Streams and small rivers

Riparian Health Assessment

Field Workbook


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Riparian Health Assessment

Streams and Small Rivers

by Saskatchewan PCAP Greencover Committee

Acknowledgement

The Saskatchewan PCAP Greencover Committee wishes to acknowledge the reproduction of text and graphics from: *Fitch, L., B.W. Adams* and *G. Hale*, 2004. Riparian Health Assessment for Streams and Small Rivers – Field Workbook, Lethbridge Alberta. Cows and Fish Program, reproduced with permission.

The following people and agencies contributed to this workbook as part of the Saskatchewan PCAP Greencover Committee: *Bill Houston, Chris Nykoluk* and *Kerry LaForge* (Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration), *Daryl Nazar, Michael Champion* (Ducks Unlimited Canada), *Cheri Sykes* (Nature Conservancy of Canada), *Tara Sample* (Nature Saskatchewan), *Karyn Scalise* and *Lauren Burton* (Prairie Conservation Action Plan), *Michel Tremblay, Lorne Klein, Don Fontaine* and *Todd Jorgenson* (Saskatchewan Ministry of Agriculture), *Ann Riemer* and *Martha O'Sullivan* (Saskatchewan Ministry of Environment), *Jeff Thorpe* (Saskatchewan Research Council) *Orin Balas* (Saskatchewan Stock Growers Association), *Tom Harrison* and *Etienne Soulodre, Krista Connick, Ross Macdonald,* and *Jody Oliver* (Saskatchewan Watershed Authority), *Dr. J. T. Romo* (University of Saskatchewan) and *Steve Suchan* (Saskatchewan Assessment Management Agency).

We acknowledge that the riparian health assessment method outlined in this workbook was originally developed in the 1980s by Dr. Paul Hansen and William Thompson, of Montana (currently Ecological Solutions Group LLC), and further adapted by Hansen and Thompson in collaboration with Cows and Fish.

The project was administered through the Saskatchewan Prairie Conservation Action Plan (PCAP) with funding support from Agriculture and Agri-Food Canada's Greencover Canada Program. Original funding for the development of this field workbook was provided to Cows and Fish by the Canada-Alberta Beef Industry Development Fund (additional funding information located at www.cowsandfish.org)

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Published by:
PCAP
Website: www.pcap-sk.org

ISBN: 978-0-9809462-2-2

Design: Chris Jordison, Coventry Design Studio
Printing: Impact Printers, Regina, Saskatchewan
Re-printing of this Project was undertaken with the financial support of the Government of Canada provided through the Department of the Environment.

Riparian Health Assessment
Streams and Small Rivers

Photo courtesy of Saskatchewan Watershed Authority

FOREWORD

This workbook describing riparian health assessment has been written for those people who can most effectively influence riparian areas with their management - landowners, livestock producers, farmers, agency staff and others who use and value these green zones.

Riparian health assessment blends many fields of science and undergoes periodic additions and modifications. In addition, the language describing the method of assessing riparian health undergoes continual revision, to clarify, expand and increase understanding. This workbook incorporates the feedback from dozens of training workshops involving hundreds of participants.

Riparian health assessment forms part of a larger package of awareness about riparian areas, leading to choices on managing these vital landscapes. It provides a starting point for future plans and management decisions.

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INTRODUCTION

Why Use This Workbook?

When we look at a riparian area, what we see and how we interpret our observations is often based on our backgrounds, experiences and perceptions. Even though we may be standing on the same streambank we don't often "see" all the same things. Riparian health assessment is a tool that allows us all to "tune our eyes", begin to appreciate the key pieces of the riparian landscape and evaluate what we see. It is an ecological "measuring stick" that provides some structure to our observations and allows us to evaluate the condition or health of a stream or small river. We need to use riparian health assessment to build a common language so we can communicate better with one another, maybe reduce the arguments, and begin to move toward fixing what's broken in riparian areas and maintaining what is healthy. This workbook gets us on that road together.

What Will the Workbook Do For Me?

This workbook is for use in the field. It will help you learn the basics of evaluating the riparian health of a stream or small river system. Riparian health assessment requires instruction and practice; both should be easier with the use of this workbook. With knowledge and experience gained from classroom and field training you will be able to apply this riparian health assessment procedure in your own area. It will start you down the road to recognising riparian health on your home turf, which is the first step to making better management decisions to maintain or restore your riparian areas. This workbook also sets a standard, so we all use a common measuring technique.

