

A3a. Identify any Indian or Métis Reserve on which work is being done.

A3b. Identify any National or Provincial Park, Preserve, or Sanctuary on which work is being done.

A3c. Identify any local Environmental, Ecological or Municipal Reserve (Exclude national or provincial reserves) on which work is being done. If yes, identify which applicable reserve is established and its number.

Ecological Reserves are areas of Crown land (Provincial and Federal Government), which have the potential to contain representative, rare and fragile landscapes, plants, animals and geological features. The intent is for the preservation of natural ecosystems, habitats and features associated with biodiversity. Public access to ecological reserves is by foot only; public roads and other facilities do not normally exist and will not be developed.

Environmental reserve generally are those lands that are considered undevelopable and may consist of a swamp, gully, ravine, coulee or natural drainage course, flood prone areas, steep slopes or land immediately adjacent to lakes, rivers, stream or other bodies of water. Governed by *The Municipal Government Act (Alberta).*

Municipal reserve may also be known, in part, as reserve, park reserve, park or community reserve. Municipal reserves are lands that have been given to the municipality by the developer of a subdivision as part of the subdivision approval process. Governed by *The Municipal Government Act (Alberta).*

A3d. Was the work done on Private or Deeded Land? Simply answer “Yes” or “No.”

A4. Observers: Name the evaluators recording the data in the field.

A5a. Date that the field data was collected: Use the format: month/day/year

A5b. Record the year that the field data was collected.

A6a. Identify any grazing lease or grazing reserve on which work is being done.

A6b. Give any grazing disposition identifying number.

A6c. Give any other grazing name (e.g. Community Pasture) to identify where the work is being done.
Note: Items A7a-h are completed in the office; field evaluators need not complete these items.

A7. The several parts of this item identify various ways in which a data record may represent a resampling of a polygon that may have been inventoried again at some other time. The data in this record may have been collected on an area that coincides precisely with an area inventoried at another time and recorded as another record in the database. It may also represent the resampling of only a part of an area previously sampled. This would include the case where this polygon overlaps, but does not precisely and entirely coincide with one inventoried at another time. One other case is where more than one polygon inventoried one year coincides with a single polygon inventoried another year. All of these cases are represented in the database, and all have some value for monitoring purposes, in that they give some information on how the status on a site changes over time.

A7a. Does this record represent the latest data recorded for this polygon?

A7b. Has any part of the area within this polygon been inventoried previously, or subsequently, as represented by another data record in the Lotic Wetland database? Such other records would logically carry different dates.

A7c. Does the areal extent of this polygon exactly coincide with that of any other inventory represented in the Lotic Wetland database? In many cases, subsequent inventories only partially overlap spatially. The purpose of this question is to identify those records that can be compared as representing exactly the same ground area.

A7d. If A7c is answered "Yes," then enter the years of any inventories of this exact polygon.

A7e. If A7c is answered "Yes," also enter the record ID number(s) of any other previous or subsequent re-inventories (resamplings) of this exact polygon for purposes of cross-reference in the database.

A7f. Even though this polygon is not a re-inventory of the exact same area as any other polygon, does it share at least some common area with one or more polygons inventoried at another time?

A7g. If A7f is answered "Yes," enter the years of any other inventories of polygons sharing common area with this one.

A7h. If A7f is answered "Yes," also enter the record ID number(s) of any other polygon(s) sharing common area with this one.

A8a. Has a management change been implemented on this polygon?

A8b. If A8a is answered "Yes," in what year was the management change implemented?

A8c. If A8a is answered "Yes," describe the management change implemented.

LOCATION DATA

B1. Province in which the field work is being done.

B2a, b. Identify the Natural Region and Sub-Region in which the field work is being done. Use the Natural Regions and Subregions of Alberta (Alberta Natural Heritage Information Centre (1999).

B3. County or municipal district in which the field works is being done.

B4a. The city, town, or village in which the fieldwork is being done.

B4b. The subdivision plan number in which the fieldwork is being done.

B4c. The block number in which the fieldwork is being done.

B4d. The lot number in which the fieldwork is being done.

B5. Identify the allotment, range unit, landowner or leasee where the fieldwork is being done.

B6. Name the waterbody or area on which the fieldwork is being done.

B7. Polygon number is a sequential identifier of the actual piece of land being surveyed. This is referenced to the map delineations.

B8a. The location of the polygon is presented as a legal land description: 1/4,1/4 section, 1/4 section, Township, Range, and Meridian are read from smallest to largest unit.

<table>
<tr><td>NW</td><td colspan="2">***NE***</td></tr>
<tr><td rowspan="2">SW</td><td>NW</td><td>NE</td></tr>
<tr><td>SW</td><td>SE</td></tr>
</table>

B8b. Identify the side of the polygon that the Assessment is completed for by using “North, South, East or West”, if assessment includes both sides enter “Both”

B9. Elevation (feet or meters) of the polygon ***centroid.*** Elevation is usually interpolated from a topographic map

B10a. Name the major watershed (e.g. North Saskatchewan River) of which the site being surveyed is a part.

B10b. Name the minor watershed (e.g. Battle River) of which the site being surveyed is a part. This is normally subordinate to the major watershed named above in #B10a.

B10c, d. The minor watershed area (km 2) and perimeter (km) are obtained from the map in the office.

B10e. Name the sub-basin (e.g. Iron Creek). This is the local watershed of which the site being surveyed is a part. This is normally subordinate to the minor watershed named above in #B10b.

B11a-c. Universal Transverse Mercator (UTM) coordinates are recorded for the upper and lower ends of the polygon using GPS units in the field. Other locations of special interest may be recorded using the GPS unit. These coordinates are considered accurate to within approximately 50 m. Field observers are to use GPS units to obtain these coordinates following standard protocol. Record UTM coordinates at each end of the long axis of the polygon.

Enter the UTM coordinate data, including the UTM zone and the identifying waypoint number, on the form for each point collected. Save the data in the GPS unit for downloading to the computer later. When starting work in a new location, always check the GPS receiving unit against a known point by using the UTM grid and map.

B11d, e. Identify the GPS unit used, and the name or number designator of the waypoints saved for the upper and lower ends of the polygon and for other locations. Describe any comments worth noting about the waypoints (i.e., monument referenced or general location descriptions).

B12a-c. Record the name(s), scale, and publication year of the quadrangle map(s) or any other map(s) locating the polygon. Use precisely the name listed on the map sheet. Provision is made for listing two maps in case the polygon crosses between two maps.

B13. Record identifying data for any aerial photos used on this polygon.

SELECTED SUMMARY DATA

C1. Wetland type is a categorical description of predominant polygon character. Select from the following list of categories that may occur within a lotic system the one that best characterizes the majority of the polygon. Observers will ***select only one category*** as representative of the entire polygon. If significant amounts of other categories are present, indicate this in the last item, "Comments and Observations," or consider dividing the original polygon into two or more polygons.

Category Description

Perennial Stream A stream or stretch of stream that flows continuously for most of most years. Perennial streams are generally fed in part by springs or discharge from groundwater.

Intermittent Stream A stream or stretch of stream, which flows only at certain periods of the year when it receives water from, springs, discharge from groundwater, or melting snow in mountainous areas. These streams generally flow continuously at least one month most years.

Ephemeral Stream A stream or stretch of stream that flows in normal water years only in direct response to precipitation. In normal years, it receives no water from springs and no extended supply from melting snow or other surface source. Ephemeral streams are not in contact with groundwater and normally do not flow continuously for as long as one month. Not all ephemeral streams support riparian plant communities.

Subterranean Stream A stream that flows underground for part of the stream reach. This occurs on systems composed of coarse textured, porous substrates. Surface flow may disappear and re-emerge farther downstream.

Pooled Channel Stream An intermittent stream that has significant channel pools after surface flow ceases. Pools are generally at meander curves and are usually considerably deeper than the rest of the channel bottom. Water sources for the pools may be springs or contact with subsurface groundwater. This stream type is typical of fine textured sedimentary plains in semi-arid regions where headwater drainages lack the extended runoff of deep mountain snow pack. This stream type may not be apparent early in the season when flow is continuous.

River Rivers are generally larger than streams. They flow year round, in years of normal precipitation and when significant amounts of water are not being diverted out of them.
Those watercourses called rivers on USGS 7.5 minute topo quads and/or those having bank full channel widths greater than 50 ft (10 m) will be classified as rivers for the purpose of this inventory.

Beaver Dams A system that is predominantly characterized by beaver dams that change the character of the system from a regular flowing channel to a "stepped" system of ponds where water is spread wide and flow velocity is apparent only at each dam outlet before it enters the next pond. Water is still flowing through the riparian system.

Wet Meadow This type of wetland may occur in either running water (lotic) or in still water (lentic) systems. A lotic wet meadow has a defined channel or flowing surface water nearby, but is typically much wider than the riparian zone associated with the classes described above. This is often the result of the influence of lateral groundwater not associated with the stream flow. Lotic and lentic wet meadows may occur in proximity (e.g., when enough groundwater emerges to begin to flow from a mountain meadow, the system goes from lentic to lotic). Such communities are typically dominated by herbaceous hydrophytic vegetation that requires saturated soils near the surface, but tolerates no standing water for most of the year. This type of wetland typically occurs as the filled-in basin of old beaver ponds, lakes, and potholes.

Spring/Seep Groundwater discharge areas. In general, springs have more flow than seeps. This wetland type may occur in a running water (lotic) or still water (lentic) system.

Irrigation Canal Includes all types of canals and ditches associated with irrigation systems.

Other Describe the water source (e.g., irrigation return flow, industrial discharge, etc.).

Non-riparian (Upland) This designation is for those areas which are included in the inventoried polygon, but which do not support functional wetland vegetation communities. Such areas may be undisturbed inclusions of naturally occurring high ground or such disturbed high ground as roadways and other elevated sites of human activity

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C2. The size (acres/hectares) of polygons large enough to be drawn as enclosed units on 1:20,000 or 1:50,000 scale maps is determined in the office using a planimeter, dot grid, or GIS. For polygons too small to be accurately drawn as enclosed units on the maps, and which are represented by line segments on the topo map along the drainage bottom, polygon size is calculated using polygon length and average polygon width (items C5 and C7).

C3a-d. Evaluators may be asked to survey some areas that have not been determined to be wetlands for the purpose of making such a determination. Other polygons include areas supporting non-wetland vegetation types. A "Yes" answer here indicates that no part of the polygon keys to a riparian habitat type or community type (HT/CT). Areas classified in item C8 as any vegetation type described in a riparian and/or wetland classification document for the region in which you are working are counted as functional wetlands. Areas listed as UNCLASSIFIED WETLAND TYPE are also counted as functional wetlands. Other areas are counted as non-wetlands, or uplands. **C3c-d are filled completed in the office once the length of the polygon is determined.**

C4. Some riparian areas do not contain an unvegetated, defined stream channel. In some cases, these polygons are in ephemeral systems which may flow infrequently, but which do support riparian plant communities. In other cases, these polygons may be associated with larger river systems that have wide floodplains where polygons may be delineated in areas not adjacent to the channel.

C5. Channel length—the length of channel contained within or adjacent to the polygon—is measured by scaling from the map. This data is considered accurate to the nearest 0.1 mile (0.16 km).

C6. In some cases, the polygon record is used to characterize, or represent, a larger portion of a stream system. The length represented by the polygon is given here. For example, a 0.5-mile polygon may be used to represent 4 miles of a stream. In the case, 0.5 is the channel length of the polygon (item C5), and 4 miles is entered in item C6.

C7. Record average width of the polygon, which on smaller streams corresponds to the width of the riparian zone. To determine this width, subtract the width of the non-vegetated stream channel from the distance between the two opposite riparian/upland boundaries. In the case of very wide systems where the polygon inventoried does not extend across the full width of the riparian zone (e.g., area with riparian vegetation communities lies outside the polygon), record the average width of the polygon inventoried and make note of the situation in the comments.

C8. List the riparian habitat type(s) and/or community type(s) found in the polygon (Thompson and Hansen 2002 or another appropriate publication). If the habitat type cannot be determined for a portion of the polygon, list the appropriate community type(s) of that portion. If neither the habitat type nor community type can be determined for any portion of the polygon (or in areas [outside of Montana] where the habitat and community types have not been named and described), list the area in question as "unclassified wetland type" and give the dominant species present. Indicate with the appropriate abbreviation if these are habitat types (HT), community types (CT), or dominance types (DT), for example, POPUTRE/CORNSTO HT. For each type listed, estimate the percent of the polygon represented. If known, record the successional stage (i.e., early seral, mid-seral, late seral, and climax) or give other comments about the type. As a minimum, list all types which cover 5% or more of the polygon. The total must approximate 100%. Slight deviations due to use of class codes or to omission of types covering less than 5% of the polygon are allowed. ***Note:*** For any area classified as an "unclassified wetland type," it is important to list any species present which can indicate the wetness or dryness of the site.

ADDITIONAL SITE CHARACTERISTICS

D1a, b. Make a call on whether the polygon has potential for tall woody type(s), and if the answer is "Yes," then tell whether such types are present on the polygon. Tall woody types are any tree HTs or CTs and such taller shrubs as willows, Saskatoon, Alder, birch, etc. Not included are shorter shrub species, such as buckbrush/snowberry, rose, etc.

D2. Give the waterbody number (FMIS/Hydro code).

D3a. If water quality data is available on this waterbody

D3b. Describe or list the reference where the water quality data for that waterbody can be found.

D4. Describe the boundaries of the polygon, especially the location of the upper and lower ends, as well as the lateral boundaries. On smaller streams the polygon usually includes the entire width of the riparian zone. Describe what you use as the indicators of the wetland-upland boundary. Use localized geologic, physical, or vegetation information to identify these boundaries of the polygon for future polygon relocation.

PHOTOGRAPH DATA
Note: Take at least one photo upstream and one downstream at each end of every polygon. This applies even to situations where the polygon is at one end of an inventoried reach and one of the photos is taken into a non-inventoried area, as well as situations in which another polygon is adjacent to the one being inventoried.

E1. Identify the film roll number, photo (frame) number, and description of each photograph taken at the upper end of the polygon. List them in the order of upper views, then lower views, and then each other shot taken to show features of interest. Also, identify the photographer and camera used.

E2. Indicate if there is adjacent polygon upstream of this one.

E3. Same as E1 above for shots taken at the most downstream end of the polygon.

E4. Indicate if there is adjacent polygon downstream of this one.

E5. Identify all additional photos taken outside of polygon (i.e., non-polygon photos) by giving roll number, frame number, and description of view.

E6. Record the brand of film, film speed, camera lens size, and lens focal length or magnification.

THE LOTIC HEALTH ASSESSMENT SCORE SHEET (SURVEY)

Some factors on the evaluation will not apply on all sites. 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. Estimate the canopy cover on the polygon that is provided by all standing, rooted plants (live or dead). Do not include fallen wood or other plant litter. Do not consider the polygon area covered by water (such as between emergent plants).

1. Vegetative Cover of Floodplain and Streambanks.
Vegetation cover helps to stabilize banks, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, and reduce the rate of evaporation (Platts and others 1987). Stream channels that go dry during the growing season can create problems for polygon delineation. Some stream channels remain

un-vegetated after the water is gone. If the total live vegetative cover of the channel is no more than 15%, it is considered a non-vegetated stream channel and is ***excluded*** from the polygo**n.** Exceptions to this minimum of 15% canopy cover include channels with the vegetation removed by human-causes (such as grazing, logging, and construction). These are considered exposed soil surface (bare ground). Those channels that do contain more than 15% live vegetative cover are included as part of the riparian vegetation.

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

Scoring:
6 = More than 95% of the polygon area is covered by 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]). 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.

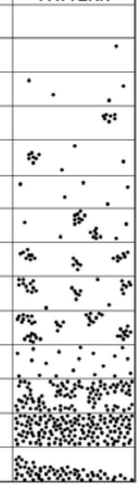
Scoring:
3 = No invasive plant species (weeds) on the site.
2 = Invasive plants present with total canopy cover less than 1 percent of the polygon area.
1 = Invasive plants present with total canopy cover between 1 and 15 percent of the polygon area.
0 = Invasive plants present with total canopy cover more than 15 percent of the polygon area.

2b. Density Distribution 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 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-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. 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 (smooth brome)	*Poa pratensis* (Kentucky bluegrass)	*Trifolium* spp. (clovers)
Fragaria spp. (strawberries)	______________________________	________________________

Scoring:

3 = Less than 5% of the site covered by disturbance-caused undesirable herbaceous species.
2 = 5% to 25% of the site covered by disturbance-caused undesirable herbaceous species.
1 = 25% to 45% of the site covered by disturbance-caused undesirable herbaceous species.
0 = More than 45% of the site covered by disturbance-caused undesirable herbaceous species.

4. Preferred Tree and Shrub Establishment and/or Regeneration.

(Skip this item if the site lacks potential for trees or shrubs; for example, the site is a herbaceous wet meadow or marsh.) Not all riparian areas can support trees and/or shrubs. However, on those sites where such species do belong, they play important roles. The root systems of woody species are excellent bank stabilizers, while their spreading canopies provide protection to soil, water, wildlife, and livestock. Young age classes of woody species are important indicators of the continued presence of woody communities not only at a given point in time but into the future. Woody species potential can be determined by using a key to site type (Thompson and Hansen 2001, 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.)

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

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (i.e., *Salix* spp. [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern. ***FOR EXAMPLE***: A polygon may have *Symphoricarpos occidentalis* (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:*** Observers should take care not to confuse short stature resulting from heavy browsing with that due to youth.)

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

5. Utilisation of Preferred Trees and Shrubs.

(Skip this item if the site lacks trees or shrubs; for example, the site is a herbaceous wet meadow or cattail marsh.) Many riparian woody species are browsed by livestock and/or wildlife. Heavy browsing can prevent establishment or regeneration of these important species. Excessive browsing can eliminate them from the community and result in their replacement by undesirable invaders. One tree species *(Elaeagnus angustifolia* [Russian olive]) and seven shrub genera or species *(Symphoricarpos* spp. [snowberry], *Rosa* spp. [rose], *Crataegus* spp. [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Caragana* spp. [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* spp. [salt cedar] are excluded from the evaluation of establishment and regeneration. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-heavy grazing pressure; ***AND*** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* spp. [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* spp. [salt cedar] are considered especially aggressive, undesirable exotic plants.

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

When estimating degree of utilisation, 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. Include also human removals by such activities as shearing and mowing. 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. If the observer is not fairly certain potential exists for preferred trees or shrubs, then enter NC and explain in the comment field below.)*
3 = None (0% to 5% of available second year and older leaders of preferred species are 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).

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

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

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

7. Streambank Root Mass Protection.
Streamside vegetation stabilizes the soil to the extent that it provides deep, binding roots. All tree and shrub species provide such roots. Herbaceous annuals lack this quality. Perennial herbs provide it in varying degree. Some rhizomatous species, such as sedges *(Carex* spp.), are excellent streambank stabilizers. Other rhizomatous species, such as Kentucky bluegrass *(Poa pratensi*s), have shallow roots and are poor streambank stabilizers. The evaluator should seek to determine if the types of root systems present in the polygon are in fact contributing to the stability of the streambanks. For this item consider the streambank to extend from the toe of the bank to approximately 18 inches beyond the top of the bank. The bank top is that point where the upper bank levels off to the relatively flat surface of a floodplain or terrace. Remember to include both banks (e.g., both sides of the stream).

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

8. Human-Caused Bare Ground. Bare ground is soil not covered by plants, litter or duff, downed wood, or rocks larger than 2.5 inches (6 cm). 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 land uses causing bare ground include livestock grazing, recreation, roads, and industrial activities. The evaluator should consider the causes of all bare ground observed and estimate the fraction that is human-caused.

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

Scoring:
6 = Less than 1% of the 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.
Streambank structural integrity is vital to good channel configuration and bank shape. Impaired structure can mobilize channel and bank materials, cause loss of fishery and wildlife habitat, lower the water table, etc. Bank alteration can result from such causes as livestock hoof shear, recreation, and resource extraction. Include all structural alterations, including pugging and hummocking. In rating this item, consider the bank area from the water's edge up to 18 inches (45 cm) beyond the top of the bank. The bank top is that point where the upper bank levels off to the relatively flat surface of a floodplain or terrace. Remember to include both banks (e.g., both sides of the stream).

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

10. Human Physical Alteration to the Rest of the Polygon. Within the remainder of the polygon area, outside the streambank area that was addressed in the previous question, estimate the amount of area that has been physically altered by human causes. The purpose of this question is to evaluate physical change to the soil, hydrology, etc. as it affects the ability of the natural 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:

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

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

11. Stream Channel Incisement (vertical stability).
Incisement can lower the water table enough to change current vegetation and site potential. It can also increase stream energy, reduce water retention/storage, and increase erosion. A stream is incised when downcutting has lowered the channel bed so that two-year flood events cannot overflow the banks. Four typical downcutting indicators are: a)headcuts; b)exposed cultural features (pipelines, bridge footings, culverts, etc.); c) lack of sediment and exposed bedrock; d)a low, vertical scarp at the bank toe on the inside of a channel bend. Channelincisement can occur in any of several stages (Figure 4). A severe disturbance can initiate downcutting, transforming the system from a steady state of high water table, appropriate floodplain, and high productivity to one of degraded water table, narrow [or no] active floodplain, and low productivity. (These stages of incisement can be categorized in terms of Rosgen Level I channel types [Rosgen 1996].)

A top rating goes to those unincised channels from which the 1-2 year high flow can 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 characterized by a broad floodplain inside which perennial riparian plant communities are well established. This condition is illustrated in Figure 4 by the following three stages.
Stage A-1. A stable, unincised meandering meadow channel (Rosgen E-type). Flows greater than `bankfull (1-2 year event) spread over a floodplain more than twice the bankfull channel width.
Stage A-2. A fairly stable, unincised wide valley bottom stream with broad curves and point bars (Rosgen C-type). Although these streams typically cut laterally on the outside of curves and deposit sediment on inside point bars, bankfull flows (1-2 year events) have access to a floodplain more than twice bankfull channel width.
Stage A-3. A stable, unincised mountain (Rosgen A-type) or foothill (Rosgen B-type) channel with limited sinuosity and slopes greater than 2%. Although bankfull flow stage is reached every 1-2 years, the adjacent floodplain is often narrower than twice the bankfull channel width. Consequently, overflow conditions are not so obvious as in Stages A-1 and A-2 systems.

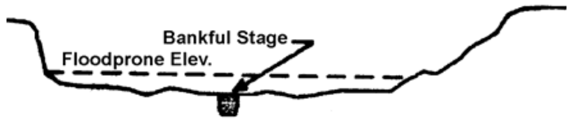
6 = Either of two incisement phases: (a) an improving phase with a sinuous curve/point bar system (Rosgen C-type) or a narrow, meandering stream (E-type) establishing in an old incisement which now represents the new floodplain, although this may be much narrower than it will become;(b) an early degrading phase in which a narrow, meandering meadow stream (E-type) is degrading into a curve/point bar type (C-type) or a wide, shallow channel (Rosgen F-type). In either case, the 1-2 year high flow event can access only a narrow floodplain less than or only slightly wider than twice the bankfull channel width. Perennial riparian vegetation is well established along much of the reach. These conditions are represented in **Stage B** of Figure 4.

3 = Two phases of incisement fit this rating. (a) A deep incisement that is starting to heal. In this phase new floodplain development, though very limited, is key. This phase is characterized by a wide, shallow channel unable to access a floodplain (Rosgen F-type) evolving into a curve/point bar system (C-type) through sediment deposition and lateral cutting. Pioneer perennial plants are beginning to establish on the new depositional surfaces. (b) An intermediate phase with downcutting and headcuts probable. Flows less than a 5-10 year event can access a narrow floodplain less than twice bankfull channel width. These conditions are represented in **Stage C** of Figure 4.

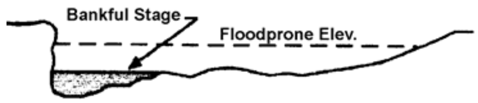
0 = The channel is deeply incised to resemble a ditch or a gully. Downcutting is likely ongoing. Only extreme floods overtop the banks, and no floodplain development has begun. Both **Stages D-1** and **D-2** of Figure 4 fall into this rating.

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

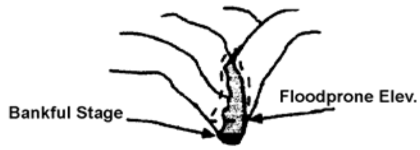
Stage D-2. A narrow, deep “gully” system (Rosgen G-type) downcut to the point that only extreme floods can overtop the banks. Distinguished from narrow mountain streams (A-type) by the presence of a flat floodplain through which the stream has downcut and by banks consisting of fine materials rather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



Stage A-1 (9 points)

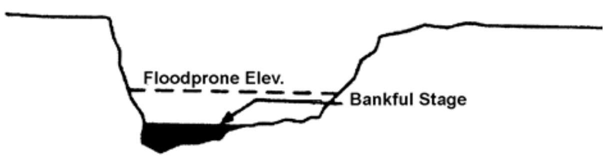


Stage A-2 (9 points)

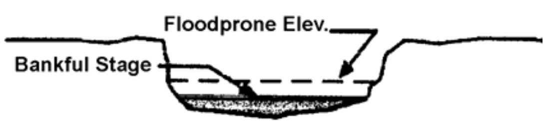


Stage A-3 (9 points)

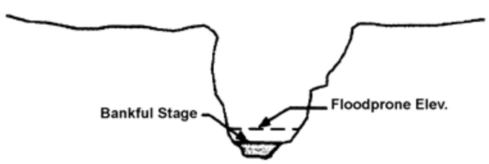
Stage B (6 points)



Stage C (3 points)



Stage D-1 (0 points)



Stage D-2 (0 points)

Figure 4. Guides for estimating stage of channel incisement.

12. Comments and Observations. Add any necessary commentary to explain or amplify the data recorded. Do not leave this space blank. Describe any unique characteristics of the site and other observations relating to the vegetation or to the physical conditions of the site. Each item in the health rating has a small space provided for specific information to enlighten the score given. This larger space is the place for more general commentary to help the reader understand the larger context of the data. Such things as landscape setting and local land use history are appropriate here.