Who is It For?

This workbook is for livestock producers, landowners, land and resource managers and others who want to learn to judge riparian health. Community groups, municipalities, and watershed groups will find this workbook helpful in understanding the procedures of riparian health assessment and to interpret the results of watershed level inventories.

Where Can I Use It?

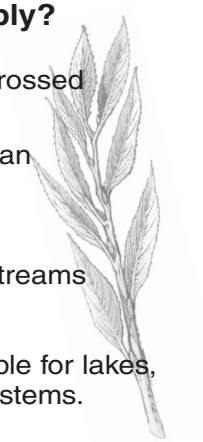
This workbook is designed for streams and small river systems in Saskatchewan. It will be useful for other jurisdictions, with modifications to acknowledge vegetation differences. Different tools are available and should be used when measuring riparian health in large river systems, or in lakes, ponds and wetlands. Contact the Saskatchewan Watershed Authority or Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration for further information (Appendix 4).

RIPARIAN HINTS

Where does this workbook apply?

- Streams or rivers that are easily crossed by humans or livestock
- Systems that are generally less than 15m (50 ft) in width
- Tributaries of major rivers
- Permanent streams, intermittent streams
- Coulees and draws

* Other assessment tools are available for lakes, ponds, wetlands and large river systems.



How to Use the Workbook

This field workbook was designed to be used with other riparian awareness materials, to train people to quickly assess riparian health and to interpret the results of a health evaluation.

- This workbook is designed for use with **Streambank Stewardship: Your Guide to Caring for Riparian Areas in Saskatchewan** (Available online at www.swa.ca under stewardship publications), an illustrated awareness guide which provides more detail on the concept of riparian health.
- This workbook can also be used with the **Classification and management of riparian and wetland sites of the Saskatchewan prairie ecozone and parts of adjacent subregions** (Available online at www.swa.ca under stewardship publications). This publication is a reference document that describes major riparian plant communities and their management requirements for several of the natural regions of Saskatchewan.
- To be effective, riparian health assessment requires some basic preparatory classroom time and field training. This workbook will help you to participate in a riparian health training session, such as those put on by the Saskatchewan Watershed Authority, Prairie Conservation Action Plan and Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration.
- Once you have some training and experience, the workbook will allow you to carry out riparian health assessment and monitoring on your own landbase.
- The workbook will also help you to interpret the results of a riparian health assessment or inventory that may be undertaken in your community.
- The workbook contains examples of field sheets to be used for recording scores (additional field sheets can be obtained from www.pcap-sk.org or www.swa.ca).

BACKGROUND

What is a Riparian Area?

To measure the health of a riparian area you first need to understand what "riparian" means. Riparian areas are transitional: they exist between the aquatic part (the river or stream) and the surrounding terrestrial (or upland) area. Think of them as "wetter than dry" but "drier than wet". There is considerable variation in riparian areas, where water, soil and vegetation interact. Common to all riparian areas are the following features:

- a combined presence and abundance of water, either on the surface or close to the surface;
- vegetation that responds to, requires and survives well in abundant water; and
- soils that are often modified by abundant water (as in high water tables), stream processes (like sediment deposition) and lush, productive and diverse vegetation.

Riparian areas are part of a larger, continuous landscape that grades from wet to dry. Sometimes it will not be easy to determine precisely where a riparian area begins and ends. However, rivers, streams, drainages and springs all have riparian areas adjacent to them. There will most often be a defined channel, that continuously or seasonally carries flowing water, and a floodplain where high flows will periodically escape the channel. Beaver ponds, seeps, wet meadows on the floodplain, coulees and draws are part of the riparian area. Figure 1 on the next page will help you recognize what a riparian area looks like.

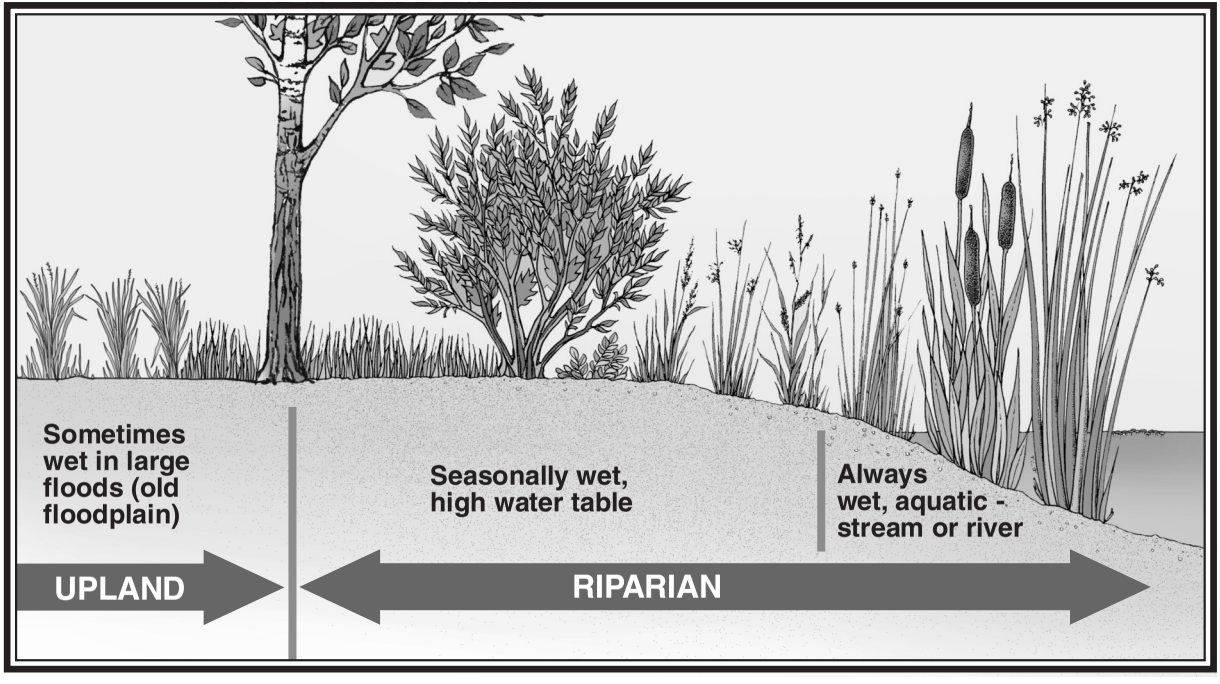


Illustration by Chris Jordison

Figure 1: Riparian versus upland area

What is Riparian Health?

The word "health" conveys an impression of something that is in properly functioning condition: things working well. If health is applied to us, it relates to the ability of our bodies to perform certain functions within a measured set of standards. Our bodies undertake functions like respiration, circulation, digestion, filtration, cell repair, energy storage and movement. If these functions are occurring, within standards, we are healthy. In a similar way, landscapes, including riparian areas, perform certain functions. "Riparian health" means the ability of a reach of stream, or an entire stream or a watershed composed of many streams, to perform a number of key ecological functions (Figures 3-6 and Table 1-4).

Why Does Riparian Health Matter?

We depend on not only our own health to sustain us, but on the health of the environment in which we live. Riparian health matters for the same reason our own health matters! Healthy, functioning riparian areas offer us:

- resiliency - the ability to bounce back from floods, droughts and human caused problems;
- ecological services - a long list of goods, benefits, functions and values; and
- stability - landscapes that maintain themselves, persist and are sustainable.

Photo courtesy of Ducks Unlimited

Figure 2: Pintail hen and drake

The following tables and diagrams indicate key riparian functions and why they are important:

Table 1: Riparian functions: Sediment trapping and filtration

Riparian Functions	Why is this function important?
Trap Sediment	• Sediment adds to and builds soil in riparian areas • Sediment aids in soil's ability to hold and store moisture • Sediment can carry contaminants and nutrients - trapping it improves water quality • Excess sediment can harm the aquatic environment
Filter and Buffer Water	• Reduces amount of contaminants, nutrients and pathogens reaching the water • Uptake and absorption of nutrients by riparian plants • Traps sediment, improves water quality and enhances amount of vegetation to perform filtering and buffering function