Calculating the Lotic Health Score

To arrive at the overall site health rating, the scores are totalled for all the factors, and that total is divided by the possible perfect score total. A sample score sheet is shown below.

A sample score sheet of a site with no apparent potential for trees or shrubs

Vegetation Factors	**Actual Pts**	**Possible Pts**
1. Vegetative Cover of Floodplain and Streambanks	6	6
2a. Total Canopy Cover of Invasive Plant Species	0	3
2b. Density/Distribution Pattern of Invasive Plant Species	1	3
3. Disturbance-Caused Undesirable Herbaceous Species	2	3
4. Preferred Tree and Shrub Establishment and Regeneration	NA	NA
5. Utilisation of Preferred Trees and Shrubs	NA	NA
6. Standing Decadent and Dead Woody Material	NA	NA
Vegetative Score:	9	15

Soil/Hydrology Factors	**Actual Pts**	**Possible Pts**
7. Streambank Root Mass Protection	4	6
8. Human-Caused Bare Ground	2	6
9. Streambank Structurally Altered by Human Activity	6	6
10. Human Alteration to the Rest of the Polygon	2	3
11. Stream Channel Incisement (Vertical Stability)	9	9
Soil/Hydrology Score:	23	30
TOTAL SCORE:	**32**	**45**

Health Rating Formula: Rating = (Total Actual) / (Total Possible) X 100%
Rating = (32) / (45) X 100% = 71%

Rating Category: 80-100% = Proper Functioning Condition (Healthy)
60-79% = Functional At Risk (Healthy, but with Problems)
Less than 60% = Nonfunctional (Unhealthy)

The manager should realize that a less than perfect score is not necessarily cause for concern. An area rated at 80% is stillconsidered to be functioning properly. At the same time, ratings of individual factors can be useful in detecting strengths or weaknesses of a site. A low score on any factor may warrant management focus. In the example reach above, low scores for invasive plants and bare ground (items 2 and 8) indicate factors that management might improve in a subsequent assessment.

ADDITIONAL MANAGEMENT CONCERNS (OPTIONAL)

The following items do not contribute to a site's health assessment rating. Rather, they may help to quantify inherent physical site characteristics that reveal structural weaknesses or sensitivities or to assess the direction of change on a site. These data can be useful for planning future site management.

13. Streambank Rock Volume and Size.

The composition of streambank materials influences the susceptibility of the streambanks to erosion caused by trampling, water flow or other disturbance.

In general, larger rocks provide better protection against disturbance than smaller materials. Thus, streambanks composed primarily of silts and clays—characteristic of the majority of streams in the Great Plains—require more vegetative protection to compensate for the smaller particle sizes.

13a. Streambank Rock Volume. Rate the streambank rock volume as the highest appropriate of the following categories:

Scoring:
3 = More than 40% of volume is rocks at least 2.5 inches.
2 = 20% to 40% of volume is rocks at least 2.5 inches.
1 = 10% to 20% of volume is rocks at least 2.5 inches.
0 = Less than 10% of volume is rocks at least 2.5 inches.

13b. Streambank Rock Size. Rate the streambank rock size for the polygon as the highest appropriate of the followingcategories:

Scoring:
3 = At least 50% of rocks present are boulders and large cobbles (>5 inch).
2 = 50% of rocks present are small cobbles and larger (>2.5 inches).
1 = At least 50% of rocks present are coarse gravels and larger (>0.6 inches).
0 = Less than 50% of rocks present are coarse gravels and larger (>0.6 inches).

14. Vegetation Use by Animals. Record the rating category which best describes the vegetation use by animals (Platts and others, 1987).

Code Category Description

---

0 to 25%
Vegetation use is light or none. Almost all plant biomass at the current development stage remains. Vegetative cover is close to that which would occur without use. Unvegetated areas (such as bedrock) are not a result of land uses.
26 to 50%
Vegetation use is moderate. At least half the potential plant biomass remains. Average stubble height is more than half its potential at the present stage of development.
51 to 75%
Vegetation use is high. Less than half the potential plant biomass remains. Plant stubble height is usually more than 2 inches (on many ranges).
76 to 100%
Vegetation use is very high. Only short stubble remains (usually less than 2 inches on many ranges). Almost all potential plant biomass has been removed. Only the root systems and parts of the stems remain.

---

15. Susceptibility of Parent Material to Erosion. The soils derived from shale or having a large clay content are highly susceptible to compaction and trampling when wet. There is evidence that trampling by hooves and subsequent loss of herbaceous vegetation when soils are wet are major contributions to site degradation. In contrast, those sites having soils derived from sandstone or any of the hard metamorphosed rock found in the northern Rocky Mountains commonly have a fine sandy loam to loam texture and are more resistant to damage when wet. Intermediate of these soils are those having textures of clay loam to loam. Texturing the soil by the ribboning technique or by feel will be required for this determination. Rate the polygon soil according to one of these categories based on indicators as described above.

Scoring:
3 = Not susceptible to erosion (well armoured).
2 = Slightly susceptible to erosion (moderately armoured).
1 = Moderately susceptible to erosion.
0 = Extremely susceptible to erosion.

15. Percent of Streambank Accessible to Livestock.
Record the percent of streambank length accessible to livestock. In general, only consider topography (steep banks, deep water, etc.) and dense vegetation as restricting access. Fences, unless part of an exclosure, do not necessarily restrict livestock access even though they may appear to be doing so at the time.

16. Polygon Trend.
Select the ***one category*** (Improving, Degrading, Static, or Status Unknown) which best indicates the current trend of the vegetative community on the polygon to the extent possible. Trend refers, in the sense used here, not specifically to successional pathway change, but in a more general sense of apparent community health. By definition, trend implies change over time. Accordingly, a trend analysis would require comparison of repeated observations over time. However, some insights into trend can be observed in a single visit. For example, the observer may notice healing (revegetating) of a degraded shoreline and recent establishment of woody seedlings and saplings. This would indicate changing conditions that suggest an improving trend. If such indicators are not apparent, enter the category "status unknown."

17. Break Down the Polygon Area into the Land Uses Listed. Name any "Others" Observed.

18. Break Down the Area Adjacent to the Polygon into the Land Uses Listed. Name any "Others" Observed.

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APPENDIX Q
Alberta Wetland Health Assessment for Large River Systems (Survey) Form (5/15/2006)

ALBERTA WETLAND HEALTH ASSESSMENT FOR LARGE RIVER SYSTEMS (Survey)

Record ID No: ________

ADMINISTRATIVE DATA

A1. Field data collected by (Organisation): ________

A2. Funding Agency/Organisation: ________

A3a. Indian or Metis Reserve? (Yes; No): ____ If Yes, Reserve Name: ________

A3b. National or Provincial Park, Preserve, or Sanctuary? (Yes; No): ____

If Yes, Name: ________

A3c. Ecological, Environmental and/or Municipal Reserve (Exclude national or provincial reserves)? (Yes; No): ____

If Yes, Name: ________

A3d. Private or Deeded Land? (Yes; No): ____ A4. Observers: ________

A5a. Date field data collected: ____ A5b. Year: ____ A6a. Grazing lease or grazing reserve? (Yes; No): ____

If Yes, A6b. Grazing disposition No.: GRL: ____ GRP: ____

FGL: ____ Other: ____

A6c. Other Grazing Name (e.g. Community Pasture): ________

A7a. Is this the latest inventory for this polygon? (Yes; No): ____

A7b. At least some part of this polygon has been inventoried more than once (resampled)? (Yes; No): ____

If No, Go to item B1. If Yes, A7c. This polygon coincides exactly with another inventoried polygon? (Yes; No): ____

If No, Go to item A7f. If Yes, A7d. Other years sampled: ________

A7e. ID No.(s) of other inventories of this exact polygon: ____ , ____ , ____ , ____ , ____

A7f. This polygon shares common area with other inventoried polygon(s), but is not exact? (Yes; No): ____

A7g. Other years: ________

A7h. ID No.(s) of other records sharing area with this polygon: ____ , ____ , ____ , ____ , ____

A8a. Has a change in management occurred? (Yes; No, Unknown): ____ If Yes, A8b. Year changed occurred: ____

A8c. Type of management change applied: ________

LOCATION DATA

B1. Province: ____ B2a. Natural Region: ____ B2b. Natural Sub-Region: ____

B3. County/Municipal District: ____ B4a. City/Town/Village: ____

B4b. Subdivision Plan No.: ____ B4c. Block No.: ____ B4d. Lot No.: ____

B5. Allotment/Range Unit/Landowner/Lessee Name: ________

B6. Waterbody/Area Name: ________ B7. Polygon number: ____

B8a. Location: 1/4 1/4 Sec: ____ 1/4 Sec: ____ Sec: ____ B8b. Side of Waterbody: ____

Township (NS): ____ Range (EW): ____ Meridian: ____ B9. Elev. (ft): ____ ; (m): ____

B10a. Major Watershed (e.g. North Saskatchewan River): ________

B10b. Minor Watershed (e.g. Battle River): ________

B10c. Minor Watershed Area (km²): ____ ; (hect): ____ B10d. Minor Watershed Perimeter (km): ____

B10e. Sub-basin (e.g. Iron Creek): ________

B11a. UTM coordinates of polygon UPPER END: Easting: ____ ; Northing: ____ ; Zone: ____

B11b. UTM coordinates of polygon LOWER END: Easting: ____ ; Northing: ____ ; Zone: ____

B11c. UTM coordinates of any other point of interest in the polygon: East: ____ ; North: ____ ; Zone: ____

B11d. GPS Unit #: ____ WPt Upper: ____ WPt Lower: ____ WPt Other: ____

B11e. Comments: ________

B12a. Map Title(s): ________ ________

B12b. Map Scale: ____ B12c. Map Year: ____

B13. Aerial Photo Info: Scale: ____ Date: ____ Job#: ____ Line#: ____

AS#: ____ Photo#: ____ Other Info: ________

Record ID No: ____________

SELECTED SUMMARY DATA

C1. Water body type: ____________ C2. Polygon size (acres): ________ ; (hect): ________

C3a. Is the entire polygon upland? (Yes; No): ______ If **No**, C3b. Does the polygon consist entirely of functional wetland types? (Yes; No): ____ C3c. Functional wetland (acres): ________ ; (hect): ________ C3d. Percent of total polygon: ________

C4. Channel length (mi): ________ ; (km): ________ C5. Number of river miles the polygon represents: ________ ; (km): ________

C6. Average polygon width (ft): ________ ; (m): ________

C7. Habitat Types And Community Types

Classification Type Name	Phase	Pct of Poly	Successional Stage or Comments

C8. Break Down the Polygon Area Into the Land Uses listed (must total to approx. 100%):

No land use apparent: ________
Turf grass (lawn): ________
Tame pasture (grazing): ________
Native pasture (grazing): ________
Recreation (ATV paths, campsites, etc.): ________
Development (buildings, corrals, paved lots, etc.): ________
Tilled Cropping: ________
Perennial forage (e.g., alfalfa hayland): ________
Roads: ________
Logging: ________
Mining: ________
Railroads: ________
Other: ________

Description of Other Usage Noted: ____________

C9. Break Down the Area Adjacent to the Polygon Into the Land Uses listed (must total to approx. 100%):

No land use apparent: ________
Turf grass (lawn): ________
Tame pasture (grazing): ________
Native pasture (grazing): ________
Recreation (ATV paths, campsites, etc.): ________
Development (buildings, corrals, paved lots, etc.): ________
Tilled Cropping: ________
Perennial forage (e.g., alfalfa hayland): ________
Roads: ________
Logging: ________
Mining: ________
Railroads: ________
Other: ________

Description of Other Usage Noted: ____________

C10a. Does the polygon have potential for tall woody type(s) (Yes, No, Unknown): ________

If Yes, C10b. Does the polygon have tall woody type(s) present? (Yes, No): ________

C11. Vegetation Use by Animals: ____________

C12. Waterbody number (FMIS/Hydro code): ____________

C13a. Is water quality data available on this waterbody? (Yes, No, Unknown, NA): ________

If **Yes**, C13b. Describe the reference for that data (name, year, etc.): ____________

C14. Comments and Observations:

Polygon name: ______________

RIVER HEALTH EVALUATION

Record ID No: ______________

	Actual Score	Possible Score	Comment
1. Cottonwood Regeneration from Seed	____	____	____
2. Regeneration of other Tree Species	____	____	____
3. Preferred Shrub Species Establishment and Regeneration	____	____	____
4. Standing Decadent and Dead Woody Material	____	____	____
5. Preferred Tree and Shrub Species Utilization	____	____	____
6. Total Canopy Cover of Woody Species	____	____	____
7a. Invasive PlantSpecies (Canopy Cover)	____	____	____
7b. Invasive PlantSpecies (Density/Distribution(	____	____	____

List the Invasive Plant Species Present, Including Percent Canopy Cover on the Polygon and Density Distribution Class:

Weed Species	Can.Cov.	Dens.Dist.
1. ____	____	____
2. ____	____	____
3. ____	____	____
4. ____	____	____
5. ____	____	____

	Actual Score	Possible Score	Comment
8. Disturbance-increaser Undesirable Herbaceous Species	____	____	____
9. Presence of Native Graminoids	____	____	____
10. Exotic Undesirable Woody Species	____	____	____
Vegetation Subtotal:	____	____	
11. Riverbank Root Mass Protection	____	____	____
12. Human-Caused Bare Ground	____	____	____
13. Dewatering of the River System	____	____	____
14. Control of Flood Peak and Timing by Upstream Dam(s)	____	____	____
15. Human Alterations to the Riverbanks	____	____	____
16. Floodplain Accessibility	____	____	____
Soil / Hydrology Subtotal:	____	____	
Overall Polygon Total:	____	____	

RATING CALCULATION

(Actual Score/Possible Score) X 100 = Rating Percent — Descriptive Category

Vegetation Rating:	____	/ ____	x100 =	____	____
Soil / Hydrology:	____	/ ____	x100 =	____	____
Total:	____	/ ____	)0 =	____	____

Rating Percent Range	***Descriptive Category***
80-100	*Proper Functioning Condition (Healthy)*
60-79	*Functional At Risk (Healthy, but with Problems)*
<60	*Nonfunctional (Unhealthy)*

17. Polygon trend (Is the polygon: Improving, Degrading, Static, or Status Unknown?): ______________

Record ID No: ____________

PHOTOGRAPH DATA

E1. Identification of photos (taken at the *upstream* end of polygon):

Photographer: ____________________

Camera Number: __________

	Roll #:	Photo #:	Description:
Upstream views:	______	______	______
Downstream views:	______	______	______
Other views:	______	______	______

E2. Is there an adjacent polygon *upstream* of this polygon? (Yes; No): ______

E3. Identification of photos (taken at the *downstream* end of polygon): ______

Photographer: ____________________

Camera Number: __________

	Roll #:	Photo #:	Description:
Upstream views:	______	______	______
Downstream views:	______	______	______
Other views:	______	______	______

E4. Is there an adjacent polygon *downstream* of this polygon? (Yes; No): ______

E5. Identification of additional photos taken outside of polygon (i.e., non-polygon photos):

Roll #:	Photo #:	Description:

E6. Film and Camera Specs: Film brand: __________ Film speed (ASA): ____ Lens dia. (mm): ____

Lens foc. len. (mm): ______ Lens foc. len. (mm): ______________

APPENDIX R
Alberta Lotic Wetland Health Assessment for Large River Systems (Survey) User Manual (5/15/2006)

The user manual is intended to accompany the Alberta Lotic Health Assessment For Large River Systems (Survey) Form for the rapid evaluation of riparian areas along large river systems (those with channels wider than 50 ft [15 m]). Another form entitled the Alberta Lotic Wetland Health Assessment For Streams and Small Rivers (Survey) is available for use on smaller rivers and streams.

ACKNOWLEDGEMENT

Development of these assessment tools has been a collaborative and reiterative process. Many people from many agencies and organizations have contributed greatly their time, effort, funding, and moral support for the creation of these documents, as well as to the general idea of devising a way for people to look critically at wetlands and riparian areas in a systematic and consistent way. Some individuals and the agencies/organizations they represent who have been instrumental in enabling this work are Dan Hinckley, Tim Bozorth, and Jim Roscoe of the USDI Bureau of Land Management in Montana; Karen Rice and Karl Gebhardt of the USDI Bureau of Land Management in Idaho; Bill Haglan of the USDI Fish and Wildlife Service in Montana; Barry Adams and Gerry Ehlert of Alberta Public Lands Division; Lorne Fitch of Alberta Environmental Protection; and Greg Hale and Norine Ambrose of the Alberta Cows and Fish program.

BACKGROUND INFORMATION

Introduction

Public and private land managers are being asked to improve or maintain lotic (riparian) habitat and stream water quality on lands throughout western North America. Three questions that are generally asked about a wetland site are: 1) What is the potential of the site (e.g., climax or potential natural community)? 2) What plant communities currently occupy the site? and 3) What is the overall health (condition) of the site? For a lotic (flowing water) site, the first two questions can be answered by using the Alberta Lotic Wetland Inventory Form along with Classification and Management of Riparian and Wetland Sites of Alberta's Grassland Natural Region (Thompson and Hansen 2002) or a similar publication written for the region in which you are working.

For riparian areas along rivers approximately 50 ft (15 m) or more in width, this is a method for rapidly addressing the third question above: what is the site's overall health (condition)? It provides a site rating useful for setting management priorities and stratifying riparian sites for remedial action or more rigorous analytical attention. It is intended to serve as a first approximation, or "coarse filter," by which to identify riparian areas along rivers in need of closer attention so that managers can more efficiently concentrate their efforts. We use the term "riparian health" to mean the ability of a riparian area (including the channel and its riparian zone) to perform certain functions. These functions include sediment trapping, bank building and maintenance, water storage, aquifer recharge, flow energy dissipation, maintenance of biotic diversity, and primary production. Excellent sources of practical ideas and tips on good management of these streamside wetland sites are found in Caring for the Green Zone (Adams and Fitch 1995), Riparian Areas: A User's Guide to Health (Fitch and Ambrose 2003). In Saskatchewan some excellent resources are Streambank Stewardship, Your Guide to Caring For Riparian Areas in Saskatchewan (Huel 1998) and Managing Saskatchewan Wetlands—A Landowner's Guide (Huel 2000).

Flowing Water (Lotic) Wetlands vs. Still Water (Lentic) Wetlands

Cowardin and others (1979) point out that no single, correct definition for wetlands exists, primarily due to the nearly unlimited variation in hydrology, soil, and vegetative types. Wetlands are lands transitional between aquatic (water) and terrestrial (upland) ecosystems. Windell and others (1986) state, "wetlands are part of a continuous landscape that grades from wet to dry. In many cases, it is not easy to determine precisely where they begin and where they end." In the semi-arid and arid portions of western North America, a useful distinction has been made between wetland types based on association with different aquatic ecosystems. Several authors have used lotic and lentic to separate wetlands associated with running water from those associated with still water. The following definitions represent a synthesis and refinement of terminology from Shaw and Fredine (1956), Stewart and Kantrud (1972), Boldt and others (1978), Cowardin and others (1979), American Fisheries Society (1980), Johnson and Carothers (1980), Cooperrider and others (1986), Windell and others (1986), Kovalchik (1987), Federal Interagency Committee for Wetland Delineation (1989), Mitsch and Gosselink (1993), and Kent (1994).

Lotic wetlands are associated with rivers, streams, and drainage ways. Such wetlands contain a defined channel and floodplain. The channel is an open conduit, which periodically or continuously carries flowing water, dissolved, and suspended material. Beaver ponds, seeps, springs, and wet meadows on the floodplain of, or associated with, a river or stream are part of the lotic wetland.

Lentic wetlands are associated with still water systems. These wetlands occur in basins and lack a defined channel and floodplain. Included are permanent (i.e., perennial) or intermittent bodies of water such as lakes, reservoirs, potholes, marshes, ponds, and stockponds. Other examples include fens, bogs, wet meadows, and seeps not associated with a defined channel.

Functional vs. Jurisdictional Wetland Criteria

Defining wetlands has become more difficult as greater economic stakes have increased the potential for conflict between politics and science. A universally accepted wetland definition satisfactory to all users has not yet been developed because the definition depends on the objectives and the field of interest. However, scientists generally agree that wetlands are characterized by one or more of the following features: 1) ***wetland hydrology,*** the driving force creating all wetlands, 2) ***hydric soils,*** an indicator of the absence of oxygen, and 3) ***hydrophytic vegetation,*** an indicator of wetland site conditions. The problem is how to define and obtain consensus on thresholds for these three criteria and various combinations of them.

Wetlands are not easily identified and delineated for jurisdictional purposes. Functional definitions have generally been difficult to apply to the regulation of wetland dredging or filling. Although the intent of legislation is to protect wetland functions, the current delineation of jurisdictional wetland still relies upon structural features or attributes. The hydrogeomorphic (HGM) approach being developed by the US Corps of Engineers is intended to focus more specifically on wetland functions.

The prevailing view among many wetland scientists is that functional wetlands need to meet only one of the three criteria as outlined by Cowardin and others (1979) (e.g., hydric soils, hydrophytic plants, and wetland hydrology). On the other hand, jurisdictional wetlands need to meet all three criteria, except in limited situations. Even though functional wetlands may not meet jurisdictional wetland requirements, they certainly perform wetland functions resulting from the greater amount of water that accumulates on or near the soil surface relative to the adjacent uplands. Examples include some woody draws occupied by the *Fraxinus pennsylvanica/Prunus virginiana* (green ash/common chokecherry) habitat type and some floodplain sites occupied by the *Artemisia cana/Agropyron smithii* (silver sagebrush/western wheatgrass) habitat type or the *Populus tremuloides/Cornus stolonifera* (aspen/red-osier dogwood) habitat type. Currently, many of these sites fail to meet jurisdictional wetland criteria. Nevertheless, these functional wetlands provide important wetland functions vital to wetland dependent species and may warrant special managerial consideration. The current interpretation is that not all functional wetlands are jurisdictional wetlands, but that all jurisdictional wetlands are functional wetlands.

Lotic (Riparian) Health of River Systems

As noted above, the health of a lotic site (a wetland adjacent to flowing water) may be defined as the ability of that system to perform certain wetland functions. These functions include sediment trapping, bank building and maintenance, water storage, aquifer recharge, flow energy dissipation, maintenance of biotic diversity, and primary biotic production. A site's health rating may also reflect management considerations. For example, although *Cirsium arvense* (Canada thistle) or *Euphorbia esula* (leafy spurge) may help to trap sediment and provide soil-binding properties, other functions (i.e., productivity and wildlife habitat) will be impaired; and their presence should be a management concern.

No single factor or characteristic of a wetland site can provide a complete picture of either site health or the direction of trend. This evaluation is based on assessment of sixteen channel and riparian vegetation factors. It relies heavily on vegetative characteristics as integrators of factors operating on the landscape. Because they are more visible than soil or hydrological characteristics, plants may provide early indications of riparian health as well as successional trend. These are reflected not only in the types of plants present, but also by the effectiveness with which the vegetation carries out its riparian functions of stabilizing the soil, trapping sediments, and providing wildlife habitat. Furthermore, the utilisation of certain types of vegetation by animals can indicate the current condition of the riparian area and may indicate trend toward or away from potential natural community (PNC).

In addition to vegetation factors, an analysis of site health and its susceptibility to degradation must consider physical factors (soils and hydrology) for both ecologic and management reasons. Changes in soil or hydrologic conditions obviously affect functioning of a wetland ecosystem.

Moreover, changes in physical characteristics are often (but not always) more difficult to remedy than vegetative changes. For example, extensive incisement (down-cutting) of a stream channel may lower the water table and thus change site potential from a *Salix lutea/Cornus stolonifera* (yellow willow/red-osier dogwood) habitat type to an *Bromus inermis* (smooth brome) community type or even to an upland (non-riparian) type. Sites experiencing significant hydrologic, edaphic (soil), or climatic changes will likely also have a change in plant community potential.

This river health assessment attempts to balance the need for a simple, quick index of health against the reality of an infinite variety of wetland situations. Although this approach will not always work perfectly, we believe in most cases it will yield a usefully accurate index of riparian health. Some more rigorous methods to determine status of a river's channel morphology are Dunne and Leopold (1978), Pfankuch (1975), and Rosgen (1996). These relate their ratings to degree of channel degradation, but do not integrate other riparian functions into the rating. Other methods are available for determining condition from perspectives that also include vegetation, most notably the USDI Bureau of Land Management (BLM) proper functioning condition (PFC) methodology (1998).

This river health assessment method is not designed for an in-depth and comprehensive analysis of ecologic processes. Much analysis may be warranted on a site and can be done after this evaluation has identified areas of concern. Nor does this rating yield an absolute rating to be used to compare riparian systems along flowing waters in other areas or of other types. Comparisons using this rating with rivers of different types (Rosgen 1996), different orders (size class), or from outside the immediate locality should be avoided. Appropriate comparisons using this rating can be made between segments of one river, between neighbouring rivers of similar size and type, and between subsequent assessments of the same site.

A single evaluation provides a rating at only one point in time. Due to the range of variation possible on a riparian site, a single evaluation cannot define absolute status of site health or reliably indicate trend (whether the site is improving, degrading, or stable). To monitor trend, health assessments should be repeated in subsequent years during the same time of year. Evaluation should be conducted when most plants can be field identified and when hydrologic conditions are most nearly normal (e.g., not during peak spring runoff or immediately after a major storm). Management regime should influence assessment timing. For example, in assessing trend on rotational grazing systems, avoid comparing a rating after a season of use one year to a rating another year after a season of rest.