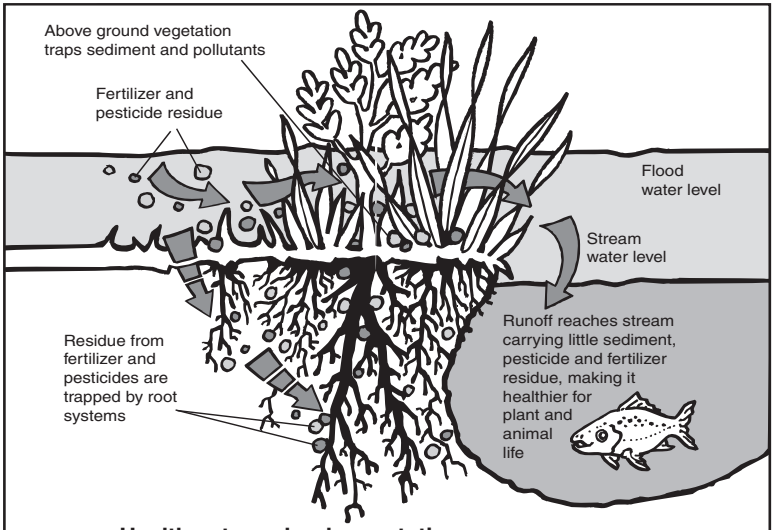


Illustration by Chris Jordison

Figure 3: Riparian functions: Sediment trapping and filtration

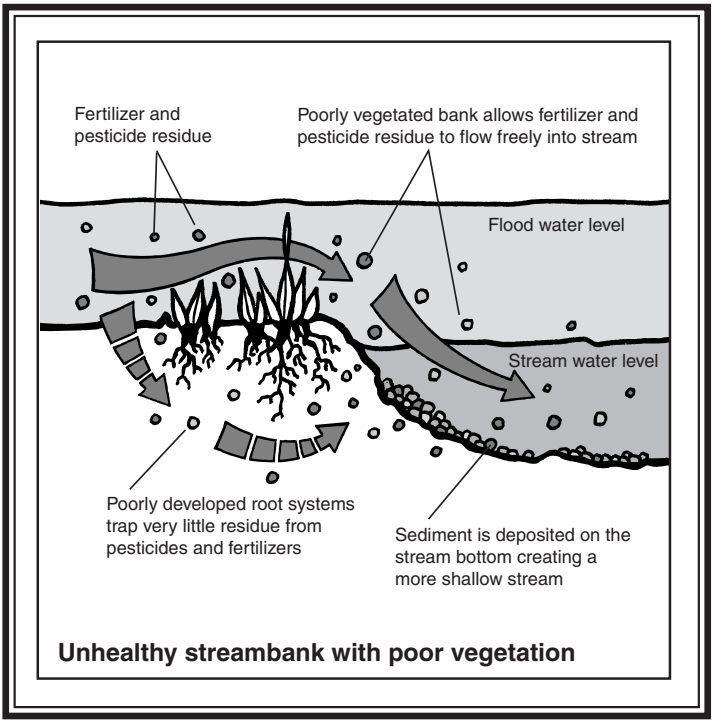


Figure 4: Riparian functions: Poor sediment trapping and filtration

Some Basics of Riparian Health Assessment

No one characteristic can provide a complete picture of riparian site health or health trend. Riparian health assessment, however, knits together several key health characteristics, including vegetative (plants) and physical (soils and hydrology) features. The assessment procedure relies heavily on vegetative characteristics because they reflect and interact with the effects of soils and hydrology that form, and operate in, riparian areas. Plants and their characteristics are seen and interpreted more easily than those for soils and hydrology, providing you with an early indication of riparian health, and helping you to understand the successional trend on a site.

Table 2: Riparian function: Streambank protection and development

Riparian Functions	Why is this function important?
Protect and maintain banks	• Balances erosion with bank restoration - reduces effects of erosion by adding bank elsewhere • Increases stability and resilience • Maintains or restores profile of channel - extends width of riparian area through higher water table

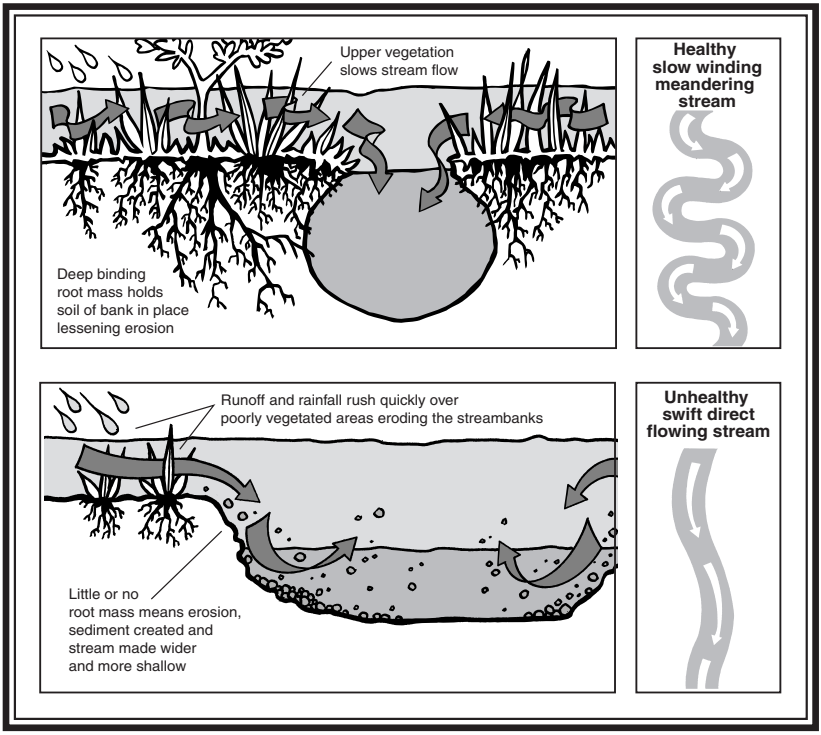


Figure 5: Riparian function: Streambank protection and development

The types of plants present on a site provides some insight into:

- whether there is a trend toward or away from the potential of the site (what the site could be);
- the utilization rates of certain types of vegetation that are key to riparian function (e.g. woody plants); and
- the effectiveness of the vegetation in performing the key ecological functions of riparian areas.

Table 3: Riparian Functions: Aquifer recharge

Riparian Functions	Why is this function important?
Recharge aquifier	• Stores, holds and slowly releases water • Maintains surface flows in rivers and streams • Maintains high water table and extends width of productive riparian area

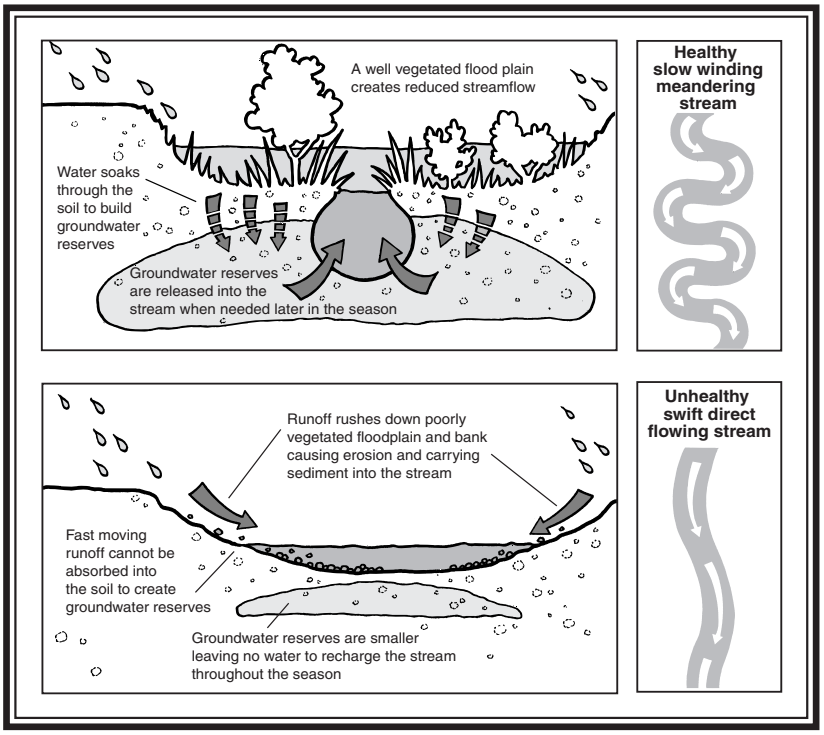


Figure 6: Riparian Functions: Groundwater recharge and streamflow regulation

In addition to vegetative features, riparian health assessment also considers physical factors for both ecological and management reasons. Changes in soils or hydrology can have major effects on riparian function and may be more difficult to remedy than changes in vegetation.