Pre-Assessment Preparation

The river health assessment process incorporates data on a wide range of biological and physical factors. The basic unit of delineation upon which an assessment is made is referred to as a ***polygon.*** Polygons are delineated on 7.5-minute topographic (topo) maps by marking the upper and lower ends before observers go to the field. (The widths of most riparian zones are unknown before the inventory and cannot be pre-marked.) On 7.5-minute topo maps, polygons are numbered sequentially proceeding downstream. It is important to clearly mark and number polygons on the topo map. Polygons must be clearly marked and numbered. Polygons are numbered pre-field (in the office) with consecutive integers (1, 2, 3 . . .). In cases where field inspection shows the need to change the delineation or to subdivide the pre-drawn polygons, additional polygons should be numbered using alpha-numerics (e.g., 1a, 1b, 2a, 2b, etc.). Combination of delineated polygons will be field identified as the hyphenated tags of both combined parts (e.g., 1-2, 2-3, etc.).

Upper and lower polygon boundaries are placed at distinct locations such as fences, stream confluences, or river meanders that can hopefully be recognized in the field. If aerial photos are available, pre-field polygon delineations may be based on vegetation differences, geologic features, or other observable characteristics.

Once in the field, observers are to verify (ground truth) the office-delineated polygon boundaries. If the pre-assigned numbers are used, be sure the inventoried polygons correspond exactly as drawn originally. Observers are allowed to move polygon boundaries, create new polygons, or consolidate polygons if the vegetation, geography, location of fences, or width of the riparian zone warrant. If polygon boundaries are changed, the changes must be clearly marked on the field copies of the 7.5- minute topographic maps. The original polygon numbers should be retained on the map for cross-reference.

The outer boundaries of riparian polygons are at the wetland vegetative type outer edges. These boundaries are sometimes clearly defined by abrupt changes in the geography and/or vegetation, but proper determination often depends on experienced interpretation of more subtle differences.

Identification of plant communities by vegetation type (Thompson and Hansen 2001, Hansen and others 1995) will be useful both in site selection and, later, in determining appropriate management.

These may be in a mosaic difficult to map. An area may have a mix of herbaceous communities, shrubs, and forest. These communities have diverse resource values and may respond differently to a management action, but it is seldom practical to manage such communities separately. Community composition can be described as percentages of component types. Management actions can then be keyed to the higher priority types present.

Selection of a Reach to Evaluate

Two considerations in determining appropriate reach size and location for river health assessments are: 1) the need for the reach boundaries to be relocated for future repeatability, and 2) the need to include adequate area and channel length to ensure a representative sample of the variability within the system.

The above needs can be met by basing reach size and location on a map grid, which is related to the average width of the floodplain being assessed. Future reassessment of the site requires the ability to relocate the same site. Due to the dynamic nature of most river systems, it is impractical to tie long-term reference points to many physical features found on a floodplain landscape. Instead, a reach can be bounded by the upstream and downstream sides (or east-west, depending on which direction is most nearly perpendicular to the valley) of a square in a map grid. The size of the grid squares can be based on the average width (to the closest quarter mile [0.4 km]) of the floodplain over a ten-mile (16.0 km) section which includes the site in question. For example: If the average floodplain width is 0.69 miles (1.1 km), then lay out a 3/4 mile (1.2 km) grid on the map system which aligns with the established Public Land Survey section and quarter-section lines. The assessed reach should extend laterally away from the river to the floodplain/upland boundary on each side. The map should show the river channel and lateral extent of the riparian zone. The evaluator should sketch the general position and extent of important riparian plant communities.

In most cases, polygons should be at least one half mile (0.8 km) in length. Because along most river systems the channel acts as a barrier to movement, polygons will usually be limited to the riparian zone on a single side. If the evaluator determines that cross-channel access is not restricted, both sides may be included in a single polygon.

In addition to reach length, riparian zone width must be considered. The riparian zone is that generally green and relatively flat area influenced by water from a stream and its floodplain. The contrast between a riparian zone and adjacent upland is most notable in late summer when many of the upland herbaceous plants have gone dormant. The area to be assessed includes any terraces dominated by facultative wetland and wetter plant species (Reed 1988), the active floodplain, streambanks, and areas in the channel with emergent vegetation (Figure 1). Reference to Reed's list of plants found in wetlands should not be necessary to determine the area for evaluation. The evaluator should simply focus on that area which is obviously more lush, dense, or greener by virtue of proximity to the stream.

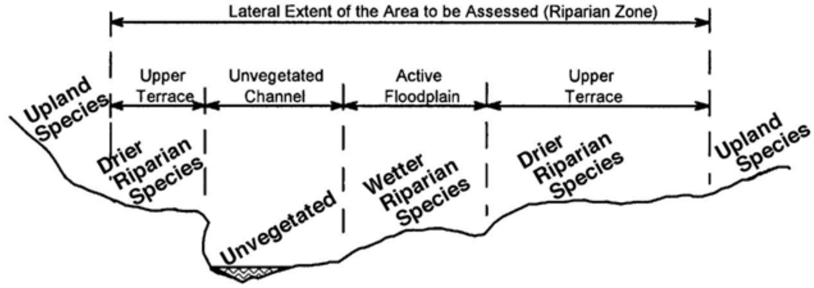


Figure 1. A schematic example of a typical riparian zone cross section showing near-channel landform features.

DATA FORM ITEMS

Record ID No. This is the unique identifier allocated to each polygon. This number will be assigned in the office when the form is entered into the database.

ADMINISTRATIVE DATA

A1. Identify what organisation is doing the evaluation field work.

A2. Identify what organisation is paying for the work.

A3a. Identify any Indian or Métis Reserve on which work is being done.

A3b. Identify any National or Provincial Park, Preserve, or Sanctuary on which work is being done.

A3c. Identify any local Environmental, Ecological or Municipal Reserve (Exclude national or provincial reserves) on which work is being done. If yes, identify which applicable reserve is established and its number.

Ecological Reserves are areas of Crown land (Provincial and Federal Government), which have the potential to contain representative, rare and fragile landscapes, plants, animals and geological features. The intent is for the preservation of natural ecosystems, habitats and features associated with biodiversity. Public access to ecological reserves is by foot only; public roads and other facilities do not normally exist and will not be developed.

Environmental reserve generally are those lands that are considered undevelopable and may consist of a swamp, gully, ravine, coulee or natural drainage course, flood prone areas, steep slopes or land immediately adjacent to lakes, rivers, stream or other bodies of water. Governed by *The Municipal Government Act (Alberta).*

Municipal reserve may also be known, in part, as reserve, park reserve, park or community reserve. Municipal reserves are lands that have been given to the municipality by the developer of a subdivision as part of the subdivision approval process. Governed by *The Municipal Government Act (Alberta).*

A3d. Was the work done on Private or Deeded Land? Simply answer “Yes” or “No.”

A4. Observers: Name the evaluators recording the data in the field.

A5a. Date that the field data was collected: Use the format: month/day/year

A5b. Record the year that the field data was collected.

A6a. Identify any grazing lease or grazing reserve on which work is being done.

A6b. Give any grazing disposition identifying number.

A6c. Give any other grazing name (e.g. Community Pasture) to identify where the work is being done.

***Note:* Items A7a-h are completed in the office; field evaluators need not complete these items.**

A7. The several parts of this item identify various ways in which a data record may represent a resampling of a polygon that may have been inventoried again at some other time. The data in this record may have been collected on an area that coincides precisely with an area inventoried at another time and recorded as another record in the database. It may also represent the resampling of only a part of an area previously sampled. This would include the case where this polygon overlaps, but does not precisely and entirely coincide with one inventoried at another time. One other case is where more than one polygon inventoried one year coincides with a single polygon inventoried another year. All of these cases are represented in the database, and all have some value for monitoring purposes, in that they give some information on how the status on a site changes over time.

A7a. Does this record represent the latest data recorded for this polygon?

A7b. Has any part of the area within this polygon been inventoried previously, or subsequently, as represented by another data record in the Lotic Wetland database? Such other records would logically carry different dates.

A7c. Does the extent of this polygon exactly coincide with that of any other inventory represented in the Lotic Wetland database? In many cases, subsequent inventories only partially overlap spatially. The purpose of this question is to identify those records that can be compared as representing exactly the same ground area.

A7d. If A7c is answered "Yes," then enter the years of any inventories of this exact polygon.

A7e. If A7c is answered "Yes," also enter the record ID number(s) of any other previous or subsequent reinventories (resamplings) of this exact polygon for purposes of cross-reference in the database.

A7f. Even though this polygon is not a re-inventory of the exact same area as any other polygon, does it share at least some common area with one or more polygons inventoried at another time?

A7g. If A7f is answered "Yes," enter the years of any other inventories of polygons sharing common area with this one.

A7h. If A7f is answered "Yes," also enter the record ID number(s) of any other polygon(s) sharing common area with this one.

A8a. Has a management change been implemented on this polygon?

A8b. If A8a is answered "Yes," in what year was the management change implemented?

A8c. If A8a is answered "Yes," describe the management change implemented.

LOCATION DATA

B1. Province in which the field work is being done.

B2a, b. Identify the Natural Region and Sub-Region in which the field work is being done. Use the Natural Regions and Subregions of Alberta (Alberta Natural Heritage Information Centre (1999).

B3. County or municipal district in which the field work is being done.

B4a. The city, town, or village in which the fieldwork is being done.

B4b. The subdivision plan number in which the fieldwork is being done.

B4c. The block number in which the fieldwork is being done.

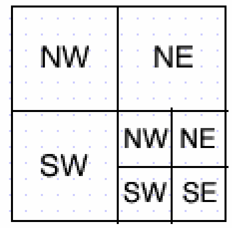
B4d. The lot number in which the fieldwork is being done.

B5. Identify the allotment, range unit, or landowner where the field work is being done.

B6. Name the waterbody or area on which the field work is being done.

B7. Polygon number is a sequential identifier of the actual piece of land being surveyed. This is referenced to the map delineations.

B8a. The location of the polygon is presented as a legal land description: 1/4,1/4 section, 1/4 section, Township, Range, and Meridian are read from smallest to largest unit.



B8b. Identify the side of the polygon that the Assessment is completed for by using "North, South, East or West", if assessment includes both sides enter "Both"

B9. Elevation (feet or meters) of the polygon ***centroid.*** Elevation is usually interpolated from a topographic map

B10a. Name the major watershed (e.g. North Saskatchewan River) of which the site being surveyed is a part.

B10b. Name the minor watershed (e.g. Battle River) of which the site being surveyed is a part. This is normally subordinate to the major watershed named above in B10a.

B10c, d. The minor watershed area (km 2) and perimeter (km) are obtained from the map in the office.

B10e. Name the sub-basin (e.g. Iron Creek). This is the local watershed of which the site being surveyed is a part. This is normally subordinate to the minor watershed named above in B10b.

B11a-c. Universal Transverse Mercator (UTM) coordinates are recorded for the upper and lower ends of the polygon using GPS units in the field. Other locations of special interest may be recorded using the GPS unit. These coordinates are considered accurate to within approximately 50 m. Field observers are to use GPS units to obtain these coordinates following standard protocol. Record UTM coordinates at each end of the long axis of the polygon.

Enter the UTM coordinate data, including the UTM zone and the identifying waypoint number, on the form for each point collected. Save the data in the GPS unit for downloading to the computer later. When starting work in a new location, always check the GPS receiving unit against a known point by using the UTM grid and map.

B11d, e. Identify the GPS unit used, and the name or number designator of the waypoints saved for the upper and lower ends of the polygon and for other locations. Describe any comments worth noting about the waypoints (i.e., monument referenced or general location descriptions).

B12a-c. Record the name(s), scale, and publication year of the quadrangle map(s) or any other map(s) locating the polygon. Use precisely the name listed on the map sheet. Provision is made for listing two maps in case the polygon crosses between two maps.

B13. Record identifying data for any aerial photos used on this polygon.

SELECTED SUMMARY DATA

C1. Wetland type is a categorical description of predominant polygon character. Select from the following list of categories that may occur within a lotic system the one that best characterizes the majority of the polygon. Observers will ***select only one category*** as representative of the entire polygon. If significant amounts of other categories are present, indicate this in the last item, "Comments and Observations," or consider dividing the original polygon into two or more polygons.

Category Description

River. Rivers are generally larger than streams. They flow year around, in years of normal precipitation and when significant amounts of water are not being diverted out of them. Those watercourses called rivers on USGS 7.5 minute topo quads and/or those having bankfull channel widths greater than 50 ft (15 m) will be classified as rivers for the purpose of this inventory.

Nonriparian (Upland). This designation is for those areas which are included in the inventoried polygon, but which do not support functional wetland vegetation communities. Such areas may be undisturbed inclusions of naturally occurring high ground, or such disturbed high ground as roadways and other elevated sites of human activity.

Other. Describe the water source.

C2. The size (acres/hectares) of polygons large enough to be drawn as enclosed units on 1:20,000 or 1:50,000 scale maps is determined in the office using a planimeter, dot grid, or GIS. For polygons too small to be accurately drawn as enclosed units on the map, and that are represented by line segments on the map along the drainage bottom, polygon size is calculated using polygon length and average polygon width (items C5 and D7).

C3a-d. Evaluators may be asked to survey some areas that have not been determined to be wetlands for the purpose of making such a determination. Other polygons include areas supporting non-wetland vegetation types **a.** "Yes" answer here indicates that no part of the polygon keys to a riparian habitat type or community type (HT/CT). Areas classified in item C8 as any vegetation type described in a riparian and/or wetland classification document for the region in which you are working are counted as functional wetlands. Areas listed as UNCLASSIFIED WETLAND TYPE are also counted as functional wetlands. Other areas are counted as non-wetlands, or uplands. **C3c-d are filled completed in the office once the length of the polygon is determined.**

Some riparian areas do not contain an unvegetated, defined stream channel. In some cases, these polygons are in ephemeral systems which may flow infrequently, but which do support riparian plant communities. In other cases, these polygons may be associated with larger river systems that have wide floodplains where polygons may be delineated in areas not adjacent to the channel.

C4. Channel length— the length of channel contained within or adjacent to the polygon—is measured by scaling from the map. This data is considered accurate to the nearest 0.1 mile (0.16 km).

C5. In some cases, the polygon record is used to characterize, or represent, a larger portion of a stream system. The length represented by the polygon is given here. For example, a 0.5 mile (0.8 km) polygon may be used to represent 4 miles (6.4 km) of a stream. In this case, 0.5 mile (0.8 km) is the channel length of the polygon, and 4 miles (6.4 km) is.

C6. Record average width of the polygon, which on smaller streams corresponds to the width of the riparian zone. To determine this width, subtract the width of the non-vegetated stream channel from the distance between the two opposite riparian/upland boundaries. In the case of very wide systems where the polygon inventoried does not extend across the full width of the riparian zone (e.g., area with riparian vegetation communities lies outside the polygon), record the average width of the polygon inventoried and make note of the situation in the comments.

C7. List the riparian habitat type(s) and/or community type(s) found in the polygon (Hansen and others 1995 or another appropriate publication). If the habitat type cannot be determined for a portion of the polygon, list the appropriate community type(s) of that portion. If neither the habitat type nor community type can be determined for any portion of the polygon (or in areas [outside of Montana] where the habitat and community types have not been named and described), list the area in question as "unclassified wetland type" and give the dominant species present. Indicate with the appropriate abbreviation if these are habitat types (HT), community types (CT), or dominance types (DT), for example, PSEUMEN/CORNSTO HT. For each type listed, estimate the percent of the polygon represented.

If known, record the successional stage (i.e., early seral, mid-seral, late seral, and climax) or give other comments about the type. As a minimum, list all types which cover 5% or more of the polygon. The total must approximate 100%. Slight deviations due to use of class codes or to omission of types covering less than 5% of the polygon are allowed. ***Note:*** For any area classified as an "unclassified wetland type," it is important to list any species present which can indicate the wetness or dryness of the site.

ADDITIONAL PHYSICAL SITE CHARACTERISTICS
Items D1-D4 may be answered at the discretion of the user.

D1. Answer "Yes" if the site has habitat types or community types characterized by tree or tall shrub species. Tall shrubs do not include the snowberries *(Symphoricarpos* spp.), wild rose *(Rosa woodsi*i), silver sagebrush *(Artemisia can*a), and greasewood *(Sarcobatus vermiculatu*s).

D2. Record the rating category which best describes the vegetation use by animals (Platts and others 1987). Do not Record a specific percent within a category.

Code	Category Description
0 to 25%	Vegetation use is light or none. Almost all plant biomass at the current development stage remains. Vegetative cover is close to that which would occur without use. Unvegetated areas (such as bedrock) are not a result of land uses.
26 to 50%	Vegetation use is moderate. At least half the potential plant biomass remains. Average stubble Height is more than half its potential at the present stage of development.
51 to 75%	Vegetation use is high. Less than half the potential plant biomass remains. Plant stubble height is usually more than 2 inches (on many ranges).
76 to 100%	Vegetation use is very high. Only short stubble remains (usually less than 2 inches on many ranges). Almost all potential plant biomass has been removed. Only the root systems and parts of the stems remain.

D3. Record ***average*** width of the polygon, which on smaller streams corresponds to the width of the riparian zone. To determine this width, subtract the width of the non-vegetated stream channel (item D3) from the distance between the two opposite riparian/upland boundaries. In the case of very wide systems where the polygon inventoried does not extend across the full width of the riparian zone (e.g., area with riparian vegetation communities lies outside the polygon), record the average width of the polygon inventoried and make note of the situation in the comments.

D4. Describe the boundaries of the polygon, especially the location of the upper and lower ends, as well as the lateral boundaries. On smaller streams the polygon usually includes the entire width of the riparian zone. Describe what you use as the indicators of the wetland-upland boundary. Use localized geologic, physical, or vegetation information to identify these boundaries of the polygon for future polygon relocation.

WATER QUALITY DATA
Note: This category (items E1-E7) currently applies only to inventories conducted in the United States. Data will be entered in the office.

E1-E2. For Montana, this information can be obtained from the current state 303(d) list of impaired waters maintained by Montana Department of Environmental Quality. In other states, contact the appropriate agency.

E3. Enter High, Medium, or Low for TMDL development priority. Obtain from current federal/state 303(d) list of impaired waters.

E4. Enter TMDL development status: EPA approved, de-listed due to reassessment, incomplete at present. Obtain from state environmental health agency.

E5-E7. Enter probable causes, probable impaired uses, and probable sources. Information can be obtained from current state 303(d) list of impaired waters.

PHOTOGRAPH DATA
Note: Take at least one photo upstream and one downstream at each end of every polygon. This applies even to situations where the polygon is at one end of an inventoried reach and one of the photos is taken into a non-inventoried area, as well as situations in which another polygon is adjacent to the one being inventoried.

F1a-c. Record items E1a-c for photos at the ***upstream*** end or within the upper half of the polygon. Record the film roll number (use unique numbers for each roll) and photographer's initials. Record the photo frame number(s) behind the word indicating the direction the photos were facing (upstream, downstream, or other). Describe the location at which other photos were shot. Describe the view of each photo with reference to direction and polygon features such as streams, vegetation, boundaries, etc. For polygons without definite upstream and downstream ends, record the locations of photos taken.

F2a, b. Indicate whether there are adjacent polygons upstream and/or downstream of this polygon.

F3a-c. Record similar information (as in items E1a-c) for photos taken at the ***downstream*** end or in the lower half of the polygon.

F4. Record the brand of film, film speed, camera lens size, and lens focal length.

FACTORS FOR ASSESSING RIVER FLOODPLAIN HEALTH

1. Cottonwood and 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 count any mode of reproduction for this group of trees, because in the Parkland and Boreale poplar populations are not nearly so dependent on seed deposited on riverine alluvium.

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 1 ft (29 cm) in height, but less than 5 inches (12.5 cm) in dbh [diameter at breast height: 4.5 ft (1.35 m)]). If the polygon is on the outside of a long meander curve where depositional material is not expected, replace both Actual Score and Possible Score with NA.

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

2. Regeneration of other Tree Species. As succession progresses on a riparian site, the pioneer cottonwood 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 cottonwoods and willows) communities and older communities (with aging cottonwoods and later seral species such as *Acer negundo* [Manitoba maple], *Fraxinus pennsylvanica* [green ash], *Populus tremuloides* [aspen], *Pseudotsuga menziesii*

[Douglas fir], and *Juniperus scopulorum* [Rocky Mountain juniper]). ***Note:*** Seedlings and saplings of these species include individuals which are less than 3 inches (7.5 cm) in dbh, with the exception of *Pseudotsuga menziesii* [Douglas fir], for which saplings go up to 5 inch (12.5 cm) dbh. If the polygon is a newly formed island where all plant communities are in an early successional stage and where no later successional species are expected to be present at this time, 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 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. ***Note:*** Do not count *Elaeagnus angustifolia* [Russian olive] in this determination because it is considered an undesirable exotic species.

Scoring:
3 = More than 5% of the other (non-cottonwood) tree cover is seedlings and saplings.
2 = 1% to 5% of the other (non-cottonwood) tree cover is seedlings and saplings.
1 = Less than 1% of the other (non-cottonwood) tree cover is seedlings and saplings.
0 = Seedlings and saplings of trees species other than cottonwoods are absent.

3. Preferred Shrub Species Establishment and Regeneration. 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.

Seven shrub genera or species (*Symphoricarpos* spp. [snowberry], *Rosa* spp. [rose], *Crataegus* spp. [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Caragana* spp. [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* spp. [salt cedar] are excluded from the evaluation of establishment and regeneration. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-heavy grazing pressure; ***AND*** for which there is rarely any problem in maintaining presence on site. *Caragana* spp. [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* spp. [salt cedar] are considered especially aggressive, undesirable exotic plants. The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (i.e., *Salix* spp. [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern.

FOR EXAMPLE: A polygon may have *Symphoricarpos occidentalis* (common snowberry) with 30% canopy cover showing young plants for replacement of older ones, while also having a trace of *Salix exigua* (sandbar willow) present, but represented only by older mature individuals. We feel that the failure of the willow to regenerate (even though there is only a small amount) is very important in the health evaluation, but by including the snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of snowberry).

For shrubs in general, seedlings and saplings can be distinguished from mature plants as follows. For those species having a mature height generally over 6.0 ft (1.8 m), seedlings and saplings are those individuals less than 6.0 ft (1.8 m) tall. For species normally not exceeding 6.0 ft (1.8 m), seedlings and saplings are those individuals less than 1.5 ft (0.45 m) tall or which lack reproductive structures and the relative stature to suggest maturity. ***(Note:*** Observers 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 shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA. If the observer is not fairly certain potential exists for preferred shrubs, then enter NC and explain in the comment field below.)*
3 = More than 5% of the preferred shrub species cover is seedlings and saplings.
2 = 1% to 5% of the preferred shrub species cover is seedlings and saplings.
1 = Less than 1% of the preferred shrub species cover is seedlings and saplings.
0 = None of the preferred shrub species cover is seedlings and 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 dewatering of the riparian site 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 due to high levels of browsing. Finally, large amounts of decadent and dead woody material may indicate climatic impacts or disease and insect damage. For instance, severe winters may cause extreme die back of trees and shrubs, and cyclic insect infestations may kill individuals in a stand. In all these cases, a high percentage of dead and decadent woody material reflects degraded vegetative health, which may lead to reduced streambank integrity, channel incisement, excessive lateral cutting, lowered production, and limited wildlife habitat.

Scores are based on the percentage of ***total woody canopy cover*** which is decadent or dead, ***not*** on the percentage of total polygon canopy cover represented by dead and decadent woody material. For example, woody vegetation may occupy 50% of the polygon. You would then only look at what percent of the woody vegetation is decadent or dead. Count only material which is standing, not that which is lying on the ground. Do not include the decadent and dead material of cottonwood trees which are decadent due to old age (rough and furrowed bark extends substantially up into the crowns of the trees).

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

5. Preferred Tree and Shrub Species Utilisation. Many riparian woody species are browsed by livestock and/or wildlife. Heavy browsing of key palatable species *(Cornus stolonifera* [red-osier dogwood], *Salix* spp. [willows], *Populus* spp. [cottonwoods and aspen], *Acer negundo* [box elder], *Fraxinus pennsylvanica* [green ash], *Prunus virginiana* [chokecherry], and *Amelanchier alnifolia* [serviceberry] can shift the community to less palatable and less desirable species or entirely remove woody species from the site. Therefore, this item reflects both current site condition and successional direction of changes in the vegetation community.

One tree species *(Elaeagnus angustifolia* [Russian olive]) and seven shrub genera or species *(Symphoricarpos* spp. [snowberry], *Rosa* spp. [rose], *Crataegus* spp. [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Caragana* spp. [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* spp. [salt cedar] are excluded from the evaluation of establishment and regeneration.

These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-heavy grazing pressure; ***AND*** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* spp. [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* spp. [salt cedar] are considered especially aggressive, undesirable exotic plants.

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (i.e., *Salix* spp. [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a heavily utilised species of greater concern.

FOR EXAMPLE: A polygon may have *Symphoricarpos occidentalis* (common snowberry) with 30% canopy cover showing only light utilisation, while also having a trace of *Salix exigua* (sandbar willow) present showing heavy utilisation. We feel that, although there is only a small amount of willow present, the fact that it is being heavily utilized is very important to the health evaluation. By including the snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of snowberry).

When estimating degree of utilisation, 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 (after the evaluation). Only record a score for that portion of the woody material that is currently available for browse. If the woody material is too high for browsing by wildlife or livestock, then do not include it in the scoring. 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 utilisation 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. If the observer is not fairly certain potential exists for preferred trees or shrubs, then enter NC and explain in the comment field below.)*

3 = None (0% to 5% of available second year and older leaders of preferred species are 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).

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 woody species.
2 = 25% to 50% of the total area is occupied by woody species.
1 = 5% to 25% of the total area is occupied by woody species.
0 = Less than 5% of the total area is occupied by 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]). 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.

7a. 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.

7b. Density Distribution of Invasive Plant Species. The observer must pick a category of pattern and extent of invasive plant distribution from the chart below that best fits what is observed on the polygon, while realizing that the real situation may be only roughly approximated at best by any of these diagrams. Choose the category that most closely matches 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.

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).

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 2. Weed density distribution class guidelines

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. 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 reach covered by undesirable herbaceous species.
2 = 5% to 25% of the reach covered by undesirable herbaceous species.
1 = 25% to 45% of the reach covered by undesirable herbaceous species.
0 = More than 45% of the reach covered by undesirable herbaceous species.