Examples include:

- extensive downcutting of the channel that will lower the water table, shrink the size of the riparian area, change the vegetation to drier or upland types, and reduce forage and shelter values;
- chronic overuse and removal of vegetation that will reduce the site's capability to trap sediment, build soil, and protect soil from erosion and removal from the reach; and
- trampling and compaction that will reduce moisture-holding and storage ability in the soil profile.

Table 4: Riparian Functions: Water and energy storage, reduction in water velocioty, biodioversity and primary production

Riparian Functions	Why is this function important?
Store water and energy	• Stream safety valve- stores high water on the floodplain during floods • Reduces flood damage • Slows flood water allowing absorption and storage in aquifer
Reduce and dissipate energy	• Reduces velocity which slows erosion and material transport • Provides erosion protection and slows meander rate • Aids in sediment capture
Maintain biodiversity	• Creates and maintains habitats for fish, wildlife, invertebrates and plants • Connects other habitats to allow corridors for movement and dispersal • Maintains a high number of individuals and species
Create primary productivity	• Increases vegetation diversity and age-class structure - links to other riparian functions • Ensures high shelter and forage values • Enhances soil development • Assists nutrient capture and recycling

There is an interrelationship between physical and vegetative features. Reaches with significant hydrological and soil changes will likely show changes in plant community structure and potential. Changes in vegetation, the "glue" of riparian systems, may have a rebounding effect on hydrologic and soil features.

The health of a riparian reach is most often a result of what has happened or is happening upstream. Sometimes health can be affected by what occurs downstream, too. Health can often be linked directly to current management on the site or the effects of previous management. Sometimes there may already be clues to problems:

- abundant invasive or disturbance-caused species;
- low forage production;
- shelter declining;
- downcutting of the channel;
- many eroding, slumping banks;
- bare soil exposure; and
- few fish or wildlife present.

Riparian health assessment puts these observations into a format that allows you to understand the significance of the site changes and to measure the condition of the reach against a standard. This is what your doctor does when you have a check-up.

Riparian health assessment gets you to focus your observations and measure 12 parameters on the reach you have selected. The observations and measurements you will make relate to the ability of the reach to perform key ecological functions that translate to health.

RIPARIAN HINTS

What do healthy riparian areas do? Key ecological functions

- Trap sediment
- Build and maintain streambanks
- Store flood water and energy
- Recharge the aquifer
- Filter and buffer water
- Reduce and dissipate stream energy
- Maintain biodiversity
- Create primary productivity

Limitations of Riparian Health Assessment

Riparian health assessment balances the need for a simple, quick and easily-taught index of health against the reality of a complex landscape with many variable situations (management and environment). This approach may not work perfectly every time, and it requires some practice to become proficient. In most cases, it provides a reasonably accurate and repeatable measure of riparian health. With training, you can use this tool to help you pursue sound management decisions.

Riparian health assessment is not designed for an in-depth and comprehensive analysis and investigation of ecological processes and issues. Riparian health assessment may provide the first step in clarifying whether an issue or problem exists and in identifying areas of concern. The next step, Riparian Health Inventory, involves more measurements, taken in greater detail. It is often used at a drainage or watershed scale to provide a more comprehensive analysis of riparian function.

Riparian health assessment does not directly measure fish production, wildlife habitat, forage produced, water quality or other goods, products and benefits of healthy, functioning riparian areas. It does follow, though, that impairment of riparian area function results in decreased potential of the site to produce these items. Assessment is an indirect method of determining the potential of the site. Riparian Health Inventory is a more detailed measuring stick, which allows a relationship to be established between health and some aspects of riparian area benefits and values. Refer to Table 5 to see the differences between "Assessment" and "Inventory".

Avoid making comparisons using the assessment method with streams of different types, different sizes, or from outside the immediate locality or watershed. Appropriate comparisons using this method can be made between reaches of one stream, between adjacent streams of similar size and type, and between repeated assessments at the same site.

Table 5: Assessment vs Inventory: What's the difference?