9. Presence of Native Graminoids. Certain riparian functions (i.e., primary forage production, wildlife habitat, and maintenance of natural biodiversity) are best served by native species, which evolved with the ecosystem. Native graminoids are very often reduced or eliminated from a site as the result of long term disturbance. Therefore, one measure of the health of a riparian site is the amount of cover by these species (as a group) remaining. Specific species will depend on location, and observers should indicate which species were included.

Scoring:
3 = More than 50% of the reach is covered by native graminoid species.
2 = 25% to 50% of the reach is covered by native graminoid species.
1 = 5% to 25% of the reach is covered by native graminoid species.
0 = Less than 5% or less of the reach is covered by native graminoid species.

10. Exotic Undesirable Woody Species. The degree to which the vegetative community consists of exotic undesirable woody species in most cases reflects a degradation of many riparian functions. Although these species may contribute to some riparian functions to varying degrees, their presence reflects s general reduction in riparian functions overall since they displace more vulnerable and valuable species. This item evaluates what percent of the total woody species canopy cover is composed of exotic undesirable woody species. The two species listed below should always be included in this item. If additional species are included, they should be noted. List those undesirable woody species present along with their infestation area in the comment section. For example, Russian olive = 10%

Elaeagnus angustifolia (Russian olive) *Tamarix chinensis* (Tamarisk)

Scoring:

3 = Less than 5% of total woody coverage in the reach consists of exotic undesirable woody species.
2 = 5% to 25% of total woody coverage in the reach consists of exotic undesirable woody species.
1 = 25% to 50% of total woody coverage in the reach consists of exotic undesirable woody species.
0 = More than 50% of total woody coverage in the reach consists of exotic undesirable woody species.

11. Riverbank Root Mass Protection. The vegetation along rivers performs the primary physical functions of stabilizing the soil with a deep, binding root mass and filtering sediments from overland flow. All tree and shrub species are considered to have deep, binding root masses. Although certain herbaceous species may provide protection on smaller streams, their value along rivers is limited; thus, this item considers only woody species root mass protection. For this item consider the riverbank to be the area extending from the toe of the bank to approximately 9 ft (3 m) beyond the top of the bank. The bank top is that point where the upper bank levels off to the relatively flat surface of a floodplain or terrace. ***(Note:*** Omit from consideration those banks that are stabilized by rip-rap).

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.

12. Human-Caused Bare Ground. Bare ground is soil not covered by plants, litter or duff, downed wood, or rocks larger than 2.5 inches (6 cm). 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.

Scoring:
6 = Less than 5% of the reach contains human-caused bare ground.
4 = 5% to 25% of the floodplain contains human-caused bare ground.
2 = 25% to 50% of the floodplain contains human-caused bare ground.
0 = More than 50% of the floodplain contains human-caused bare ground.

13. Dewatering of 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 removed from the system is directly reflected in a reduction of riparian functions (i.e., wetland plant community maintenance, channel bank stability, wildlife habitat, overall system primary production, etc.) Dewatering of the system can be estimated by determining the fraction of the average river discharge which is removed 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 irrigation withdrawals from a river segment. 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 discharge during the critical growing season is removed.
6 = 10% to 25% of average river discharge during the critical growing season is removed.
3 = 25% to 50% of average river discharge during the critical growing season is removed.
0 = More than 50% of average river discharge during the critical growing season is removed.

14. 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 effects of these dams are debits against 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.

15. Human Alterations to the Riverbanks. Such human activities as residential development, road construction, farming, railroad construction, water diversion weirs, boat ramps, rip-rap, and levees along the immediate riverbanks negatively impact many functions of a riparian ecosystem. These alterations disrupt vegetative communities, alter bank integrity, constrict flows to the immediate channel, and otherwise change the natural system dynamics. Observers should consider both sides of all active channels when estimating the amount of total bank length altered by these activities.
Scoring:
9 = Less than 10% of the bank length has been restructured by human activity.
6 = 10% to 25% of the bank length has been restructured by human activity.
3 = 25% to 50% of the bank length has been restructured by human activity.
0 = More than 50% of the bank length has been restructured by human activity.

16. Floodplain Accessibility. Many of the most important functions of a riparian ecosystem depend upon the ability of thechannel to access its floodplain during high flows. This access is restricted by levees and other human constructed embankments, such as roadbeds. Observers should determine what fraction of the historic 100 year floodplain 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) to the area within the FEMA (US Federal emergency Management Agency) 100 year floodplain map of the reach.
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 = More than 35% or less of the floodplain is accessible to flood flows.

Calculating the Riparian Health Score

The scores are totalled for all the factors rated, and that total is divided by the possible perfect score. Below is a sample score sheet.

A sample score sheet of a riparian site along a major river

Vegetation Factors	**Actual Pts**	**Possible Pts**
1. Cottonwood Regeneration from Seed	2	6
2. Regeneration of other Tree Species	2	3
3. Shrub Regeneration	2	3
4. Standing Decadent and Dead Woody Material	2	3
5. Tree and Shrub Utilisation	2	3
6. Total Canopy Cover of Woody Species	2	3
7a. Invasive Herbaceous Species Canopy Cover	2	3
7b. Invasive Herbaceous Species Density Distribution	2	3
8. Disturbance-increaser Undesirable Herbaceous Species	2	3
9. Presence of Native Graminoids	2	3
10. Exotic Undesirable Woody Species	3	3
Vegetative Score:	23	36

Soil/Hydrology Factors	**Actual Pts**	**Possible Pts**
11. Riverbank Root Mass Protections	4	6
12. Human-Caused Bare Ground	6	6
13. Dewatering of the River System	3	9
14. Control of Flood Peak/Timing by Upstream Dam(s)	3	9
15. Human Alterations to the Riverbanks	6	9
16. Floodplain Accessibility	6	6
Soil/Hydrology Score:	28	45
TOTAL SCORE:	**51**	**81**

Rating = (Total Actual) / (Total Possible) X 100%
Rating = (51) / (81) X 100% = 63%

Because of their size and the cumulative effects from upstream as well as downstream impacts, management of individual reaches along a river may be more difficult to implement than actions appropriate for smaller riparian areas. This characteristic of river systems argues for the larger watershed approach which is increasingly being taken to address riverine ecosystems.

The manager should realize that while certain factors affecting function of the river on his site may be outside his control, the system health is nevertheless degraded by such factors as “Dewatering of the River System” and “Control of Flood Peak/Timing by Upstream Dam(s),” even though these are occurring off his property upstream. His only recourse may be to lobby for a more cooperative, integrated approach to management of the whole system. While a less than perfect score is not always cause for great concern, and an area rating at 80% is considered to be functioning properly, the scores of individual factors on the form can be useful in detecting strengths or weaknesses of a site. A low score on any factor may warrant management focus. For example, the sample shown above has low scores for “Cottonwood Regeneration from Seed”, “Dewatering of the River System” and “Control of Flood Peak/Timing by Upstream Dam(s)” (items #1, #13, and #14). Of these factors the manager might bring improvement to #1 by changing timing of grazing.

17. Trend. Select a category (Improving, Degrading, Static, or Status Unknown) to indicate the trend of the vegetative community on the polygon. Trend refers, in the sense used here, not specifically to successional pathway change, but in a more general sense of apparent community health. By definition, trend implies change over time. Accordingly, a precise trend analysis would require comparison of repeated observations over time. However, some insights into trend can be observed in a single visit. For example, the observer may notice healing (revegetating) of a degraded streambank and recent establishment of woody seedlings and saplings. This would indicate changing conditions that suggest an improving trend. If such indicators are not apparent, select the category "status unknown."

18. Comments and Observations. Add any necessary commentary to explain or amplify the data recorded. Do not leave this space blank. Describe any unique characteristics of the site and other observations relating to the vegetation.

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APPENDIX S
Alberta Lentic Wetland Inventory Form (7/11/2006)

ALBERTA LENTIC WETLAND INVENTORY FORM Record ID No: ______

ADMINISTRATIVE DATA

A1. Field data collected by (Organisation): ______

A2. Funding Agency/Organisation: ______

A3a. Indian or Metis Reserve? (Yes; No): ______ **If Yes**, Reserve Name: ______

A3b. National or Provincial Park, Preserve, or Sanctuary? (Yes; No): ______

If **Yes**, Name: ______

A3c. Ecological, Environmental and/or Municipal Reserve (Exclude national or provincial reserves)? (Yes; No): ______

If **Yes**, Name: ______

A3d. Private or Deeded Land? (Yes; No): ______ **A4.** Observers: ______

A5a. Date field data collected: ______ **A5b.** Year: ______ **A6a.** Grazing lease or grazing reserve? (Yes; No): ______

If **Yes**, **A6b.** Grazing disposition No.: GRL: ______ GRP: ______

FGL: ______ Other: ______

A6c. Other Grazing Name (e.g. Community Pasture): ______

A7a. Is this the latest inventory for this polygon? (Yes; No): ______

A7b. At least some part of this polygon has been inventoried more than once (resampled)? (Yes; No): ______

If **No**, Go to item A8a. **A7c.** This polygon coincides exactly with another inventoried polygon? (Yes; No): ______

If **No**, Go to item **A7f.**, **A7d.** Other years sampled: ______

A7e. ID No.(s) of other inventories of this exact polygon: ______ , ______ , ______ , ______ , ______

A7f. This polygon shares common area with other inventoried polygon(s), but is not exact? (Yes; No): ______

A7g. Other years: ______

A7h. ID No.(s) of other records sharing area with this polygon: ______ , ______ , ______ , ______ , ______

A8a. Has a change in management occurred? (Yes; No, Unknown): ______ **A8b.** Year changed occurred: ______

A8c. Type of management change applied: ______

LOCATION DATA

B1. Province: ______ **B2a.** Natural Region: ______ **B2b.** Natural Sub-Region: ______

B3. County/Municipal District: ______ **B4a.** City/Town/Village: ______

B4b. Subdivision Plan No.: ______ **B4c.** Block No.: ______ **B4d.** Lot No.: ______

B5. Allotment/Range Unit/Landowner/Lessee Name: ______

B6. Waterbody/Area Name: ______ **B7.** Polygon number: ______

B8a. Location: 1/4 1/4 Sec: ______ 1/4 Sec: ______ Sec: ______ **B8b.** Side of Waterbody: ______

Township (NS): ______ Range (EW): ______ Meridian: ______ **B9.** Elev. (ft): ______ ; (m): ______

B10a. Major Watershed (e.g. North Saskatchewan River): ______

B10b. Minor Watershed (e.g. Battle River): ______

B10c. Minor Watershed Area (km^2): ______ ; (hect): ______ **B10d.** Minor Watershed Perimeter (km): ______

B10e. Sub-basin (e.g. Iron Creek): ______

B11a. UTM coordinates of polygon North/West end Easting: ______ Northing: ______ Zone: ______

B11b. UTM coordinates of polygon South/East end Easting: ______ Northing: ______ Zone: ______

B11c. UTM coordinates of any other point of interest in the polygon: East: ______ North: ______; Zone: ______

B11d. GPS Unit #: ______ WPt Upper: ______ WPt Lower: ______ WPt Other: ______

B11e. Comments: ______

B12a. Map Title(s): ______ ______

B12b. Map Scale: ______ **B12c.** Map Year: ______

B13. Aerial Photo Info: Scale: ______ Date: ______ Job#: ______ Line#: ______

AS#: ______ Photo#: ______ Other Info: ______

Record ID No: ______

SELECTED SUMMARY DATA

C1. Water body type: ______ C2. Polygon size (acres): ______ ; (hect): ______

C3a. Is the entire polygon an upland? (Yes; No): ______ If No, C3b. Does the polygon consist entirely of functional wetland types? (Yes; No): ______ C3c. Functional wetland (acres): ______ ; (hect): ______ C3d. Percent of total polygon: ______

C4. Does the polygon contain a defined shoreline? (Yes; No; NC): ______

C5. Polygon length (mi): ______ ; (km): ______ C6. Number of miles the polygon represents (mi): ______; (km): ______

C7a. Average polygon width (ft): ______ ; (m): ______

C7b. Polygon width range (ft): ______ to ______ ; (m): ______ to ______

Health Assessment Summary

C8. Polygon Health:

	Rating Percent (%)	Descriptive Category:
Vegetation:	______	______
Soil / Hydrology:	______	______
Overall:	______	______

Rating Percent Range	*Descriptive Category*
80-100	*Proper Functioning Condition (Healthy)*
60-79	*Functional At Risk (Healthy, but with Problems)*
<60	*Nonfunctional (Unhealthy)*

VEGETATION DATA

D1a. Wetland prevalence index: ______

D1b. Vegetation structural diversity: ______

Trees

D2a. Are trees present? (Yes; No): ______ D2b. Tree species by canopy cover (%) and percent age group (%)

SPECIES	COV (%)	SDLG/DEC	SPLG/DEC	POLE/DEC	MAT/DEC	DEAD

SPECIES	D3. Regeneration Category	D4. Age Group Distribution Category	D5. Seedling/Sapling Utilization

Shrubs

Record ID No: ________________

D6a. Are shrubs present? (Yes; No): ______

D6b. Is there potential for preferred shrubs? (Yes; No): ______

D6c. Shrub species canopy cover (%), age/size groups (%), and utilization

SPECIES	COV (%)	SDLG-SPLG/UTIL	MATURE/UTIL	DEC-DEAD/UTIL	**D6c.** Shrub Growth Form (N,F,U)

Record ID No: ____________

D7. Graminoids

Graminoids present?
(Yes; No): ______

SPECIES	COV (%)

D8. Forbs

Forbs present?
(Yes; No): ______

SPECIES	COV (%)

D9. Plant Group by Canopy Cover (%)

Layer	Trees	Shrubs	Graminoids	Forbs
3 (>6.0 ft):	________	________	________	________
2 (>1.5 - 6.0 ft):	________	________	________	________
1 (0 - 1.5 ft):	________	________	________	________

D10. Total canopy cover (%) by lifeform:

Trees: __________ Shrubs: __________

Graminoids: __________ Forbs: __________

D11. Total canopy cover (%) by woody species: ________

D12. Total canopy cover (%) by all plant lifeforms: ______

Weed Data

D13a. Are invasive species present ? (Yes; No; NC): ______

If Yes, **D13b.** Enter the Canopy Cover and the Density/Distribution Class for each of the following invasive species:

		Canopy Cover	Density/Distribution Class
Bladder Campion:		______	______
Blueweed:		______	______
Canada Thistle:		______	______
Common Hound's-tongue:		______	______
Common Tansy:		______	______
Dalmatian Toadflax:		______	______
Diffuse Knapweed:		______	______
Leafy Spurge:		______	______
Ox-eye Daisy:		______	______
Perennial Sowthistle:		______	______
Purple Loosestrife:		______	______
Russian Knapweed:		______	______
Russian Olive:		______	______
Scentless Chamomile:		______	______
Spotted Knapweed:		______	______
Tall Buttercup:		______	______
Yellow Toadflax:		______	______
Others:	__________	______	______
Others:	__________	______	______
Others:	__________	______	______
Others:	__________	______	______
Others:	__________	______	______
Others:	__________	______	______

D13c. Cumulative totals for all invasive species:

Canopy Cover: ________ Density/Distribution Class: ______

D14a. Are undesirable herbaceous species present?
(Yes; No; NC): ______

If **Yes, D15b.** Record the combined canopy cover (%) of all undesirable herbaceous species observed: ______

Record ID No: ____________

D15. Habitat Types and Community Types

Classification Type Name	Phase	Percent of Polygon	Successional Stage or Comments

D16. Polygon trend: Improving, Degrading, Static, or Status Unknown? ____________________

D17. Explain trend description and give other vegetation comments:

PHYSICAL SITE DATA Record ID No: ________

F1. What is the primary water source on the polygon? (Perennial stream, Overland surface flow, Springs/seeps, Topograqhic contact with groundwater table, Unknown, Other): ________ Explain Other: ________

F2. Is the water body in a closed basin with no outlet? (Yes, No, NA, NC): ________

F3. Describe the water chemistry (Alkaline/Saline; Fresh, Unknown, NC): ________

F4a. Degree of artificial drawdown (Not Subjected, Minor, Moderate, Extreme, NC): ________

F4b. Basis of call: ________

F5a. Is there an overflow structure? (Yes, No, NA, NC): ________

If Yes, F5b. Indicate type (Concrete, Pipe, Rock Armored, Unprotected, Other): ________

Explain "Other": ________

F5c. Does the overflow structure appear stable? (Yes, No, NA, NC): ________

Explain: ________

F6a. Does the polygon contain a defined shoreline? (Yes; No; NC): ________ If No, Skip to item F8a below.

If Yes, F6b. Are shore substrates visible? (Yes; No; NC): ________

If Yes, F6c. Give the percent of each size (total must approx. 100%):

________ >20 inches (Medium Boulders +) ________ 2.5 - 5 inches (Small Cobbles) ________ 0.062 mm - 2 mm (Sand)

________ 10 - 20 inches (Small Boulders) ________ 0.6 - 2.5 inches (Coarse Gravel) ________ <0.062 mm (Silt and Clay)

________ 5 - 10 inches (Large Cobbles) ________ 0.08 inches - 0.6 inches (Fine Gravel)

F7. Percent of the shore with deep, binding root mass (0-35%; 36–65%; 66–85%; over 85%; NA; NC): ________

F8. Is there alteration of polygon vegetation by human activities? (Yes; No; NC): ________

F8a. What percent of the polygon vegetation has been altered by human activities? ________

F8b. Breakdown the causes of human-caused alteration to the polygon vegetation (must approx. 100%):

________ Grazing ________ imber Harvest ________ Construction ________ Roads and RR's ________ Other Causes

________ Cultivation ________ Mining Activites ________ Cottage Devel ________ Recreation

Explain "other": ________

F8c. Breakdown the kinds of human-caused alteration to the polygon vegetation (must approx.100%):

________ Clearing ________ Deep to Shallow Rooted Species ________ Tall to Short Woody species

________ Removal of Structural Layers ________ Native to Tame/Exotic Species ________ Other Kinds

________ Invasion by Weedy Species ________ Woody to Herbaceous Species

Explain "other": ________

F8d. Comment on the nature and extent of human-caused alteration to the vegetation

____

____

F9. Is there physical alteration of polygon by human activities? (Yes; No; NC): ________

F9a. What percent of the polygon has been physically altered by human activities (aside from the vegetation)? ________

F9b. Breakdown the causes of human-caused alteration to the physical polygon site (must approx. 100%):

________ Grazing: ________ Construction ________ Water Management ________ Timber Harvest ________ Recreation

________ Cultivation ________ Roads & RR's ________ ottage Development ________ Mining Activities ________ Other Kinds

Explain "other": ________

F9c. Breakdown the kinds of human-caused alteration to the physical polygon site (must approx.100%):

________ Soil Compaction (Hum/Pug, trails, paths, wallows, etc.) ________ Shore Alteration (hoof shear, riprap, berms, etc.)

________ Human Impervious surface (pavement, roofs, walks, etc.) ________ Landscaping (altered topography)

________ Hydrological Change (ditching, draining, flooding, berms, etc.) ________ Plowing/Tilling

________ Other Explain "other": ________

F9d. Comment on any odd or unusual aspect of human-caused alteration to the physical polygon:

____

____

Record ID No: ________

F10a. Is there exposed soil surface (bare ground) in the polygon? (Yes; No; NC): ______

If **Yes**, complete items **F10b-d**; if **No** or **NC**, go to item **F11**.

F10b. What percent of the polygon which is exposed soil surface (bare ground): ______

F10c. Of this, how much is due to Natural Processes: ______ Human-caused disturbance: ______ (must approx. 100%)

F10d. Within *each* category (natural & human-caused), how much resulted from the listed processes?

NATURAL PROCESSES	*(must approx. 100%)*	HUMAN-CAUSED PROCESSES	*(must approx. 100%)*
______ Erosional	______ Type Dependent	______ Grazing	______ Construction
______ Depositional	______ Saline/Alkaline	______ Logging	______ Mine tailings
______ Wildlife Use	______ Exposed lake bottom	______ Recreation	______ Other
______ Other	Explain "Other": ______		

F11. Non-vegetated ground cover. (**Note:** Bare ground and vascular plant cover recorded above.)

Rocks (>2.5 in.): ______ Moss: ______ Litter and Duff: ______ Wood: ______ Human Imperv. Surf: ______ Other: ______

F12a. Animal-caused pugging and/or hummocks present? (Yes; No; NC): ______

If **Yes**, **F12b.** Percent (%) of polygon affected: ______

F13a. Are side drainages and hillslopes contributing to degradation of the system? (Yes; No; NA; NC): ______

If **Yes**, **F13b.** Human-caused? (Yes; No; NA; NC): ______ Causes: ______

F13c. Natural cause? (Yes; No; NA; NC): ______ List major soil type: ______

F14. Is water quality sufficient to support wetland plants? (Yes; No; NA; Unknown; NC): ______

F15. Is standing surface water present on the polygon? (Yes; No; NA; NC): ______

F16. Are chemicals that affect plant productivity/composition (i.e., salts) accumulating on the site? (Yes; No; NA; NC): ______

F17. Comments (Summarize unique characteristics or problems not evident from the data collected. Include topics related to any of the optional data. Consider current and historic attributes resulting from human-caused and natural processes.):

F18. Detailed description of the polygon boundaries if it does not include the entire wetland area at the site:

Record ID No: ____________

PHOTOGRAPH DATA

G1. Identification of photos (taken at the ***north/west*** end of polygon):

Photographer: ____________

Camera Number: ____________

Roll #: Photo #: Description:

N/W views: ________ ________ ________________

S/E views: ________ ________ ________________

Other views ________ ________ ________________

G2. Is there an adjacent polygon ***north/west*** of this polygon? (Yes; No): ______

G3. Is there an adjacent polygon ***south/east*** of this polygon? (Yes; No): ______

G4. Identification of photos (taken at the ***south/east*** end of polygon):

Photographer: ____________

Camera Number: ____________

Roll #: Photo #: Description:

N/W views: ________ ________ ________________

S/E views: ________ ________ ________________

Other views ________ ________ ________________

G5. Identification of additional photos taken outside of polygon (i.e., non-polygon photos):

Roll #:	Photo #:	Description:

G6. Film and Camera Specs: Film brand: ________ Film speed (ASA): ____ Lens dia. (mm): ____

Lens foc. len. (mm): ______ Lens foc. len. (mm): ____________

OPTIONAL DATA

Record ID No: ____________

H1. Vegetative use by animals (0-25%; 26-50%; 51-75%; 76-100%): ____________

H2. Adjacent uplands (Agriculture; Grassland; Shrubland; Forest; or Other): ____________ ____________

H3. Break down the polygon into percentages of the area in the land uses listed (must total to approx. 100%):

No land use apparent: ______
Turf grass (lawn): ______
Tame pasture (grazing): ______
Native pasture (grazing): ______
Recreation (ATV paths, campsites, etc.): ______
Development (buildings, corrals, paved lots, etc.): ______
Tilled Cropping: ______
Perennial forage (e.g., alfalfa hayland): ______
Roads: ______
Logging: ______
Mining: ______
Railroads: ______
Other: ______

Description of Other Usage Noted: ____________

H4. Break down the area adjacent to the polygon into the land uses listed (must total to approx. 100%):

No land use apparent: ______
Turf grass (lawn): ______
Tame pasture (grazing): ______
Native pasture (grazing): ______
Recreation (ATV paths, campsites, etc.): ______
Development (buildings, corrals, paved lots, etc.): ______
Tilled Cropping: ______
Perennial forage (e.g., alfalfa hayland): ______
Roads: ______
Logging: ______
Mining: ______
Railroads: ______
Other: ______

Description of Other Usage Noted: ____________

H5. Percent of shoreline accessible to livestock: ______

H6a. Has the bank or shoreline profile been modified by construction? (Yes; No; NC): ______

If Yes, **H6b**. How much of the bank or shoreline length is modified (%)? ______

H6c. What part resulted from the various sources: (must approx. 100%)

Dikes	______	Road Construction	______	Railroads	______
Berms	______	Water Diversion Structures	______	Mining	______
Dams	______	Vegetation Removal	______	Bridges	______
Rip-rap	______	Channelization	______	Logging	______
Other	______	Explain "Other":	____________		

H6d. Location(s): ____________

Waterfowl Data

H7a. Were waterfowl nests or broods observed? (Yes; No): ______

If Yes, **H7b**. Describe: ____________

Fishery Data

H8a. Does the polygon contain a fishery? (Yes; No; Unknown): ______

If Yes, **H8b**. Is it a sport fishery, non-sport fishery, or unknown: ______

H8c. Fish types present, if known (use common names or descriptions): ____________

H8d. How many fish were observed? (0; 1-10; 11-50; >50): ______

H8e. If the polygon does not contain a fishery, is there potential for one? (Yes; No; Unknown): ______

Explain: ____________

Record ID No: ____________

Amphibian and Reptile Data

H9a. Were amphibians observed? (Yes; No): ______

If Yes, H9b. Number observed: Frogs: ______ Toads: ______ Salamanders: ______

H10a. Were reptiles observed? (Yes; No): ______

If Yes, H10b. Number observed: Snakes: ______ Turtles: ______ Lizards: ______

H11. List amphibian or reptile species and the quantity of each identified in the polygon.

Spp. #1: ____________________ No.: ______ Loc.: ____________________

Spp. #2: ____________________ No.: ______ Loc.: ____________________

Spp. #3: ____________________ No.: ______ Loc.: ____________________

Spp. #4: ____________________ No.: ______ Loc.: ____________________

Threatened and Endangered Species Data

H12a. Were Threatened and Endangered animal species observed? (Yes; No): ______

H12b. Species observed:

Species	Number	Species	Number

H12c. Location in polygon where Threatened and Endangered animals or nests were sighted:

____

H13. Additional Comment:

____

APPENDIX T
Alberta Lentic Wetland Inventory User Manual (5/16/2006)

The user manual is intended to accompany the Alberta Lentic Wetland Inventory Form for the inventory of still water (lentic) wetlands. This document serves as a field reference to assist data collectors in answering each item on the form. It can also serve as an aid to the database user in the interpretation of data presented in the Alberta Lentic Wetland Inventory format. Another form entitled Alberta Lotic Wetland Inventory, with a different set of user guidelines, is available for lotic (flowing water) wetlands.

ACKNOWLEDGEMENT

Development of these assessment tools has been a collaborative and reiterative process. Many people from many agencies and organizations have contributed greatly their time, effort, funding, and moral support for the creation of these documents, as well as to the general idea of devising a way for people to look critically at wetlands and riparian areas in a systematic and consistent way. Some individuals and the agencies/organizations they represent who have been instrumental in enabling this work are Dan Hinckley, Tim Bozorth, and Jim Roscoe of the USDI Bureau of Land Management in Montana; Karen Rice and Karl Gebhardt of the USDI Bureau of Land Management in Idaho; Bill Haglan of the USDI Fish and Wildlife Service in Montana; Barry Adams and Gerry Ehlert of Alberta Public Lands Division; Lorne Fitch of Alberta Environmental Protection; and Greg Hale and Norine Ambrose of the Alberta Cows and Fish Program.

BACKGROUND INFORMATION

Flowing Water (Lotic) Wetlands vs. Still Water (Lentic) Wetlands

Cowardin and others (1979) point out that no single, correct definition for wetlands exists, primarily due to the nearly unlimited variation in hydrology, soil, and vegetative types. Wetlands are lands transitional between aquatic (water) and terrestrial (upland) ecosystems. Windell and others (1986) state, “wetlands are part of a continuous landscape that grades from wet to dry. In many cases, it is not easy to determine precisely where they begin and where they end.”

In the semi-arid and arid portions of western North America, a useful distinction has been made between wetland types based on association with different aquatic ecosystems. Several authors have used lotic and lentic to separate wetlands associated with flowing water from those associated with still water. The following definitions represent a synthesis and refinement of terminology from Shaw and Fredine (1956), Stewart and Kantrud (1972), Boldt and others (1978), Cowardin and others (1979), American Fisheries Society (1980), Johnson and Carothers (1980), Cooperrider and others (1986), Windell and others (1986), Kovalchik (1987), Federal Interagency Committee for Wetland Delineation (1989), Mitsch and Gosselink (1993), and Kent (1994).

Lentic wetlands are associated with still water systems. These wetlands occur in basins and lack a defined channel and floodplain. Included are permanent (i.e., perennial) or intermittent bodies of water such as lakes, reservoirs, potholes, marshes, ponds, and stockponds. Other examples include fens, bogs, wet meadows, and seeps not associated with a defined channel.

Lotic wetlands are associated with rivers, streams, and drainage ways. They contain a defined channel and floodplain. The channel is an open conduit, which periodically or continuously carries flowing water. Beaver ponds, seeps, springs, and wet meadows on the floodplain of, or associated with, a river or stream are part of the lotic wetland.

Functional vs. Jurisdictional Wetland Criteria

Defining wetlands has become more difficult as greater economic stakes have increased the potential for conflict between politics and science. A universally accepted wetland definition satisfactory to all users has not yet been developed because the definition depends on the objectives and the field of interest. However, scientists generally agree that wetlands are characterized by one or more of the following features: 1) *wetland hydrology,* the driving force creating all wetlands, 2) *hydric soils,* an indicator of the absence of oxygen, and 3) *hydrophytic vegetation,* an indicator of wetland site conditions. The problem is how to define and obtain consensus on thresholds for these three criteria and various combinations of them.

Wetlands are not easily identified and delineated for jurisdictional purposes. Functional definitions have generally been difficult to apply to the regulation of wetland dredging or filling. Although the intent of regulation is to protect wetland functions, the current delineation of jurisdictional wetland still relies upon structural features or attributes.

The prevailing view among many wetland scientists is that functional wetlands need to meet only one of the three criteria as outlined by Cowardin and others (1979) (e.g., hydric soils, hydrophytic plants, and wetland hydrology).

On the other hand, jurisdictional wetlands need to meet all three criteria, except in limited situations. Even though functional wetlands may not meet jurisdictional wetland requirements, they certainly perform wetland functions resulting from the greater amount of water that accumulates on or near the soil surface relative to the adjacent uplands. Examples include some woody draws occupied by the *Acer negundo/Prunus virginiana* (Manitoba maple/choke cherry) habitat type (Thompson and Hansen 2002) and some floodplain sites occupied by the *Artemisia cana/Agropyron smithii* (silver sagebrush/western wheatgrass) habitat type or the *Populus tremuloides/Cornus stolonifera* (aspen/red-osier dogwood) habitat type. Currently, many of these sites fail to meet jurisdictional wetland criteria. Nevertheless, these functional wetlands provide important wetland functions vital to wetland dependent species and may warrant special managerial consideration. The current interpretation is that not all functional wetlands are jurisdictional wetlands, but that all jurisdictional wetlands are functional wetlands.

Polygon Delineation

The lentic wetland inventory process incorporates data on a wide range of biological and physical categories. The basic unit of delineation within which this data is collected is referred to as a ***polygon.*** A polygon is the area upon which one set of data is collected. One inventory form is completed (i.e., one set of data is collected) for each polygon. One or more (usually several) polygons constitute a project. A lentic (still water) wetland polygon is a wetland, or portion of a wetland, which is not associated with a waterway (stream or river) and which has no defined channel. Polygons are delineated on topographic maps before observers go to the field. It is important to clearly mark and number the polygons on the map.

If aerial photos are available, polygon delineations can be based on vegetation differences, geologic features, or other observable characteristics. On larger systems with wide wetland areas, aerial photos may allow delineation of multiple vegetation-based polygons away from the water source. In these cases, where polygons can be drawn as enclosed units aminimum mapping unit of possibly 5 to 10 acres (2 to 4 ha) should be followed. The size of the minimum mapping unitshould be based on factors such as management capabilities, available funds, and capabilities of data collection.

If pre-delineated polygons are drawn on the maps, and pre-assigned numbers are given, be sure the inventoried polygons correspond exactly to those drawn. Observers are allowed to move polygon boundaries, create new polygons, or consolidate polygons if the vegetation, geography, location of fences, or width of the wetland zone warrant. If polygon boundaries are changed, the changes must be clearly marked on the field copies of the maps. Observers should draw the complete polygon boundary onto their field maps if possible at the 1:20,000 or 1:50,000 scale.

In most cases involving small bodies of water or small lentic wetlands, the inventoried polygon will be a single unit of area. Around larger lakes, extensive marshes, or other large lentic wetlands, it may be necessary to divide the wetland into separate polygons (Figure 1). Polygons should be divided at distinct locations such as fences, stream entrances or exits, or other features easily recognized in the field. When selecting "representative sites," consideration should be given to the differences presented by landform position (i.e., point vs. bay, or windward vs. leeward side of the water body). ***Polygons should not cross fences between areas with different management.***

The outer boundaries of polygons are usually at the wetland ecosystem outer edges. These boundaries are sometimes easily determined by abrupt changes in the landform and/or vegetation, but proper determination often depends on experienced interpretation of more subtle features. The inner polygon boundary is the landward edge of the deep-water habitat, or where persistent vegetation gives way to open water. Deep-water habitat is the area covered by surface water deeper than 6.6 ft [2 m], or where sunlight cannot penetrate to support erect, rooted, plant life. Persistent emergent vegetation consists of emergent species that normally remain standing at least until the beginning of the next growing season, e.g., *Typha* spp. (cattails) or *Scirpus* spp. (bulrushes).

When using the inventory on artificial or artificially enlarged water bodies (e.g. dugout, manmade pond, reservoirs), use the same criteria, but remember that there will be questions that are difficult to apply appropriately. Focus on consistently applying the methods, including site boundaries, as well as recording all decisions made in applying the methodology. The goal of this exercise is to assess the ability of the site to perform riparian functions to its potential.

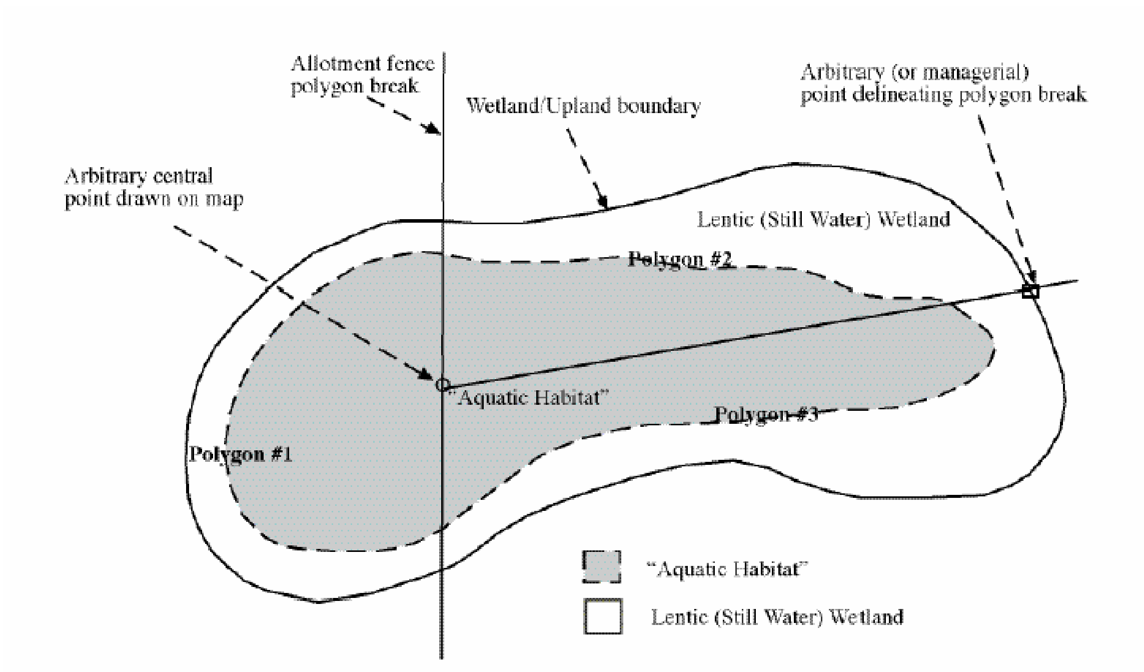


Figure 1. Schematic drawing of a lentic (still water) wetland showing: 1) delineation of polygons on larger systems, i.e. those too big to inventory as a single polygon (more than about one half mile in length) or those with managerial breaks across them; 2) a typical relationship between "aquatic habitat" (open water) and surrounding lentic wetland, including all areas of persistent emergent vegetation in standing water.

INVENTORY FORM CODES AND INSTRUCTIONS

Class Codes

Field observers will use class codes to represent ranges of percent wherever percent data is recorded. The class codes are defined below. These codes and range classes are from the USDA Forest Service Northern Regions ECODATA (1989) program.

T= 0.1<1%	**2** = 15<25%	**5** = 45<55%	**8** = 75<85%
P= 1<5%	**3** = 25<35%	**6** = 55<65%	**9** = 85<95%
1= 5<15%	**4** = 35<45%	**7** = 65<75%	**F** = 95-100%

The class codes are converted to class midpoints in the office. The class midpoints are: **T** = 0.5%; **P** = 3.0%; **1** = 10.0%; **2** = 20.0%; **3** = 30.0%; **4** = 40.0%; **5** = 50.0%; **6** = 60.0%; **7** = 70.0%; **8** = 80.0%; **9** = 90.0%; **F** = 97.5%. These class midpoints are used in data reporting and in all calculations throughout the data analysis process.

Polygon Data

The following are the codes and instructions for the individual data items on the form. All data items are to be recorded in the field unless otherwise noted. Numbering corresponds to that of items on the form. Also included are comments about the data, how it is collected, and its meaning. When the inventory methodology follows a published source, that source is cited. However, in many instances, due to the lack of pre-existing guidelines, we have developed our own methodologies.

Field data collection may be done using field forms customized by deleting certain items from the Lentic Data Form, which need not be completed while in the field. ***Fill in all blanks on the Field Form.*** Enter "0" for any item to indicate the absence of value. Do not use "—" and do not leave items blank, except for the following: 1) items that logically would not be answered because they follow an answer of "No" in a leading "Yes/No" question, and 2) lines in a species list below the last species observed. An answer of "**0**" means the observer looked and saw none, whereas a blank line means the observer did not look, either by negligence or because the point was moot. ***NA*** means the item is not applicable to a particular polygon. ***NC*** means data was not collected for that item in a particular polygon. Observers must write legibly and should limit their use of abbreviations throughout to those, which allow for no confusion.

Record ID No. This is the unique identifier allocated to each polygon. This number will be assigned in the office when the form is entered into the database.

ADMINISTRATIVE DATA
A1. Identify what organisation is doing the evaluation field work.

A2. Identify what organisation is paying for the work.

A3a. Identify any Indian or Métis Reserve on which work is being done.

A3b. Identify any National or Provincial Park, Preserve, or Sanctuary on which work is being done.

A3c. Identify any local Environmental, Ecological or Municipal Reserve (Exclude national or provincial reserves) on which work is being done. If yes, identify which applicable reserve is established and its number.

Ecological Reserves are areas of Crown land (Provincial or Federal Government), which have the potential to contain representative, rare and fragile landscapes, plants, animals and geological features. The intent is for the preservation of natural ecosystems, habitats and features associated with biodiversity. Public access to ecological reserves is by foot only; public roads and other facilities do not normally exist and will not be developed.

Environmental reserve generally are those lands that are considered undevelopable and may consist of a swamp, gully, ravine, coulee or natural drainage course, flood prone areas, steep slopes or land immediately adjacent to lakes, rivers, stream or other bodies of water. Governed by *The Municipal Government Act (Alberta).*

Municipal reserve may also be known, in part, as reserve, park reserve, park or community reserve. Municipal reserves are lands that have been given to the municipality by the developer of a subdivision as part of the subdivision approval process. Governed by *The Municipal Government Act (Alberta).*

A3d. Was the work done on Private or Deeded Land? Simply answer "Yes" or "No."

A4. Observers: Name the evaluators recording the data in the field.

A5a. Date that the field data was collected**:** Use the format: month/day/year

A5b. Record the year that the field data was collected**.**

A6a. Identify any grazing lease or grazing reserve on which work is being done.

A6b. Give any grazing disposition identifying number.

A6c. Give any other grazing name (e.g. Community Pasture) to identify where the work is being done.

Note: **Items A7a-h are completed in the office; field evaluators need not complete these items.**

A7. The several parts of this item identify various ways in which a data record may represent a resampling of a polygon that may have been inventoried again at some other time. The data in this record may have been collected on an area that coincides precisely with an area inventoried at another time and recorded as another record in the database. It may also represent the resampling of only a part of an area previously sampled. This would include the case where this polygon overlaps, but does not precisely and entirely coincide with one inventoried at another time. One other case is where more than one polygon inventoried one year coincides with a single polygon inventoried another year.

All of these cases are represented in the database, and all have some value for monitoring purposes, in that they give some information on how the status on a site changes over time.

A7a. Does this record represent the latest data recorded for this polygon?

A7b. Has any part of the area within this polygon been inventoried previously, or subsequently, as represented by another data record in the Lentic Wetland database? Such other records would logically carry different dates.

A7c. Does the areal extent of this polygon exactly coincide with that of any other inventory represented in the Lentic Wetland database? In many cases, subsequent inventories only partially overlap spatially. The purpose of this question is to identify those records that can be compared as representing exactly the same ground area.

A7d. If A7c is answered "Yes," then enter the years of any inventories of this exact polygon.

A7e. If A7c is answered "Yes," also enter the record ID number(s) of any other previous or subsequent reinventories (resamplings) of this exact polygon for purposes of cross-reference in the database.

A7f. Even though this polygon is not a re-inventory of the exact same area as any other polygon, does it share at least some common area with one or more polygons inventoried at another time?

A7g. If A7f is answered "Yes," enter the years of any other inventories of polygons sharing common area with this one.

A7h. If A7f is answered "Yes," also enter the record ID number(s) of any other polygon(s) sharing common area with this one.

A8a. Has a management change been implemented on this polygon?

A8b. If A8a is answered "Yes," in what year was the management change implemented?

A8c. If A8a is answered "Yes," describe the management change implemented.

LOCATION DATA

B1. Province in which the field work is being done.

B2a, b. Identify the Natural Region and Sub-Region in which the fieldwork is being done. Use the Natural Regions and Subregions of Alberta (Alberta Natural Heritage Information Centre (1999).

B3. County or municipal district in which the field work is being done.

B4a. The city, town, or village in which the fieldwork is being done.

B4b. The subdivision plan number in which the fieldwork is being done.

B4c. The block number in which the fieldwork is being done.

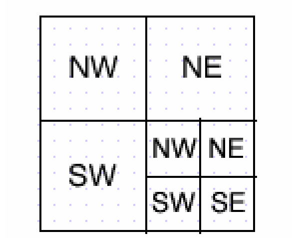
B4d. The lot number in which the fieldwork is being done.

B5. Identify the allotment, range unit, or landowner where the fieldwork is being done.

B6. Name the waterbody or area on which the fieldwork is being done.

B7. Polygon number is a sequential identifier of the actual piece of land being surveyed. This is referenced to the map delineations. Sequences normally progress clockwise on lentic systems.

B8. The location of the polygon is presented as a legal land description: 1/4,1/4 section, 1/4 section, Township, Range, and Meridian are read from smallest to largest unit.



B9. Elevation (feet or meters) of the polygon ***centroid.*** Elevation is usually interpolated from a topographic map

B10a. Name the major watershed (e.g. North Saskatchewan River) of which the site being surveyed is a part.

B10b. Name the minor watershed (e.g. Battle River) of which the site being surveyed is a part. This is normally subordinate to the major watershed named above in #B10a.

B10c, d. The minor watershed area (km2) and perimeter (km) are obtained from the map in the office.

B10e. Name the sub-basin in which you are working (e.g. Iron Creek). This is the third level down from the largest (major watershed) (e.g., North Saskatchewan River—Battle River—***Iron Creek***; or South Saskatchewan River—Red Deer River— ***Little Red Deer River***), although you may be working on an even lower level tributary. The sub-basin is the local watershed of which the site being surveyed is a part. It is subordinate to the minor watershed named above in #B10b.

B11a-c. Universal Transverse Mercator (UTM) coordinates are recorded for the upper (or most northerly and westerly) and lower (or most southerly and easterly) ends of the polygon using GPS units in the field. Other locations of special interest may be recorded using the GPS unit. These coordinates are considered accurate to within approximately 50 m. Field observers are to use GPS units to obtain these coordinates following standard protocol. Record UTM coordinates at each end of the long axis of the polygon.

Enter the UTM coordinate data, including the UTM zone and the identifying waypoint number, on the form for each point collected. Save the data in the GPS unit for downloading to the computer later. When starting work in a new location, always check the GPS receiving unit against a known point by using the UTM grid and map.

B11d, e. Identify the GPS unit used, and the name or number designator of the waypoints saved for the upper and lower ends of the polygon and for other locations. Describe any comments worth noting about the waypoints (i.e., monument referenced or general location descriptions).

B12a-c. Record the name(s), scale, and publication year of the quadrangle map(s) or any other map(s) locating the polygon. Use precisely the name listed on the map sheet. Provision is made for listing two maps in case the polygon crosses between two maps.

B13. Record identifying data for any aerial photos used on this polygon.

SELECTED SUMMARY DATA

C1. Wetland type is a categorical description of predominant polygon character. Select from the following list of categories that may occur within a lentic system the one that best characterizes the majority of the polygon. Observers will ***select only one category*** as representative of the entire polygon. If significant amounts of other categories are present, indicate this in Vegetation Comments (item D17) or consider dividing the original polygon into two or more polygons.

Category Description

Wet Meadow. This type of wetland may occur in either riparian (lotic) or in still water (lentic) systems. A lotic wet meadow has a defined channel or flowing surface water nearby, but is typically much wider than the riparian zone associated with the classes described above. This is often the result of the influence of lateral groundwater not associated with the stream flow. Lotic and lentic wet meadows may occur in proximity (e.g., when enough groundwater emerges to begin to flow from a mountain meadow, the system goes from lentic to lotic). Such communities are typically dominated by herbaceous hydrophytic vegetation that requires saturated soils near the surface, but tolerates no standing water for most of the year. This type of wetland typically occurs as the filled-in basin of old beaver ponds, lakes, and potholes.
Spring/Seep. Groundwater discharge areas. In general, springs have more flow than seeps. This wetland type may occur in a riparian (lotic) or still water (lentic) system.
Reservoir. An artificial (dammed) water body with at least 20 acres (8 ha) covered by surface water.
Stock pond. An artificial (dammed) body of water of less than 20 acres (8 ha) covered by surface water.
Lake. A natural topographic depression collecting a body of water covering at least 20 acres (8 ha) with surface water.
Pothole, slough, or **Small Mountain Lake.** A natural topographic depression collecting a body of water covering less than 20 acres (8 ha) with surface water.
Other. Describe any other wetland type encountered, which is not associated with a surface water channel.
Non-wetland (Upland). This designation is for those areas which are included in the inventoried polygon, but which do not support functional wetland vegetation communities. Such areas may be undisturbed inclusions of naturally occurring high ground or such disturbed high ground as roadways and other elevated sites of human activity.

C2. The size (acres/hectares) of polygons large enough to be drawn as enclosed units on 7.5-minute (1:24,000) topo maps is determined in the office using a planimeter, dot grid, or GIS. For polygons too small to be accurately drawn as enclosed units on the maps, polygon size is calculated using polygon length (item C7) and average polygon width (item C8a).

C3a-d. Evaluators may be asked to survey some areas that have not been determined to be wetlands for the purpose of making such a determination. Other polygons include areas supporting non-wetland vegetation types. A "Yes" answer here indicates that no part of the polygon keys to a riparian habitat type or community type (HT/CT). Areas classified in item C8 as any vegetation type described in a riparian and/or wetland classification document for the region in which you are working are counted as functional wetlands. Areas listed as UNCLASSIFIED WETLAND TYPE are also counted as functional wetlands. Other areas are counted as non-wetlands, or uplands. The functional wetland fraction of the polygon area is listed in item C3c in acres and as a percentage of the entire polygon area in item C3d.

C4. Some lentic polygons may not contain a defined shoreline between wetland and open water. In some cases these polygons are in ephemeral depressions which may be infrequently inundated, but do support wetland plant communities. In other cases, these polygons may be part of large marsh systems that may or may not be associated with lakes, but where polygons may be delineated in areas not adjacent to open water.

C5. Polygon length is measured in the field or by scaling from the map. This data is considered accurate to the nearest 0.1 mile (0.16 km). Polygon length may be the same as shoreline length, but may not be in cases of much curved shoreline, or for polygons that have no shoreline (i.e., wet meadows or marshes).

C6. In some cases, the polygon data is used to characterize, or represent, a much larger shoreline. The length represented by the polygon is given here. For example, a 0.5-mile (0.8 km) polygon may be used to represent 2 miles (3.2 km) of total shoreline length. In this case, 0.5 (0.8 km) is the shoreline length in the polygon (item C5), and 2 miles (3.2 km) is the overall shoreline length entered in item C6.

C7a. Record average width of the polygon, which in smaller wetlands corresponds to the width of the entire wetland area.

C7b. Record the range of width (ft/m), narrowest to widest, of the wetland area in the polygon.

Health Evaluation Summary

C8. Polygon Health (PFC) Score is an ecological function rating derived by computer using data from several items in the polygon inventory. For detailed discussion of this process, see the companion document *Lentic Wetland Health Assessment (derived from the Lentic Wetland Inventory Form).* The techniques used to obtain the data do not allow the ratings to be interpreted with a fine degree of precision. For example, two polygons rating 74% and 79% should be interpreted as functionally equivalent to each other, but they both are likely to differ functionally from a third polygon that rates 61%, although all three fall within the "Functional At Risk (Healthy, but with Problems)" category. When considering the Health Assessment result for any site, one should always look at the individual items, as well as the "bottom line" rating. Two sites can score overall identical results, but have profoundly differing areas of problem.
The health ratings are presented both as an overall polygon score and in two subsections (vegetation and physical site) to give a broad indication of what part of the system may be in need of more management attention.

VEGETATION DATA

D1a. The wetland prevalence index is compiled by the computer from the U.S. National Wetland Inventory (NWI) wetland status classes for plant species recorded on the site (Reed 1988) and weighted by species abundance measured in terms of canopy cover. The range of index values is from 1.0 to 5.0. Lower values indicate wetter sites.

D1b. The vegetation structural diversity category is automatically calculated in the office by computer using plant group and height layer data (item D9). Trees and shrubs are considered major components of structural diversity. These terms are used to describe vegetation height: tall = > 6.0 ft (layer 3); medium = >1.5-6.0 ft (layer 2); short = 0-1.5 ft (layer 1). Graminoids and forbs are combined as the "herbaceous" lifeform. Trees and shrubs in layer 2 are also combined as "medium trees/ shrubs." A polygon is assigned the highest structural diversity category it can meet. To meet a category, each lifeform (by height) named in the description must have a canopy cover of at least 15% in the polygon. Combination groups (i.e., medium trees/shrubs; and short, medium, and tall herbaceous) must have at least 5% cover of both components or at least 15% cover of one component. ***Note:*** Structural diversity on a site can change as succession proceeds or if management changes.

Category Description
Tall trees; tall shrubs; medium trees/shrubs; herbaceous understory present[1]
Tall trees; tall shrubs; herbaceous understory present[1]
Tall trees; medium trees/shrubs; herbaceous understory present[1]
Tall trees; herbaceous understory present[1]
Tall shrubs; medium trees/shrubs; herbaceous understory present[1]
Tall shrubs; herbaceous understory present[1]
Medium trees/shrubs; herbaceous understory present[1]
Tall herbaceous
Medium herbaceous
Short herbaceous
Sparsely vegetated[2]

[1]The herbaceous understory present does not need to have a minimum canopy cover.
[2]Sparsely vegetated refers to polygons in which the minimum canopy cover by the various lifeforms is not met.

D2a, b. If present, record the 7-letter species code and the canopy cover in the two left-most columns for ***all*** tree species observed. Canopy cover is evaluated using ocular estimation following the Daubenmire (1959) method. Within the total canopy cover of each species, estimate the proportion of each of five groups (seedling, sapling, pole, mature, and dead trees). The canopy covers of the five groups of each species must total approximately 100%. If some individuals in an age group have at least 30% of the upper canopy dead (are decadent), record the decadence as a percentage of that group. Record the total group cover to the left of the slash (/) and the decadent portion to the right.

Example:

Species	Cover	Sdlg/Dec	Splg/Dec	Pole/Dec	Mat/Dec	Dead
POPUBAL	3	T / 0	P / 0	1 / P	8 / 1	P

Note: 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, not restricted to the over-mature. We count decadent plants, both trees and shrubs, as those with 30% or more dead wood in the upper canopy.

Tree Age Groups

Age Group	**Conifers1 and Cottonwoods**	**Other Broadleaf Species** 2
Seedling	<4.5 ft tall **OR** <1.0 inch dbh	<3.0 ft tall
Sapling	4.5 ft tall **AND** 1.0 inch to 4.9 inch dbh	>3.0 ft tall **AND** <3.0 inch dbh
Pole	5.0 inch to 8.9-inch dbh	>6.0 ft tall **AND** 3.0 inch to 5.0-inch dbh
Mature	> 9.0-inch dbh	>5.0-inch dbh
Dead	100% of canopy is dead	100% of canopy is dead

[1]*Juniperus scopulorum* (Rocky Mountain juniper) is an exception to the specifications given, because it lacks typical coniferous size, age, and growth form relationships. Assign age classes to individuals of these two species based on relative size, reproductive ability, and overall appearance.
[2]Other Broadleaf Species may include *Fraxinus pennsylvanica* (green ash), *Acer negundo* (box-elder), *Populus tremuloides* (quaking aspen), *Betula papyrifera* (paper birch), and *Ulmus americana* (American elm).

D3. The tree regeneration category is automatically calculated in the office by the computer using the age group data collected with the species' canopy cover as described in item D2b. The canopy covers of the seedling and sapling age groups are combined to quantify tree regeneration. The categories represent actual, not potential, tree regeneration.

Code	**Description**
1	No seedlings or saplings were observed in the polygon.
2	Seedlings and/or saplings were observed; individually, or in combination, these age groups have less than 5% of the species canopy cover.
3	Seedlings and/or saplings were observed; individually, or in combination, these age groups have 5% or more of the species canopy cover, but less than 15%.
4	Seedlings and/or saplings were observed; individually, or in combination, these age groups have 15% or more of the species canopy cover, but less than 25%.
5	Seedlings and/or saplings were observed; individually, or in combination, these age groups have 25% or more of the species canopy cover.

D4. The tree age group distribution category is automatically calculated in the office by the computer using age group canopy covers recorded in item D2b. In classifying tree age group distribution, the seedling and sapling groups are combined. Three resulting age groups (seedlings/saplings, pole, and mature), ***and*** the percent of the mature individuals which are decadent, determine age group distribution categories.

Decadence of younger age groups is ignored in this calculation. Younger decadent trees are assumed to have the capacity to grow out of any current condition caused by injury, disease, or other non-age related factors. A species with decadent mature individuals may fall into one of two classes: those having 75% or more of mature individuals decadent and those having less than 75% of mature individuals decadent. The age distribution category of a tree species on a polygon is defined by the presence of certain age groups. To be present, age groups must have minimum canopy covers in the polygon: seedlings/saplings must have a combined total canopy cover of at least 1%; pole and mature are treated

Tree Age Group Categories (An "X" under an age group indicates presence in that category.)

Category	**Sdlg**1/**Splg**2	**Pole**	**Mature (Decadent**3)

Code	(CC > 1%)	(CC > 5%)	(CC>5%)	Description
1	X			seedling/sapling only
2		X		pole age only
3	X	X		seedling/sapling and pole
4	X		X	seedling/sapling and mature (<75% dec.)
5		X	X	pole and mature (<75% dec.)
6	X	X	X	seedling/sapling, pole, and mature (<75% dec.)
7			X	mature only (<75% dec.)
8	X		X	seedling/sapling and mature (≥75% dec.)
9		X	X	pole and mature (≥75% dec.)
10	X	X	X	seedling/sapling, pole, and mature (≥75% dec.)
11			X	mature only (≥75% dec.)

[1]Sdlg indicates seedlings, Splg indicates saplings, Decadent indicates percent of mature trees, which are decadent

D5. Record the appropriate category, which best describes the amount of utilisation (Utl) of the combined seedling (Sdlg) and sapling (Splg) age groups for each tree species. Include all herbivore use by livestock and wildlife, including beaver. ***Note:*** If a plant is entirely mushroom/umbrella shaped by long term heavy browse or rubbing use or is chewed off at the stem base, count this as heavy utilisation. Be sure to include physical and mechanical damage or cutting by humans, as well as consumptive use by animals.

Category	Description
None	0 to 5% of the available second year and older leaders are clipped (browsed).
Light	>5 to 25% of the available second year and older leaders are clipped (browsed).
Moderate	>25 to 50% of the available second year and older leaders are clipped (browsed).
Heavy	More than 50% of the available second year and older leaders are clipped (browsed).
Unavailable	Woody plants provide no browsed or unbrowsed material below 1.5 m, or are inaccessible due to location or protection by other plants.
NA	Neither seedlings nor saplings of tree species are present.

D6a, b. Are there shrubs present on the polygon, and does the polygon have potential for woody species, such as tall shrubs and trees? Some riparian and wetland sites are marshes, wet meadows, or other wetland types that lack potential for woody species. Such sites should not be penalized on health assessment rating for this lack of potential. Other sites lacking these species do have the potential, but lack the plants due to disturbance. Observers are to answer D6b on the basis of species noted on similar, nearby, less disturbed sites, or other indications. On polygons where the observer cannot find sufficient evidence to make a confident determination, enter NC and explain in the comment field at the end of the Vegetation Section.

D6c. Record the species code and canopy cover for ***every*** shrub species observed on the polygon. Determine the portion of the species cover represented by each of three groups: seedling/saplings, mature, or decadent/dead. (***Note:*** For shrubs, all decadent individuals are included in one group with dead individuals. This contrasts to the method of recording tree decadence, where the decadence within each age group is recorded.) As with trees, decadent shrubs are individuals having 30% or more dead material in the canopy. The canopy covers of the three age/size groups for a species must total approximately 100%.

In general, shrub seedling/saplings can be distinguished from mature plants on the following basis: For normally tall shrubs, which have an average mature height of over 6.0 ft, seedlings and saplings will be plants reaching only into the first and second vegetation layers (shorter than 6.0 ft). For shrub species having normal mature height between 1.6 and 6.0 ft, seedlings and saplings are individuals reaching only into the first vegetation layer (below 1.5 ft).

For short shrub species, whose mature height is 1.5 ft or less, observers must judge individual plants for height, reproductive structures, and other characteristics that indicate relative age. Refer to reference manuals on the regional flora for information of normal sizes for unfamiliar species. Remember that browsing may have shortened the stature of mature specimens.

Record to the right of the slash (/) the ***one category*** that best describes shrub utilisation for each age group (using the five categories in item D5).

Example:

Species	Cover	Sdlg-Splg/Util	Mature/Util	Dec-Dead/Util	Shrub Growth Form
ALNUTEN	2	P / Moderate	7 / Light	3 / Unavail.	N

D6d. Record the category best describing the dominant appearance of each shrub species in the polygon.

Code	Description
N	***Normal Growth Form.*** No apparent deviation from the normal appearance of the lifeform.
F	***Flat-Topped Growth Form.*** Shrubs with the tallest leaders hedged (e.g., hedging from the top down). (Moose during winter in deep snow browse exposed branches of shorter plants.)
U	***Umbrella-shaped/Heavily-hedged/High-lined.*** Shrubs that have most of the branches (up to 1.5 m in height) removed by browsing.

D7 and **D8.** Record the species code and the percent canopy cover for graminoid and forb species observed in the polygon. ***As a minimum,*** include all species having at least 5% cover on the polygon. This inventory is not intended to be comprehensive. It is not necessary to search for obscure species, just record all species readily seen. Observers should especially look, however, for hydrophytic (wetland) species that may be reduced to trace representation by site disturbance. Herbaceous species other than invasive species (see item D13) with minor presence may be overlooked without serious compromise to the inventory value.

D9. The purpose of this item is to describe the vegetation structure in terms of height layers and plant lifeforms on the polygon. (Think of the layering as though it were a GIS file with 12 layers, each one representing one of four lifeforms [trees, shrubs, graminoids, and forbs] in one of three height layers.) Include the canopy cover on the polygon that is provided by all standing, rooted plants (live or dead). Do not include fallen wood or other plant litter.

Record the percent canopy cover of each plant lifeform in each of the three height layers. Consider each group in each layer separately. For example, shrubs in layer 2 will be the canopy cover of all plants of all shrubs in the polygon between >1.5 and 6.0 ft tall (roughly knee high to head high). In estimating this value, ignore all plants taller and shorter than this range.Similarly, estimate the cover separately of those taller and those shorter shrubs. Proceed in this way through each lifeform and layer. As a check, refer to your species/canopy lists to help remember what all you have seen on the site. ***Leave no field blank***; enter “0” to indicate absence of a value. See further discussion in the note for item D10.

D10. Record the total percent of the polygon area occupied by canopy cover of each plant lifeform. Include the canopy cover on the polygon that is provided by all standing, rooted plants (live or dead). Do not include fallen wood or other plant litter. Avoid counting overlapping areas more than once for one group. (For example, an area is not counted twice for total tree cover if seedlings cover all ground under mature trees.) However, the same piece of ground may occur under the canopy of more than one group. (For example, areas covered by grass which are also under trees would be counted for both tree and grass lifeforms.) On the other hand, when estimating total cover of all plants (item D12), the area covered by both trees and grass would only be counted once—trees and grass in this case being part of the same group (“all four plant groups”).

D11. Record the percent of the polygon area covered by tree and shrub (woody species) canopy considered as a group in the sense described above. Include the canopy cover on the polygon that is provided by all standing, rooted plants (live or dead). Do not include fallen wood.

D12. Record the percent of the polygon area covered by the canopy of all four plant groups together. Include the canopy cover on the polygon that is provided by all standing, rooted plants (live or dead). Do not include fallen wood or other plant litter. Do not consider the polygon area covered by water (such as between emergent plants).

D13a, b. Invasive plants (noxious weeds) are alien species whose introduction does or is likely to cause economic or environmental harm. Without regard to 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 impacted by the presence of noxious weeds. The severity of the weed problem on a site is a function of density/distribution (pattern of occurrence), as well as abundance of the weeds. A weed list should be used that is standard for the region (i.e., *Weeds and Disturbance Species Fact Sheet* [Cows and Fish 2001]).

Record the combined percent canopy cover and the overall density distribution class of all invasive plants on the polygon. Common invasive species in Alberta 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 species. For each weed species observed record canopy cover as a percentage of the polygon (area being evaluated) and density/distribution class. Choose a density/distribution class from the chart (Figure 2) below that best represents each species' pattern of presence on the site.

NOTE: Prior to the 2001 season, weed infestation was assessed with a single numerical value representing the part of the polygon on which a weed species had a well-established population of individuals (i.e., the area it infested).

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 2. Weed density distribution class guidelines

D13c. Record total presence of all invasive species on the polygon. Use the same method described above without consideration of individual species, but instead by considering all weed species together as though they were one. Enter the total canopy cover of all invasive species and the density/distribution class of all invasive species considered together.

D14a, b. Areas with historically heavy grazing often have large canopy cover of undesirable herbaceous species, which tend to be less productive and which contribute less to ecological functions. 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.

Record the percent area covered by this general group, which may include the following listed species, among others of like character. ***Count overlapping areas only once.*** The following list is intended only to be representative. Additional species may be appropriate for specific regions and can be added in the spaces below.

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)	______________________________	______________________________

D15. List the riparian habitat type(s) and/or community type(s) found in the polygon using a manual for identifying types in the region in which you are working, such as *Classification and Management of Riparian and Wetland Sites of Alberta's Grassland Natural Region* (Thompson and Hansen 2002). If the habitat type cannot be determined for a portion of the polygon, then list the appropriate community type(s) of that portion. If neither the habitat type nor community type can be determined for any portion of the polygon (or in areas [outside of Montana] where the habitat and community types have not been named and described), list the area in question as "unclassified wetland type" and give the dominant species present.

Indicate with the appropriate abbreviation if these are habitat types (HT), community types (CT), or dominance types (DT), for example, POPUTRE/CORNSTO HT. For each type listed, estimate the percent of the polygon represented. If known, record the successional stage (i.e., early seral, mid-seral, late seral, and climax), or give other comments about the type. As a minimum, list all types that cover 5% or more of the polygon. The total must approximate 100%. Slight deviations due to use of class codes or to omission of types covering less than 5% of the polygon are allowed. ***Note:*** For any area designated as an "unclassified wetland type," it is important to list any species present that can indicate the wetness or dryness of the site.

NOTE: Open water in the polygon that does not have emergent vegetation, but that is less than 2 meters (6 feet) deep is counted here as a "type" called "Open Water."

D16. Select the ***one category*** (Improving, Degrading, Static, or Status Unknown) that best indicates the current trend of the vegetative community on the polygon to the extent possible. Trend refers, in the sense used here, not specifically to successional pathway change, but in a more general sense of apparent community health. By definition, trend implies change over time. Accordingly, a trend analysis would require comparison of repeated observations over time. However, some insights into trend can be observed in a single visit. For example, the observer may notice healing (revegetating) of a degraded shoreline and recent establishment of woody seedlings and saplings. This would indicate changing conditions that suggest an improving trend. If such indicators are not apparent, select the category "status unknown."

D17. Add any necessary commentary to explain or amplify the vegetation data recorded. ***Do not leave this space blank.*** Describe any unique characteristics of the site and other observations relating to the vegetation. This space is the place for general commentary to help the reader understand the larger context of the data. Such things as landscape setting and local land use history are appropriate here.

STOP and Check the Vegetation data for completeness.

Water Quality Data

E1. Give the waterbody number (FMIS/Hydro code).

E2a, b. If water quality data is available on this waterbody, list the reference where the data can be found.

PHYSICAL SITE DATA

F1. Record the primary water source for the polygon from the listed choices. If appropriate, list more than one in descending order of volume. Explain "unknown" and "other" entries.

F2. Indicate whether the water body has an outlet or is an internally draining closed basin.

F3. Make the distinction between "fresh water" and "alkaline/saline water" systems on the basis of the presence or absence of crystallized salts on the soil surface or a predominance of salt tolerant plant species.

F4a. Although water levels naturally fluctuate on a seasonal basis in most systems, many wetland systems are affected by human-caused (artificial) additions or withdrawals. This artificial changes of water level rarely follow a temporal regime that maintains healthy native wetland plant communities.

The result is often a barren band of shore exposed or inundated for much of each growing season. This causes shore material to destabilize, and often provides sites for weeds to invade. Such conditions are extremely detrimental to healthy riparian function.

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 (or into) 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 severity described. (***Note:*** Be careful to consider the scale of the water body a it relates to the scale of change. 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 added or removed, it may be better to describe 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	
Not Subjected	The water body, or wetland, is not subjected to artificial drawdown.
Minor	The waterbody or wetland is subject to no more than minor artificial water level change. The shore area emains 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 or wetland 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 or wetland 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.

F4b. Describe the evidence upon which you made your call.

F5a-c. For human-constructed dams, indicate the type of provision made for passage of overflow. Indicate the type of structure (if any) observed and the apparent stability. If no protected overflow structure is provided, describe any evidence of dam overflow and resultant cutting. Describe any other apparent instability (erosion, cutting, through-dam leakage, etc.) Categories of stability are described below.

Categories of Stability of Lentic System Overflow Structures	
Highly stable	Overflow channelled through a protected and durable conduit; unable to erode at either end.
Moderately stable	Overflow structure of durable material, but showing some sign of inadequacy in the form of slight erosion at the ends or infrequent inability to contain maximum overflows.
Marginally stable	Earthen overflow (spillway directly over earthen dam) or a durable material overflow structure showing sign of frequent inability to contain high overflow events.

Unstable	An overflow structure showing significant erosion at the ends, sign of dam erosion due to downcutting by overflows in excess of the capacity of the structure, or an earthen overflow showing definite downcutting.

F6a-c. If the lentic wetland has a distinguishable shore and there is shore substrate visibly exposed, estimate the proportional breakdown of this substrate into the listed particle size categories. (Category sizes are based on the measurement of the middle length axis of the particle. This is the dimension that would limit the screen size the particle could pass through.) The sum of these values must approximate 100%.

F7. The vegetation covering the soil and along a shore performs the primary physical functions of stabilizing the soil against wave erosion with a deep, binding root mass and filtering sediments from overland flow. Few studies have documented the depth and extent of the root systems of the various plant species that are found in Alberta wetlands. Despite this lack of documented evidence, some generalizations can be made. All tree and shrub species are considered to have deep, binding root masses. Among wetland herbaceous species, annuals do not have deep, binding root masses. Perennial species offer a wide range of root mass qualities. Some rhizomatous species, such as the deep-rooted *Carex* spp. (sedges), *Typha* species (cattails), and *Scirpus* species (bulrushes), are excellent shoreline stabilizers. Other rhizomatous species, such as *Poa pratensis* (Kentucky bluegrass), have only shallow root systems and are poor shoreline stabilizers. Still other species, such as *Juncus balticus* (Baltic rush), appear to have root systems that are intermediate in their ability to stabilize shores. (Information is being accumulated on the ability of various wetland species to perform this function. This information will be incorporated as available.)

In rating this item consider a band from 1 to 2 metres (3 to 6.6 feet) wide (depending on size of the water body) adjacent to the edge of the current level of surface water. If the wetland has no surface water at the time of inventory, you should have answered "No" to Item F6a, and you should skip this item. Answer this question by estimating the percent of the entire polygon area that is covered by vegetation species with deep-binding root masses appropriate to the location (i.e., larger species with deeper roots are needed to hold banks where large waves may strike; and smaller species, such as grasses and sedges, where less energetic overland flows are likely).

F8a-d. Human alteration of the vegetation is meant to include all changes to the plant community composition or structure on the polygon from human causes. 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 function of the vegetation. Among the kinds of change to look for are:

- Physical clearing of vegetation, such as for lake visibility or access, logging, road construction, etc;
- Changing plant community composition and structure by replacing tall species with short species, (e.g., willows for rose and buckbrush, woody species for herbaceous species, etc.) by long term overgrazing, or regressing natural succession to an earlier or disclimax stage;
- Removal of structural layers within the plant community (e.g., elimination of a tall shrub layer under a tree canopy, replacement of a tall grass layer with low grasses and forbs in a meadow, or replacing a cattail stand with *Hordeum jubatum* [foxtail barley], etc.)
- Replacing native plants with tame plants, such as for landscaping or to create pasture for livestock;
- Replacing deep-rooted plants with shallow rooted, generally disturbance tolerant plants (i.e., *Poa pratensis* [Kentucky bluegrass] for native riparian grasses, or dandelion and low clovers for native forbs).
- Allowing invasion of human-introduced aggressive weeds that need little help to displace native vegetation

Human changes to the vegetation community do not include beaver activities—this is included with utilisation. On polygons adjacent to 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 vegetative 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 it causes both clearing of vegetation and disruption of the soil by heavy equipment.

In **F8a,** estimate the total part of the polygon vegetation that has been altered in ways such as described above. In **F8b** break this total down among the causes or agents of cause listed on the form, and in **F8c** break down the total into the kinds of vegetation change listed. Often, more than one category may apply, but pick the kind(s) that best reflect the change in plant community in general. In **F8d,** comment on the general nature and relative extent of alteration to vegetation on the polygon. **F9a-d.** Human alteration of the physical site is meant to include all changes to physical attributes of the site caused by human actions (e.g., logging, mining, human structures, etc.) or by agents of human management (e.g., livestock). The kinds of physical change that diminish or disrupt natural wetland functions include, but are not limited to, such things as:

hummocking, pugging, and trails by large animals	human roads, driveways, walkways, trails, etc.
buildings and landscaping	boat launches and docks
beach clearing and building	rip-rapping of shores and banks
plowing and tilling the land	hydrologic draining, ditching, berming, etc.

(***NOTE:*** Do not count the same area twice by including it as both a vegetative 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 causing vegetation, but not physical, damage; whereas, if he/she hauls in sand to make a beach, then there is also physical alteration.)

In **F9a,** estimate the total part of the polygon area that has been altered physically. In **F9b,** break this total down among the various causes listed, and in **F8c** break down the total among the kinds of alterations listed. In **F9d,** comment on any unusual or odd degree or aspect of the alteration to the polygon physical site.

F10a, b. Record the portion of the polygon with exposed soil surface (bare ground). Exposed soil surfaces are those surfaces not protected from erosional forces by plants, litter or duff, downed woody materials, rocks of cobble size or larger (>2.5 in [6.25 cm]), or hardened impervious surfaces. Hardened, impervious surfaces (e.g., asphalt, concrete, etc.) are not bare ground (i.e., do not erode nor allow weeds to invade).

F10c. Separate the exposed soil surface from F10b into two categories: that resulting from natural and human causes. (These must total approximately 100%. Examples of human causes include livestock wallows and trails, hiking tails, ATV trails, roads, timber harvesting skid trails, mining, and construction activities.

F10d. Within both the natural and human-caused categories, record the proportions of exposed soil surface (bare ground) resulting from the listed causes. Within each category, the portions assigned to the individual causes must total approximately 100%. Explain whatever is put in the "other" category.

F11. Record how much of the polygon is covered by the items listed, which are not already taken into account as live vegetative cover, exposed soil surface, or open water (under the habitat type/community type question). Include areas covered only by litter or duff, downed woody materials, rocks of cobble size or larger (>2.5 in [6.25 cm]), or man-made impervious surface (concrete, asphalt, roofed structure, etc.).

These are ground covers not accounted for by exposed soil surface (bare ground) and standing trees or shrubs or herbaceous vascular plant canopy of the season, which are recorded elsewhere. Although they do not support vegetation, they are not erodible. ***NOTE:*** Animal dung and dead, non-rooted, plant material that is not considered "wood" are all considered "litter and duff."

F12a, b. If pugging, hummocking and/or rutting are present in the polygon, record the percent of polygon area affected. ***NOTE:*** Hummocking and pugging are included as one form of alteration to the polygon physical site in Item F9. Other than as that inclusion, this item is not a factor of derived polygon functional health assessment.

Pugging is tracking depressions left by large animals (typically hooved animals, but occasionally humans) left in fine textured soil. Moist clay or silt usually has a consistency to hold tracks. Upon drying, pugged areas will have a hard, irregular surface, difficult to walk across. Bare soil may or may not be present.
Hummocking is a form of micro-topographic relief characterized by raised pedicels of vegetated soil as much as 2 ft higher than the surrounding ground which results from long term large animal trampling and tracking in soft soil. Vegetation on the pedicels usually differs from that on the surrounding lower area due to moisture difference between the two levels.

F13a-c. Check for sediment and debris being introduced from side slopes immediately adjacent to the polygon. Indicate whether the problem is human-caused or of natural causes and list the causes of the sedimentation: the kind of human

disturbance (grazing, logging, recreation, development, roads, etc.) or the major soil type in cases of natural causes (erodible shale, unconsolidated sands and silts, etc.).
F14. This question distinguishes between sites contaminated with materials toxic to wetland plants native to the site and sites upon which viable communities of wetland species normal to the locality are present.

F15. At the time of the inventory, is standing surface water present on the polygon?

F16. Is there evidence of chemical accumulation on the site, such as salts concentrated by evaporation of water from a closed basin?

F17. Record comments that would amplify the meaning of the inventory data on the physical characteristics of the polygon. This would include a description of the landform setting context of the site, as well as any alteration or other extreme uses of the site.

F18. Describe the polygon boundaries in terms of landmark features, fences, or whatever the delineation is based upon. This is to help future observers relocate the same polygon area. Describe inner and outer boundaries. Name physical character of the delineations between wetland and upland; or give arbitrary dimensions, if that is what was used.

PHOTOGRAPH DATA
Note: At a minimum, take two photos from identifiable points along the upland edge of the polygon viewing toward the water body and along the longitudinal axis of the polygon. Identify all photo point locations sufficiently that they could be relocated by another individual.

G1. Identify the film roll number, photo (frame) number, and description of each photograph taken at the most northerly/westerly end or side of the polygon. List them in the order of northerly/westerly views first, then southerly/easterly views, and then each other shot taken to show other features of interest. Also, identify the photographer and camera used.

G2. Tell if there is another polygon adjacent to this one to the ***north/west***.

G3. Same as G1 above for shots taken at the most southerly/easterly end or side of the polygon.

G2. Tell if there is another polygon adjacent to this one to the ***south/east***.

G5. Identify all additional photos taken outside of polygon (i.e., non-polygon photos) by giving roll number, frame number, and description of view.

G6. Record the brand of film, film speed, camera lens size, and lens focal length or magnification.

STOP and Check the Physical Site data and Photograph data for completeness.

ADDITIONAL DATA
H1. Record the rating category that best describes the vegetation use by animals (Platts and others 1987). This is intended as a measure of herbivore utilisation of available forage. However, it may be extended to include human removal of this same forage by mowing or other means. Although Platts and others (1987) state that this available forage is mainly herbaceous, the concept here is extended to also include normally utilized and available woody species. Record the category, not a precise value.

Code	Category Description

0 to 25%	Vegetation use is light or none. Almost all plant biomass at current development stage remains. Vegetation cover is close to that which would occur without use. Unvegetated areas (such as bedrock) are not a result of land uses.
26 to 50%	Vegetation use is moderate. At least half the potential plant biomass remains. Average stubble height is more than half its potential at the present stage of development.
51 to 75%	Vegetation use is high. Less than half the potential plant biomass remains. Plant stubble height is usually more than 2 inches (on many ranges).
76 to 100%	Vegetation use is very high. Only short stubble remains (usually less than 2 inches on many ranges). Almost all plant biomass has been removed. Only the root systems and parts of the stems remain.

H2. Record the type(s) of uplands adjacent to the lentic wetland; if "other" is selected, describe.

H3. Break down the polygon area into percentages of the land uses listed. Name any "others" observed.

H4. Break down the area adjacent to the polygon into the land uses listed. Name any "others" observed.

H5. Record the percent of shoreline length accessible to livestock. In general, only consider topography (steep banks, deep water, etc.) and dense vegetation as restricting access. Fences, unless part of an exclosure, do not necessarily restrict livestock access, even though they may appear so at the time of inventory.

H6a-d. Note the types and locations of any of the listed human-caused shoreline modifications observed within the polygon. Use "other" to note kinds of modification observed but not included on this list.

Wildlife Data (These wildlife data represent incidental observations only.)
H7a, b. If waterfowl nests or young broods were observed, describe location, type, and whether the nest was in use, of the year, or old.

H8a-e. Respond to the fishery questions based on observations.

H9a, b. Record the number and type of any amphibians observed.

H10a, b. Record the number and type of any reptiles observed.

H11. If possible, name the species, number of each, and sighting locations observed within the polygon (e.g., "upper 1/3 of polygon," "throughout polygon," "lower 1/4 of polygon").

H12a-d. List threatened and endangered animal species observed in the polygon along with any nesting sites. Space is provided to list species observed. Consult relevant documents to determine appropriate species. Record the location in the polygon where animals or nests were sighted.

H13. This space is provided for any additional commentary the observers may wish to record concerning any aspect of the site that is not more appropriately entered in the vegetation section (item D17) or in the physical site section (item F19).

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APPENDIX U
Alberta Lentic Wetland Health Assessment for Lakes and Wetlands (Survey) Form (5/16/2006)

ALBERTA LENTIC WETLAND HEALTH ASSESSMENT (Survey)

Record ID No: ______

ADMINISTRATIVE DATA

A1. Field data collected by (Organisation): ______

A2. Funding Agency/Organisation: ______

A3a. Indian or Metis Reserve? (Yes; No): ______ **If Yes**, Reserve Name: ______

A3b. National or Provincial Park, Preserve, or Sanctuary? (Yes; No): ______

If Yes, Name: ______

A3c. Ecological, Environmental and/or Municipal Reserve (Exclude national or provincial reserves)? (Yes; No): ______

If **Yes**, Name: ______

A3d. Private or Deeded Land? (Yes; No): ______ **A4**. Observers: ______

A5a. Date field data collected: ______ **A5b**. Year: ______ **A6a**. Grazing lease or grazing reserve? (Yes; No): ______

If Yes, A6b. Grazing disposition No.: GRL: ______ GRP: ______

FGL: ______ Other: ______

A6c. Other Grazing Name (e.g. Community Pasture): ______

A7a. Is this the latest inventory for this polygon? (Yes; No): ______

A7b. At least some part of this polygon has been inventoried more than once (resampled)? (Yes; No): ______

If **No**, Go to item B1. If **Yes**, **A7c**. This polygon coincides exactly with another inventoried polygon? (Yes; No): ______

If **No**, Go to item **A7f**. If **Yes**, **A7d**. Other years sampled: ______

A7e. ID No.(s) of other inventories of this exact polygon: ______ , ______ , ______ , ______ , ______

A7f. This polygon shares common area with other inventoried polygon(s), but is not exact? (Yes; No): ______

A7g. Other years: ______

A7h. ID No.(s) of other records sharing area with this polygon: ______ , ______ , ______ , ______ , ______

A8a. Has a change in management occurred? (Yes; No, Unknown): ______ **If Yes, A8b**. Year changed occurred: ______

A8c. Type of management change applied: ______

______

______

LOCATION DATA

B1. Province: ______ **B2a**. Natural Region: ______ **B2b**. Natural Sub-Region: ______

B3. County/Municipal District: ______ **B4a**. City/Town/Village: ______

B4b. Subdivision Plan No.: ______ **B4c**. Block No.: ______ **B4d**. Lot No.: ______

B5. Allotment/Range Unit/Landowner/Lessee Name: ______

B6. Waterbody/Area Name: ______ **B7**. Polygon number: ______

B8a. Location: 1/4 1/4 Sec: ______ 1/4 Sec: ______ Sec: ______ **B8b**. Side of Waterbody: ______

Township (NS): ______ Range (EW): ______ Meridian: ______ **B9**. Elev. (ft): ______ ; (m): ______

B10a. Major Watershed (e.g. North Saskatchewan River): ______

B10b. Minor Watershed (e.g. Battle River): ______

B10c. Minor Watershed Area (km^2): ______ ; (hect): ______ **B10d**. Minor Watershed Perimeter (km): ______

B10e. Sub-basin (e.g. Iron Creek): ______

B11a. UTM coordinates of polygon North/West end Easting: ______ Northing: ______ Zone: ______

B11b. UTM coordinates of polygon South/East end Easting: ______ Northing: ______ Zone: ______

B11c. UTM coordinates of any other point of interest in the polygon: East: ______ North: ______; Zone: ______

B11d. GPS Unit #: ______ WPt Upper: ______ WPt Lower: ______ WPt Other: ______

B11e. Comments: ______

B12a. Map Title(s): ______ ______

B12b. Map Scale: ______ **B12c**. Map Year: ______

B13. Aerial Photo Info: Scale: ______ Date: ______ Job#: ______ Line#: ______

AS#: ______ Photo#: ______ Other Info: ______

SELECTED SUMMARY DATA Record ID No: ________

C1. Water body type: ________ C2. Polygon size (acres): ________ ; (hect): ________

C3a. Is the entire polygon an upland? (Yes; No): ________ If No, C3b. Does the polygon consist entirely of functional wetland types? (Yes; No): ____ C3c. Functional wetland (acres): ________ ; (hect): ________ C3d. Percent of total polygon: ________

C4. Does the polygon contain ponded surface water? (Yes; No; NC): ________

C5. Polygon length (mi): ________ ; (km): ________

C6. Number of extra miles the polygon is used to represent: ________ ; (km): ________

C7. Average polygon width (ft): ________ ; (m): ________

C8. Habitat Types And Community Types

Classification Type Name	Phase	Pct of Poly	Successional Stage or Comments

ADDITIONAL PHYSICAL SITE CHARACTERISTICS

D1a. Does the polygon have potential for tall woody type(s)? (Yes, No): ________

D1b. Does the polygon have tall woody type(s) present? (Yes, No): ________

D2. Waterbody number (FMIS/Hydro code): ________

D3a. Is water quality data available on this waterbody? (Yes, No, Unknown, NA): ________

If Yes, D3b. Describe the reference for that data (name, year, etc.): ________

D4. Detailed description of upper and lower ends and width (lateral boundaries) of the polygon:

Record ID No: ______________

PHOTOGRAPH DATA

E1. Identification of photos (taken at the ***north/west*** end of polygon):

Photographer: ______________

Camera Number: ________

	Roll #:	Photo #:	Description:
N/W views:	____	____	____
S/E views:	____	____	____
Other views	____	____	____

E2. Is there an adjacent polygon ***north/west*** of this polygon? (Yes; No): ______

E3. Identification of photos (taken at the ***south/east*** end of polygon): ______

Photographer: ______________

Camera Number: ________

	Roll #:	Photo #:	Description:
N/W views:	____	____	____
S/E views:	____	____	____
Other views	____	____	____

E4. Is there an adjacent polygon ***south/east*** of this polygon? (Yes; No): ______

E5. Identification of additional photos taken outside of polygon (i.e., non-polygon photos):

Roll #:	Photo #:	Description:
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____

E6. Film and Camera Specs: Film brand: ________ Film speed (ASA): ____ Lens dia. (mm): ____

Lens foc. len. (mm): ______ Lens foc. len. (mm): ________

LENTIC WETLAND HEALTH ASSESSMENT SCORE SHEET

	Actual Score	Possible Score	Comment
1. Vegetative Cover of the Polygon			
2a. Invasive Plant Species Canopy Cover			
2b. Invasive Plant Species Density Distribution			

List Invasive Plant Species present, including Percent Canopy Cover and Density Distribution Class:

	Species	Can.Cov.	Dens.Dist.
1.			
2.			
3.			
4.			
5.			

	Actual Score	Possible Score	Comment
3. Disturbance-increaser Undesirable Herbaceous Species			
4. Tree and Preferred Shrub Species Establishment and Regeneration			
5. Utilization of Tree and Preferred Shrub Species			
6. Human Alteration of Polygon Vegetation			
Vegetation Subtotal:			
7. Human Alteration of Polygon Physical Structure			
8. Human-Caused Bare Ground			
9. Degree of Artificial Removal or Raising of Water			
Soil/Hydrology Subtotal:			
Overall Polygon Total:			

10. Comments and Observations:

RATING CALCULATION

	(Actual Score/Possible Score) X 100 = Rating Percent			Descriptive Category
Vegetation Rating:	/	)0 =		
Soil / Hydrology Rating:	/	)0 =		
Total Rating:	/	)0 =		

Rating Percent Range	*Descriptive Category*
80-100	*Proper Functioning Condition (Healthy)*
60-79	*Functional At Risk (Healthy, but with Problems)*
<60	*Nonfunctional (Unhealthy)*

ADDITIONAL MANAGEMENT CONCERNS (OPTIONAL)

The following items do not contribute to a site's score. Rather they help to quantify inherent physical site characteristics or assess the direction of change on a site. These data can be useful for planning future site management.

11. Overflow structure stability: ______

12a. Shoeline rock volume: ______

12b. Shoreline rock size: ______

13. Vegetation use by animals: ______

14. Susceptibility of parent material to erosion: ______

15. Percent of shoreline accessible to livestock: ______

16. Quantify the percent of tree and shrub cover on the polygon that is dead and/or decadent: ______

17. Polygon trend (Is the polygon: Improving, Degrading, Static, or Status Unknown?): ______

18. Break Down the Polygon Area Into the Land Uses listed (must total to approx. 100%):

- No land use apparent: ______
- Turf grass (lawn): ______
- Tame pasture (grazing): ______
- Native pasture (grazing): ______
- Recreation (ATV paths, campsites, etc.): ______
- Development (buildings, corrals, paved lots, etc.): ______
- Tilled Cropping: ______
- Perennial forage (e.g., alfalfa hayland): ______
- Roads: ______
- Logging: ______
- Mining: ______
- Railroads: ______
- Other: ______

Description of Other Usage Noted: ______

19. Break Down the Area Adjacent to the Polygon Into the Land Uses listed (must total to approx. 100%):

- No land use apparent: ______
- Turf grass (lawn): ______
- Tame pasture (grazing): ______
- Native pasture (grazing): ______
- Recreation (ATV paths, campsites, etc.): ______
- Development (buildings, corrals, paved lots, etc.): ______
- Tilled Cropping: ______
- Perennial forage (e.g., alfalfa hayland): ______
- Roads: ______
- Logging: ______
- Mining: ______
- Railroads: ______
- Other: ______

Description of Other Usage Noted: ______

APPENDIX V
Alberta Lentic Wetland Health Assessment for Lakes and Wetlands (Survey) User Manual (5/16/2006)

This document is intended to accompany the Alberta Lentic Wetland Health Assessment (Survey) Form for the rapid evaluation of the functional health status of lentic (still water) wetlands. Other forms are available for lotic (flowing water) wetlands.

ACKNOWLEDGEMENT
Development of these assessment tools has been a collaborative and reiterative process. Many people from many agencies and organizations have contributed greatly their time, effort, funding, and moral support for the creation of these documents, as well as to the general idea of devising a way for people to look critically at wetlands and riparian areas in a systematic and consistent way. Some individuals and the agencies/organizations they represent who have been instrumental in enabling this work are Dan Hinckley, Tim Bozorth, and Jim Roscoe of the USDI Bureau of Land Management in Montana; Karen Rice and Karl Gebhardt of the USDI Bureau of Land Management in Idaho; Bill Haglan of the USDI Fish and Wildlife Service in Montana; Barry Adams and Gerry Ehlert of Alberta Public Lands Division; Lorne Fitch of Alberta Environmental Protection; and Greg Hale and Norine Ambrose of the Alberta Cows and Fish Program.

BACKGROUND INFORMATION
Introduction
Public and private land managers are being asked to improve or maintain wetland (lentic) habitat and water quality on lands throughout the western North America. Three questions that are generally asked about a wetland site are: 1) What is the potential of the site (e.g., climax or potential natural community)? 2) What plant communities currently occupy the site? and 3) What is the overall health (condition) of the site? For a lentic (still water) site, the first two questions can be answered by using the Alberta Lentic Wetland Inventory Form along with Classification and management of riparian and wetland sites of Alberta's Grassland Natural Region (Thompson and Hansen 2002) or a similar publication.

This Alberta Lentic Wetland Health Assessment (Survey) is a method for rapidly addressing the third question above: what is the site's overall health (condition)? It provides a site rating useful for setting management priorities and stratifying wetland sites for remedial action or closer analytical attention. It is intended to serve as a first approximation, or "coarse filter," by which to identify lentic wetlands in need of closer attention so that the manager can more efficiently concentrate effort. We use the term "lentic (still water wetland) health" to mean the ability of a lentic wetland to perform certain functions. These functions include sediment trapping, shoreline maintenance, water storage, aquifer recharge, wave energy dissipation, maintenance of biotic diversity, and primary production. Excellent sources of practical ideas and tips on good management of these wetland sites in Alberta are found in Caring for Shoreline Properties (Valastin and others 1999) and Caring for the Green Zone (Adams and Fitch 1995), and Riparian Areas: A User's Guide to Health (Fitch and Ambrose 2003).

Flowing Water (Lotic) vs. Still Water (Lentic) Wetlands
Cowardin and others (1979) point out that no single, correct definition for wetlands exists, primarily due to the nearly unlimited variation in hydrology, soil, and vegetative types. Wetlands are lands transitional between aquatic (water) and terrestrial (upland) ecosystems. Windell and others (1986) state that "wetlands are part of a continuous landscape that grades from wet to dry. In many cases, it is not easy to determine precisely where they begin and where they end."
In the semi-arid and arid portions of western North America, a useful distinction has been made between wetland types based on association with different aquatic ecosystems. Several authors have used lotic and lentic to separate wetlands associated with running water from those associated with still water. The following definitions represent a synthesis and refinement of terminology from Shaw and Fredine (1956), Stewart and Kantrud (1972), Boldt and others (1978), Cowardin and others (1979), American Fisheries Society (1980), Johnson and Carothers (1980), Cooperrider and others (1986), Windell and others (1986), Environmental Laboratory (1987), Kovalchik (1987), Federal Interagency Committee for Wetland Delineation (1989), Mitsch and Gosselink (1993), and Kent (1994).

Lentic wetlands are associated with still water systems. These wetlands occur in basins and lack a defined channel and floodplain. Included are permanent (i.e., perennial) or intermittent bodies of water such as lakes, reservoirs, potholes, marshes, ponds, and stockponds. Other examples include fens, bogs, wet meadows, and seeps not associated with a defined channel.

Lotic wetlands are associated with rivers, streams, and drainageways. They contain a defined channel and floodplain. The channel is an open conduit, which periodically or continuously carries flowing water. Beaver ponds, seeps, springs, and wet meadows on the floodplain of, or associated with, a river or stream are part of the lotic wetland.

Functional vs. Jurisdictional Wetland Criteria

Defining wetlands has become more difficult as greater economic stakes have increased the potential for conflict between politics and science. A universally accepted wetland definition satisfactory to all users has not yet been developed because the definition depends on the objectives and the field of interest. However, scientists generally agree that wetlands are characterized by one or more of the following features: 1) ***wetland hydrology,*** the driving force creating all wetlands, 2) ***hydric soils,*** an indicator of the absence of oxygen, and 3) ***hydrophytic vegetation,*** an indicator of wetland site conditions. The problem is how to define and obtain consensus on thresholds for these three criteria and various combinations of them.

Wetlands are not easily identified and delineated for jurisdictional purposes. Functional definitions have generally been difficult to apply to the regulation of wetland dredging or filling. Although the intent of legislation is to protect wetland functions, the current delineation of jurisdictional wetland still relies upon structural features or attributes.

The prevailing view among many wetland scientists is that functional wetlands need to meet only one of the three criteria as outlined by Cowardin and others (1979) (e.g., hydric soils, hydrophytic plants, and wetland hydrology). On the other hand, jurisdictional wetlands need to meet all three criteria, except in limited situations. Even though functional wetlands may not meet jurisdictional wetland requirements, they certainly perform wetland functions resulting from the greater amount of water that accumulates on or near the soil surface relative to the adjacent uplands. Examples include some woody draws occupied by the *Acer negundo/Prunus virginiana* (Manitoba maple/choke cherry) habitat type (Thompson and Hansen 2002) and some floodplain sites occupied by the *Artemisia cana/Agropyron smithii* (silver sagebrush/western wheatgrass) habitat type or the *Populus tremuloides/Cornus stolonifera* (aspen/red-osier dogwood) habitat type. Currently, many of these sites fail to meet jurisdictional wetland criteria. Nevertheless, these functional wetlands provide important wetland functions vital to wetland dependent species and may warrant special managerial consideration. The current interpretation is that not all functional wetlands are jurisdictional wetlands, but that all jurisdictional wetlands are functional wetlands.

Lentic Wetland Health

As noted above, the health of a lentic site (a wetland located adjacent to a still water body) may be defined as the ability of that system (including the saturated and inundated near-shore emergent wetland and all the shoreline area that is influenced by the lentic waters) to perform certain wetland functions. These functions include sediment trapping, shoreline maintenance, water storage, aquifer recharge, wave energy dissipation, and primary biotic production. A site's health rating may also reflect management considerations. For example, although *Cirsium arvense* (Canada thistle) or *Euphorbia esula* (leafy spurge) may help to trap sediment and provide soil-binding properties, other functions (i.e., productivity and wildlife habitat) will be impaired; and their presence should be a management concern. Excellent sources of practical ideas and tips on good management of these wetland sites in Alberta are found in *Caring for Shoreline Properties* (Valastin and others 1999) and *Caring for the Green Zone* (Adams and Fitch 1995), and *Riparian Areas: A User's Guide to Health* (Fitch and Ambrose 2003). In Saskatchewan some excellent resources are *Streambank Stewardship, Your Guide to Caring For Riparian Areas in Saskatchewan* (Huel 1998) and *Managing Saskatchewan Wetlands—A Landowner's Guide* (Huel 2000).

No single factor or characteristic of a wetland site can provide a complete picture of either site health or the direction of trend. The lentic wetland health assessment is based on consideration of physical, hydrologic and vegetation factors. It relies heavily on vegetative characteristics as integrators of factors operating on the landscape. Because they are more visible than soil or hydrological characteristics, plants may provide early indications of riparian health as well as successional trend.

These are reflected not only in the types of plants present, but also by the effectiveness with which the vegetation carries out its wetland functions of stabilizing the soil, trapping sediments, and providing wildlife habitat. Furthermore, the utilisation of certain types of vegetation by animals may indicate the current condition of the wetland and may indicate trend toward or away from potential natural community (PNC).

In addition to vegetation factors, an analysis of site health and its susceptibility to degradation must consider physical factors (soils and hydrology) for both ecologic and management reasons. Changes in soil or hydrologic conditions obviously affect functioning of a wetland ecosystem. Moreover, changes in physical characteristics are often (but not always) more difficult to remedy than vegetative changes. For example, downcutting of an unstable overflow point may lower the water table and thus change site potential from a *Typha latifolia* (cattail) habitat type to a *Calamagrostis canadensis* (bluejoint) habitat type or even to an upland type. Sites experiencing significant hydrologic, edaphic (soil), or climatic changes will likely also have a change in plant community potential.

This method is not designed for an in-depth, comprehensive, analysis of ecologic processes. Such analysis may be warranted on a site and can be done after this evaluation has identified areas of concern. Nor does this approach yield an absolute rating to be used in comparison with wetlands in other areas or of other types. Appropriate comparisons using this rating can be made between neighbouring wetlands of similar size and type and between subsequent assessments of the same site.

A single evaluation provides a rating at only one point in time. Due to the range of variation possible on a wetland site, a single evaluation cannot define absolute status of site health or reliably indicate trend (whether the site is improving, degrading, or stable). To monitor trend, health assessments should be repeated in subsequent years during the same time of year. Evaluation should be conducted when most plants can be identified in the field and when hydrologic conditions are most nearly normal (e.g., not during peak spring runoff or immediately after a major storm). Management regime should influence assessment timing. For example, in assessing trend on rotational grazing systems, one should avoid comparing a rating after a season of use one year to a rating another year after a season of rest.

Pre-Assessment Preparation

The lentic health assessment process incorporates data on a wide range of biological and physical categories. The basic unit of delineation upon which an assessment is made is referred to as a ***polygon.*** A lentic polygon is a wetland, or portion of a wetland, not associated with a waterway (stream or river) and which has no defined channel. Polygons are delineated on topographic maps before evaluators go to the field. It is important to clearly mark and number the polygons on the maps.

If aerial photos are available, polygon delineations can be based on vegetation differences, geologic features, or other observable characteristics. On larger systems with wide wetland areas, aerial photos may allow delineation of multiple vegetation-based polygons away from the water source. In these cases, where polygons can be drawn as enclosed units a minimum mapping unit of possibly 5 to 10 acres (2 to 4 ha) should be followed. The size of the minimum mapping unit should be based on factors such as management capabilities, available funds, and capabilities of data collection.

If pre-delineated polygons are drawn on the maps, and pre-assigned numbers are given, be sure the inventoried polygons correspond exactly to those drawn. Evaluators are allowed to move polygon boundaries, create new polygons, or consolidate polygons if the vegetation, geography, location of fences, or width of the wetland zone warrant. If polygon boundaries are changed, the changes must be clearly marked on the field copies of the maps. Evaluators should draw the complete polygon boundary onto their field maps if possible at the 1:20,000 or 1:50,000 scale.

In most cases involving small bodies of water or small lentic wetlands, the inventoried polygon will be a single unit of area. Around larger lakes, extensive marshes, or other large lentic wetlands, it may be necessary to divide the wetland into separate polygons (Figure 1). Polygons should be divided at distinct locations such as fences, stream entrances or exits, or other features easily recognized in the field. When selecting “representative sites,” consideration should be given to the differences presented by landform position (i.e., point vs. bay, or windward vs. leeward side of the water body). ***Polygons should not cross fences between areas with different management.***

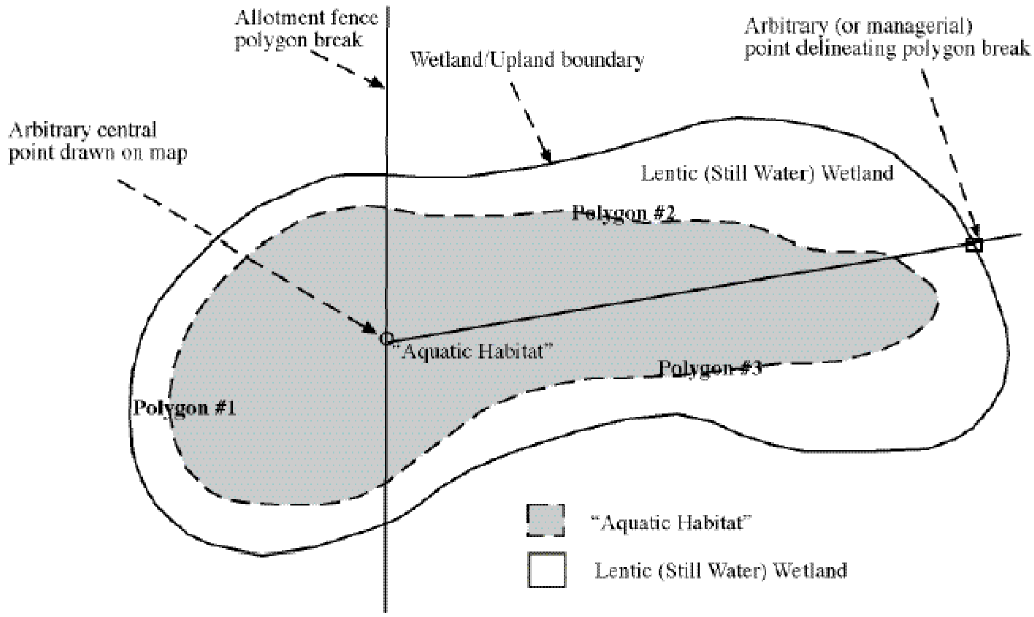


Figure 1. Schematic drawing of a lentic (still water) wetland showing: 1) delineation of polygons on larger systems, i.e. those too big to inventory as a single polygon (more than about one half mile in length) or those with managerial breaks across them; 2) a typical relationship between "aquatic habitat" (open water) and surrounding lentic wetland, which includes areas of persistent emergent vegetation in standing water.

The outer boundaries of polygons are usually at the wetland ecosystem outer edges. These boundaries are sometimes easily determined by abrupt changes in the landform and/or vegetation, but proper determination often depends on experienced interpretation of more subtle features. The inner polygon boundary is the landward edge of the deep-water habitat. Deepwater habitat is the area covered by surface water deeper than 6.6 ft [2 m], or where sunlight cannot penetrate to support erect, rooted, plant life. Persistent emergent vegetation consists of emergent species that normally remain standing at least until the beginning of the next growing season, e.g., *Typha* spp. (cattails) or *Scirpus* spp. (bulrushes).

When using the inventory on artificial or artificially enlarged waterbodies (eg. dugout, manmade pond, reservoirs), use the same criteria, but remember that some questions may be difficult to apply appropriately. Focus on being consistent in applying the methods, including delineation of site boundaries. Remember to record all decisions made in applying the methodology. The goal is to assess the site's ability to perform ecological functions ***to its potential***.

Identification of plant communities by vegetation type (Thompson and Hansen 2001, Thompson and Hansen 2002) will be useful both in delineating lentic areas and, later, in determining appropriate management. These may be in a mosaic difficult to map. An area may have a mix of herbaceous communities, shrubs, and forest. These communities have diverse resource values and may respond differently to a management action, but it is seldom practical to manage such communities separately. Community composition can be described as percentages of component types comprising the polygon vegetation. Management actions can then be keyed to the higher priority types present.

DATA FORM ITEMS

Record ID No. This is the unique identifier allocated to each polygon. This number will be assigned in the office when the form is entered into the database.

ADMINISTRATIVE DATA

A1. Identify what organisation is doing the evaluation field work.

A2. Identify what organisation is paying for the work.

A3a. Identify any Indian or Métis Reserve on which work is being done.

A3b. Identify any National or Provincial Park, Preserve, or Sanctuary on which work is being done.

A3c. Identify any local Environmental, Ecological or Municipal Reserve (Exclude national or provincial reserves) on which work is being done. If yes, identify which applicable reserve is established and its number.

Ecological Reserves are areas of Crown land (Provincial or Federal Government), which have the potential to contain representative, rare and fragile landscapes, plants, animals and geological features. The intent is for the preservation of natural ecosystems, habitats and features associated with biodiversity. Public access to ecological reserves is by foot only; public roads and other facilities do not normally exist and will not be developed.

Environmental reserve generally are those lands that are considered undevelopable and may consist of a swamp, gully, ravine, coulee or natural drainage course, flood prone areas, steep slopes or land immediately adjacent to lakes, rivers, stream or other bodies of water. Governed by *The Municipal Government Act (Alberta).*

Municipal reserve may also be known, in part, as reserve, park reserve, park or community reserve. Municipal reserves are lands that have been given to the municipality by the developer of a subdivision as part of the subdivision approval process. Governed by *The Municipal Government Act (Alberta).*

A3d. Was the work done on Private or Deeded Land? Simply answer “Yes” or “No.”

A4. Observers: Name the evaluators recording the data in the field.

A5a. Date that the field data was collected: Use the format: month/day/year

A5b. Record the year that the field data was collected.

A6a. Identify any grazing lease or grazing reserve on which work is being done.

A6b. Give any grazing disposition identifying number.

A6c. Give any other grazing name (e.g. Community Pasture) to identify where the work is being done.

Note: Items A7a-h are completed in the office; field evaluators need not complete these items.

A7. The several parts of this item identify various ways in which a data record may represent a resampling of a polygon that may have been inventoried again at some other time. The data in this record may have been collected on an area that coincides precisely with an area inventoried at another time and recorded as another record in the database. It may also represent the resampling of only a part of an area previously sampled. This would include the case where this polygon overlaps, but does not precisely and entirely coincide with one inventoried at another time. One other case is where more than one polygon inventoried one year coincides with a single polygon inventoried another year. All of these cases are represented in the database, and all have some value for monitoring purposes, in that they give some information on how the status on a site changes over time.

A7a. Does this record represent the latest data recorded for this polygon?

A7b. Has any part of the area within this polygon been inventoried previously, or subsequently, as represented by another data record in the Lentic Wetland database? Such other records would logically carry different dates.

A7c. Does the areal extent of this polygon exactly coincide with that of any other inventory represented in the Lentic Wetland database? In many cases, subsequent inventories only partially overlap spatially. The purpose of this question is to identify those records that can be compared as representing exactly the same ground area.

A7d. If A7c is answered “Yes,” then enter the years of any inventories of this exact polygon.

A7e. If A7c is answered "Yes," also enter the record ID number(s) of any other previous or subsequent reinventories (resamplings) of this exact polygon for purposes of cross-reference in the database.

A7f. Even though this polygon is not a re-inventory of the exact same area as any other polygon, does it share at least some common area with one or more polygons inventoried at another time?

A7g. If A7f is answered "Yes," enter the years of any other inventories of polygons sharing common area with this one.

A7h. If A7f is answered "Yes," also enter the record ID number(s) of any other polygon(s) sharing common area with this one.

A8a. Has a management change been implemented on this polygon?

A8b. If A8a is answered "Yes," in what year was the management change implemented?

A8c. If A8a is answered "Yes," describe the management change implemented.

LOCATION DATA

B1. Province in which the field work is being done.

B2a, b. Identify the Natural Region and Sub-Region in which the field work is being done. Use the Natural Regions and Subregions of Alberta (Alberta Natural Heritage Information Centre (1999).

B3. County or municipal district in which the field work is being done.

B4a. The city, town, or village in which the fieldwork is being done.

B4b. The subdivision plan number in which the fieldwork is being done.

B4c. The block number in which the fieldwork is being done.

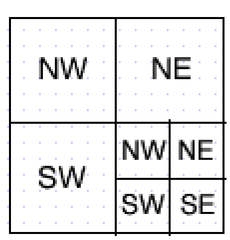
B4d. The lot number in which the fieldwork is being done.

B5. Identify the allotment, range unit, or landowner where the field work is being done.

B6. Name the waterbody or area on which the field work is being done.

B7. Polygon number is a sequential identifier of the actual piece of land being surveyed. This is referenced to the map delineations. Sequences normally progress clockwise on lentic systems.

B8a. The location of the polygon is presented as a legal land description: 1/4,1/4 section, 1/4 section, Township, Range, and Meridian are read from smallest to largest unit.



B8b. Identify the side of the polygon that the Assessment is completed for by using "North, South, East or West"

B9. Elevation (feet or meters) of the polygon ***centroid.*** Elevation is usually interpolated from a topographic map

B10a. Name the major watershed (e.g. North Saskatchewan River) of which the site being surveyed is a part.

B10b. Name the minor watershed (e.g. Battle River) of which the site being surveyed is a part. This is normally subordinate to the major watershed named above in #B10a.

B10c, d. The minor watershed area (km 2) and perimeter (km) are obtained from the map in the office.

B10e. Name the sub-basin (e.g. Iron Creek). This is the local watershed of which the site being surveyed is a part. This is normally subordinate to the minor watershed named above in #B10b.

B11a-c. Universal Transverse Mercator (UTM) coordinates are recorded for the upper (or most northerly and westerly) and lower (or most southerly and easterly) ends of the polygon using GPS units in the field. Other locations of special interest may be recorded using the GPS unit. These coordinates are considered accurate to within approximately 50 m. Field observers are to use GPS units to obtain these coordinates following standard protocol. Record UTM coordinates at each end of the long axis of the polygon.

Enter the UTM coordinate data, including the UTM zone and the identifying waypoint number, on the form for each point collected. Save the data in the GPS unit for downloading to the computer later. When starting work in a new location, always check the GPS receiving unit against a known point by using the UTM grid and map.

B11d, e. Identify the GPS unit used, and the name or number designator of the waypoints saved for the upper and lower ends of the polygon and for other locations. Describe any comments worth noting about the waypoints (i.e., monument referenced or general location descriptions).

B12a-c. Record the name(s), scale, and publication year of the quadrangle map(s) or any other map(s) locating the polygon. Use precisely the name listed on the map sheet. Provision is made for listing two maps in case the polygon crosses between two maps.

B13. Record identifying data for any aerial photos used on this polygon.

SELECTED SUMMARY DATA

C1. Wetland type is a categorical description of predominant polygon character. Select from the following list of categories that may occur within a lentic system the one that best characterizes the majority of the polygon. Observers will ***select only one category*** as representative of the entire polygon. If significant amounts of other categories are present, indicate this in Comments and Observations or consider dividing the original polygon into two or more polygons.

Category Description

Wet Meadow. This type of wetland may occur in either riparian (lotic) or in still water (lentic) systems. A lotic wet meadow has a defined channel or flowing surface water nearby, but is typically much wider than the riparian zone associated with the classes described above. This is often the result of the influence of lateral groundwater not associated with the stream flow. Lotic and lentic wet meadows may occur in proximity (e.g., when enough groundwater emerges to begin to flow from a mountain meadow, the system goes from lentic to lotic). Such communities are typically dominated by herbaceous hydrophytic vegetation that requires saturated soils near the surface, but tolerates no standing water for most of the year. This type of wetland typically occurs as the filled-in basin of old beaver ponds, lakes, and potholes.

Spring/Seep. Groundwater discharge areas. In general, springs have more flow than seeps. This wetland type may occur in a riparian (lotic) or still water (lentic) system.

Reservoir. An artificial (dammed) water body with at least 20 acres (8 ha) covered by surface water.

Stock pond. An artificial (dammed) body of water of less than 20 acres (8 ha) covered by surface water.

Lake. A natural topographic depression collecting a body of water covering at least 20 acres (8 ha) with surfacewater.

Pothole, slough, or **Small Mountain Lake.** A natural topographic depression collecting a body of water covering less than 20 acres (8 ha) with surface water.
Other. Describe any other wetland type encountered which is not associated with a surface water channel.
Non-wetland (Upland). This designation is for those areas which are included in the inventoried polygon, but which do notsupport functional wetland vegetation communities. Such areas may be undisturbed inclusions of naturally occurring high ground or such disturbed high ground as roadways and other elevated sites of human activity.

C2. The size (acres/hectares) of polygons large enough to be drawn as enclosed units on 7.5-minute (1:24,000) topo maps is determined in the office using a planimeter, dot grid, or GIS. For polygons too small to be accurately drawn as enclosed units on 7.5-minute maps, polygon size is calculated using polygon length and average polygon width.

C3a-d. Evaluators may be asked to survey some areas that have not been determined to be wetlands for the purpose of
making such a determination. Other polygons include areas supporting non-wetland vegetation types. A "Yes" answer here indicates that no part of the polygon keys to a riparian habitat type or community type (HT/CT). Areas classified in item C8 as any vegetation type described in a riparian and/or wetland classification document for the region in which you are working are counted as functional wetlands. Areas listed as UNCLASSIFIED WETLAND TYPE are also counted as functional wetlands. Other areas are counted as non-wetlands, or uplands. **C3c-d are completed in the office once the length of the polygon is determined.**

C4. Some lentic polygons may not contain a defined shoreline between wetland and open water. In some cases these polygons are in ephemeral depressions which may be inundated infrequently, but do support wetland plant communities. In other cases, these polygons may be part of large marsh systems that may or may not be associated with lakes, but where polygons may be delineated in areas not adjacent to open water.

C5. Polygon length is measured in the field or by scaling from the map. This data is considered accurate to the nearest 0.1 mile (0.16 km). Polygon length may be the same as shoreline length, but may not be in cases of much curved shoreline, or for polygons that have no shoreline (i.e., wet meadows or marshes).

C6. In some cases, the polygon data is used to characterize, or represent, a much larger shoreline. The length represented by the polygon is given here. For example, a 0.5 mile (0.8 km) polygon may be used to represent 2 miles (3.2 km) of total shoreline length. In this case, 0.5 (0.8 km) is the shoreline length in the polygon, and 2 miles (3.2 km) is the overall shoreline length.

C7. Record average width of the polygon, which in smaller wetlands corresponds to the width of the entire wetland area.

C8. List the riparian habitat type(s) and/or community type(s) found in the polygon (Thompson and Hansen 2002 or another appropriate publication). If the habitat type cannot be determined for a portion of the polygon, list the appropriate community type(s) of that portion. If neither the habitat type nor community type can be determined for any portion of the polygon (or in areas [outside of Montana] where the habitat and community types have not been named and described), list the area in question as "unclassified wetland type" and give the dominant species present. Indicate with the appropriate abbreviation if these are habitat types (HT), community types (CT), or dominance types (DT), for example, POPUTRE/CORNSTO HT. For each type listed, estimate the percent of the polygon represented. If known, record the successional stage (i.e., early seral, mid-seral, late seral, and climax) or give other comments about the type. As a minimum, list all types, which cover 5% or more of the polygon. The total must approximate 100%. Slight deviations due to use of class codes or to omission of types covering less than 5% of the polygon are allowed. ***Note:*** For any area classified as an "unclassified wetland type," it is important to list any species present which can indicate the wetness or dryness of the site.

ADDITIONAL PHYSICAL SITE CHARACTERISTICS
D1a, b. Make a call on whether the polygon has potential for tall woody type(s), and if the answer is "Yes," then tell whether such types are present on the polygon. Tall woody types are any tree HTs or CTs and such taller shrubs as willows, Saskatoon, Alder, birch, etc. Not included are shorter shrub species, such as buckbrush/snowberry, rose, etc.

D2. Give the waterbody number (FMIS/Hydro code).

D3a. If water quality data is available on this waterbody

D3b. Describe or list the reference where the water quality data for that waterbody can be found.

D4. Describe the boundaries of the polygon, especially the location of the upper and lower ends, as well as the lateral boundaries. On smaller streams the polygon usually includes the entire width of the riparian zone. Describe what you use as the indicators of the wetland-upland boundary. Use localized geologic, physical, or vegetation information to identify these boundaries of the polygon for future polygon relocation.

PHOTOGRAPH DATA

Note: At a minimum, take two photos from identifiable points along the upland edge of the polygon viewing toward the water body and along the long axis of the polygon. Identify all photo point locations sufficiently, so that they could be relocated by another individual.

E1. Identify the film roll number, photo (frame) number, and description of each photograph taken at the most northerly/westerly end or side of the polygon. List them in the order of northerly/westerly views first, then southerly/easterly views, and then each other shot taken to show other features of interest. Also identify the photographer and camera used.

E2. Tell if there is another polygon adjacent to this one to the ***north/west***.

E3. Same as E1 above for shots taken at the most southerly/easterly end or side of the polygon.

E4. Tell if there is another polygon adjacent to this one to the ***south/east***.

E5. Identify all additional photos taken outside of polygon (i.e., non-polygon photos) by giving roll number, frame number,
and description of view.

E6. Record the brand of film, film speed, camera lens size, and lens focal length or magnification.

THE LENTIC HEALTH ASSESSMENT SCORE SHEET (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., 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.

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. Vegetative 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 standing 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, including water between emergent plants such as cattails and bulruhes. Areas such as boat docks, hardened pathways, and artificial structures are counted as unvegetated along with any bare ground, downed wood, and other plant litter. 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 occularly 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]). Some common invasive species are listed on the form, and space is allowed for recording others. Include both woody and herbaceous invasive species. ***Leave no listed species field blank, however;*** enter “0” to indicate absence of a value.

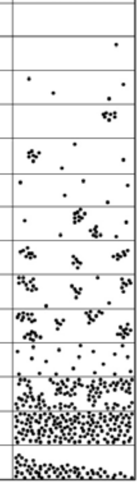
2a. Total Canopy Cover of Invasive Plant Species. The observer must evaluate the total percentage of the polygon area that is covered by the combined canopy of all plants of all species of invasive plants. Determine which rating applies in the scoring scale below.

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 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.	



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 that 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 (smooth brome) *Poa pratensis* (Kentucky bluegrass) *Trifolium* spp. (clovers)
Fragaria spp. (strawberries) ________________________________
____

Scoring:
3 = Less than 5% of the site covered by disturbance-caused undesirable herbaceous species.
2 = 5% to 25% of the site covered by disturbance-caused undesirable herbaceous species.
1 = 25% to 45% of the site covered by disturbance-caused undesirable herbaceous species.
0 = More than 45% of the site covered by disturbance-caused undesirable herbaceous species.

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

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

Elaeagnus angustifolia (Russian olive), *Caragana* spp. [caragana], *Rhamnus cathartica* [European/common buckthorne], and *Tamarix* spp. [salt cedar] are considered especially aggressive, undesirable exotic plants.

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. If the observer 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.

5. Utilisation 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, including beaver. Heavy browsing can prevent establishment or regeneration of these important species. Excessive browsing can eliminate them from the community and result in their replacement by undesirable invaders.

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

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

We feel that, although there is only a small amount of willow present, the fact that it is being heavily utilised 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 utilisation, 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. Include also human removals by such activities as shearing and mowing. Do not include use of dead plants unless it is clear this condition was the result of over-grazing. ***Note:*** If a plant is entirely mushroom/umbrella shaped by long term heavy browse or rubbing use, count this as heavy utilisation. Be sure to include physical and mechanical damage or cutting by humans, as well as consumptive use by animals.
Scoring: *(If the site has no potential for trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA. If the observer is not fairly certain potential exists for preferred trees or shrubs, then enter NC and explain in the comment field below.)*

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

6. Human Alteration of Polygon Vegetation. Alteration of the vegetation is meant to include all changes to the plant
community composition or structure within the polygon caused by human actions (e.g., logging, mining, roads, construction, or development) or by agents of human management (e.g., livestock). Also include impacts caused by extreme concentrations of managed wildlife, rationale being that wildlife concentrations great enough to cause significant site damage are usually the result of human management activities. Beaver activities that alter vegetative communities will not be included in this question, but are included in the utilisation question.). Intention here is to assess long term, or permanent, vegetation changes, not 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, conversion of natural communities to lawns or hayfields (but not the actual mowing), 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 water, remember that the polygon extends out to where the water is two metres deep. (***NOTE:*** Do not count the same area twice by including it as both a vegetative 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 it may cause both clearing of vegetation and disruption of the soil by heavy equipment.)

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. The purpose of this question is to assess physical change to the soil,
shoreline integrity, hydrology, etc. as it affects the ability of the natural system to function normally. Changes in shore and bank contour and any change in soil structure will alter infiltration of water, increase soil compaction, and cause increased sediment contribution 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.

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) and also any effects from concentrated wildlife use
(Rationale being that wildlife concentrations great enough to cause significant site damage are usually the result of human management activities.) The kinds of physical change that diminish or disrupt the natural wetland functions on the site include, but are not limited to, hummocking, pugging, animal trails (livestock or wildlife), human roads, trails, buildings, landscaping, boat launches/docks, beach clearing and building, or rip-rapping of shores and banks.

(***NOTE:*** Do not count the same area twice by including it as both a vegetative 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 may also be physical alteration of the same site.)

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 = More than 35% 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]). Hardened, impervious surfaces (e.g., asphalt, concrete, etc.) are not bare ground—these do not erode nor allow weeds sites to invade. 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 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 = 15% or more of the polygon is human-caused bare ground.

9. Degree of Artificial Withdrawal or Raising of Water Level. Although water levels naturally fluctuate on a seasonal basis in most systems, many wetland systems are affected by human-caused (artificial) additions or withdrawals. This artificial changes of water level rarely follow a temporal regime that maintains healthy native wetland plant communities. The result is often a barren band of shore exposed or inundated for much of each growing season. This causes shore material to destabilize, and often provides sites for weeds to invade. Such conditions are extremely detrimental to healthy riparian function.

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 (or into) 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 severity described. (***Note:*** Be careful to consider the scale of the water body as it relates to the scale of change. 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 added or removed, it may be better to describe 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.***

—**Severity Categories of Lentic Water Level Manipulation**

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Not Subjected The water body, or wetland, is not subjected to artificial water level change.
Minor The waterbody or wetland 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 soil exposure. A relatively narrow band affected by the water level fluctuation may support only annual plants.
Moderate The waterbody or wetland 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 or wetland 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 level change.
6 = The degree of artificial water level change is **minor**.
3 = The degree of artificial water level change is **moderate**.
0 = The degree of artificial water level change is **extreme**.

10. Comments and Observations. Add any necessary commentary to explain or amplify the data recorded. Do not leave this space blank. Describe any unique characteristics of the site and other observations relating to the vegetation or to the physical conditions of the site. Each item in the health rating has a small space provided for specific information to enlighten the score given. This larger space is the place for more general commentary to help the reader understand the larger context of the data. Such things as landscape setting and local land use history are appropriate here.

Calculating the Lentic Health Score
To arrive at the overall site health rating, the scores are totalled for all the factors, and that total is divided by the possible perfect score total. A sample score sheet is shown below.

Vegetation Factors	**Actual Pts**	**Possible Pts**
1. Vegetative Cover of Polygon	6	6
2a. Total Canopy Cover of Invasive Plant Species	1	3
2b. Density/Distribution Pattern of Invasive Plant Species	1	3
3. Disturbance-Caused Undesirable Herbaceous Species	2	3
4. Preferred Tree and Shrub Establishment and Regeneration	2	6
5. Utilisation of Preferred Trees and Shrubs	2	3
6. Human Alteration of Polygon Vegetation	4	6
Vegetative Score:	**18**	**30**
Soil/Hydrology Factors		
7. Human Alteration of Polygon Physical Site	8	12
8. Human-Caused Bare Ground	2	6
9. Degree of Artificial Withdrawal of Water	9	9
Soil/Hydrology Score:	**19**	**27**
TOTAL SCORE:	**37**	**57**

Rating = (Total Actual) / (Total Possible) X 100%
Rating = (37) / (57) X 100% = 65%

Rating Category: 80-100% = Proper Functioning Condition (Healthy)

60-79% = Functional At Risk (Healthy, but with Problems)
Less than 60% = Nonfunctional (Unhealthy)

The manager should realize that a less than perfect score is not necessarily cause for concern. An area rated at 80% is still considered to be functioning properly. At the same time, ratings of individual factors can be useful in detecting strengths or weaknesses of a site. A low score on any factor warrants management focus. For example, the sample score sheet shown above has low scores for invasive plant species, tree and shrub regeneration, and bare ground (items 2, 4, and 8). These are factors in which a management change might result in improvement on a subsequent assessment.

ADDITIONAL MANAGEMENT CONCERNS (OPTIONAL)

The following items do not contribute to a site's health assessment rating. Rather, they may help to quantify inherent physical site characteristics that reveal structural weaknesses or sensitivities or to assess the direction of change on a site. These data can be useful for planning future site management.

11. Overflow Structure Stability. Often the most dynamically unstable point in a lentic system is at the overflow, or outlet. Natural systems usually evolve behind a relatively stable outlet structure, but the overflow structures, or spillways, of human made water bodies often become unstable and erode, wash out, or downcut causing severe disruption to the lentic system dependent on that body of water.

Scoring: (If the water body is not human constructed nor structurally altered, and lacks an overflow structure, replace both Actual and Possible Scores with NA.)

6 = The overflow structure is made of concrete, pipe, or armoured rock and appears stable.
4 = The overflow structure is unprotected or is made of other material, but still appears stable.
2 = The overflow structure is made of concrete, pipe, or armoured rock, but appears unstable.
0 = The overflow structure is unprotected or is made of other material and appears unstable.

12. Shoreline Rock Volume and Size. The composition of shoreline materials influences the susceptibility of the shoreline to erosion caused by trampling, wave action, or other disturbance. In general, larger rocks provide better protection against disturbance than smaller materials. Thus, shoreline composed primarily of silts and clays—characteristic of many lentic systems in the Great Plains—require more vegetative protection to compensate for the smaller particle sizes.

12a. Shoreline Rock Volume. Rate the shoreline rock volume as the highest appropriate of the following categories:

Scoring:
3 = More than 40% of shoreline volume is rocks at least 2.5 inches.
2 = 20% to 40% of shoreline volume is rock at least 2.5 inches.
1 = 10% to 20% of shoreline volume is rock at least 2.5 inches.
0 = Less than 10% of shoreline volume is rocks at least 2.5 inches.

12b. Shoreline Rock Size. Rate the shoreline rock size for the polygon as the highest appropriate of the following categories:

Scoring:
3 = At least 50% of rocks present are boulders and large cobbles (>5 inch).
2 = 50% of rocks present are small cobbles and larger (>2.5 inches).
1 = At least 50% of rocks present are coarse gravels and larger (>0.6 inches).
0 = Less than 50% of rocks present are coarse gravels and larger (>0.6 inches).

13. Vegetation Use by Animals. Record the rating category, which best describes the vegetation use by animals (Platts and others, 1987).

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Code Category Description

0 to 25%	Vegetation use is light or none. Almost all plant biomass at the current development stage remains. Vegetative cover is close to that which would occur without use. Unvegetated areas (such as bedrock) are not a result of land uses.
26 to 50%	Vegetation use is moderate. At least half the potential plant biomass remains. Average stubble height is more than half its potential at the present stage of development.
51 to 75%	Vegetation use is high. Less than half the potential plant biomass remains. Plant stubble height is usually more than 2 inches (on many ranges).
76 to 100%	Vegetation use is very high. Only short stubble remains (usually less than 2 inches on many ranges). Almost all plant biomass has been removed. Only the root systems and parts of the stems remain.

14. Susceptibility of Parent Material to Erosion. The soils derived from shale or having a large clay content are highly susceptible to compaction and trampling when wet. There is evidence that trampling by hooves and subsequent loss of herbaceous vegetation when soils are wet are major contributions to site degradation. In contrast, those sites having soils derived from sandstone or any of the hard metamorphosed rock found in the northern Rocky Mountains commonly have a fine sandy loam to loam texture and are more resistant to damage when wet. Intermediate of these soils are those having textures of clay loam to loam. Texturing the soil by the ribboning technique or by feel will be required for this determination. Rate the polygon soil according to one of these categories based on indicators as described above.

Scoring:
3 = Not susceptible to erosion (well armoured).
2 = Slightly susceptible to erosion (moderately armoured).
1 = Moderately susceptible to erosion.
0 = Extremely susceptible to erosion.

15. Percent of Shoreline Accessible to Livestock. Record the percent of shoreline length accessible to livestock. In general, only consider topography (steep banks, deep water, etc.) and dense vegetation as restricting access. Fences, unless part of an exclosure, do not necessarily restrict livestock access even though they may appear to be doing so at the time.

16. Quantify the percent of tree and shrub cover in the polygon that is dead and/or decadent. A decadent plant is one having at least 30% of its upper canopy dead. Dead lower branches are not a problem if the upper canopy is vigorous.

17. Polygon Trend. Select the ***one category*** (Improving, Degrading, Static, or Status Unknown) which best indicates the current trend of the vegetative community on the polygon to the extent possible. Trend refers, in the sense used here, not specifically to successional pathway change, but in a more general sense of apparent community health. By definition, trend implies change over time. Accordingly, a trend analysis would require comparison of repeated observations over time. However, some insights into trend can be observed in a single visit. For example, the observer may notice healing (revegetating) of a degraded shoreline and recent establishment of woody seedlings and saplings. This would indicate changing conditions that suggest an improving trend. If such indicators are not apparent, enter the category "status unknown."

18. Break Down the Polygon Area into the Land Uses Listed. Name any "Others" Observed.

19. Break Down the Area Adjacent to the Polygon into the Land Uses Listed. Name any "Others" Observed.

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