ASSESSMENT	INVENTORY
• Understanding the basic pieces of riparian areas	• Measuring, analysing and recording; detecting ecological problems, diagnosing them and decision making
• Most useful at the site level	• Useful at the site, drainage and watershed level
• 12 questions or parameters evaluated	• 79 questions or parameters evaluated
• Minimal training and experience required	• Significant training, background and experience required for proficiency
• A first step; overview, initial or preliminary impression of condition	• Comprehensive measurement and evaluation
• Quick and relatively easy to grasp; useful for awareness and education	• More time required for measurement and analysis; uses include problem diagnoses, management decisions, monitoring and watershed scale evaluations
• Identify and stratify reaches for inventory	• Detailed measurements to determine watershed condition, aid in preparation of management plans and monitoring
• Assess current condition	• Measures current condition and evaluates site potential; identifies the current plant community and the successional pathway with current management

A single riparian health assessment provides a rating at only one point in time

Like a health check-up for us, once may not be enough. A single assessment cannot define the absolute status of site health or reliably indicate trend (whether the site is improving, degrading or stable), but it may provide a warning signal. To monitor trend and to account for the range of variation possible on a site, health assessments should be repeated, in subsequent years, at the same location, at the same time of year.

There is no simple way to measure some changes to riparian area health, even though these may be obvious and visible. These changes may result from problems that exist elsewhere in the drainage or in the watershed and are not part of the site being assessed. However, the effect of these distant impacts on the health rating of the site may be negative and result from:

- excessive amounts of sediment, either deposited on the substrate of the stream or dumped on the floodplain and banks;
- diversion or removal of water upstream;
- additional water added to the stream;
- changes in streamflow (timing of flow, duration of flooding, higher peak flows, lower flows) resulting from damming, major modification to vegetation cover, drainage or road networks; and
- extreme flooding from greater than normal precipitation or fast snowmelt.

Watershed scale evaluations, using the Riparian Health Inventory and instream flow assessment, may be required to analyse these effects.

Photo courtesy of Denis Huel

Figure 7: Example of healthy riparian area with abundant vegetation

Photo courtesy of Denis Huel

Figure 8: Example of unhealthy riparian area with poor vegetation cover and unstable stream bank

Why Develop Riparian Health Assessment? Some History and Uses

Riparian areas are the focus of attention because of their agricultural benefits, the biodiversity values they represent and for concerns about water quality. Some riparian areas have declined in their ability to perform the ecological functions that relate directly to these benefits and values. Often, the health of these valuable landscapes has changed over time, even though that decline isn't readily apparent. We need to understand the current status of riparian areas so that we can improve or maintain their health. The first step is to determine the condition or health of the site. Once we know the health of a site, we have a mechanism to link management actions to improving or maintaining ecological function.

In response to many concerns in the United States, the University of Montana, through its Riparian and Wetland Research Program, devised a system to survey and measure the overall health or condition of a riparian site. Many scientific disciplines participated to determine what the key ecological functions of riparian areas were and how these could be measured with a relatively quick and easy assessment technique. This method was initially used to evaluate riparian health on approximately 8,000 km of rivers and streams in Montana, Idaho, Wyoming, North Dakota and South Dakota. The testing and refinement of the method was expanded to include Alberta, British Columbia and Saskatchewan. With this experience, the method has evolved into the present riparian health assessment. The following methodology has been adopted from a workbook produced by the Cows and Fish Program in Alberta, with the original method concept developed by Dr. Paul Hansen and William Thompson of Montana. It includes riparian situations found in Saskatchewan, but may be useful for other areas.

There are four equally important purposes behind the development and use of a riparian health assessment:

- riparian health assessment is a standard method to allow landowners, land/resource managers and others to quickly assess current health, and to identify the presence, scale and magnitude of issues and problems.
- it can be repeated, over time, to monitor changes that may result from natural variation or management actions and choices.
- it can be a catalyst to begin thinking about management changes to correct declines in riparian health or to verify and continue management that maintains health.
- it is an educational tool, to allow those who use, manage and value riparian areas to better understand key functions, identify a way to measure those functions and to serve as a vehicle for better communications among riparian users.

Yellow Rail
Illustration by Chris Jordison

HOW TO ASSESS RIPARIAN HEALTH

When to Do Your Assessment

- When plants are in the growth phase and can be identified (June, July, August and September).
- When flow conditions are close to normal - assessments should not be done during peak spring run off or immediately after a major storm.
- To be consistent, either do your assessment before or after grazing use - ensure follow-up assessments follow the same timing and that different pastures assessed in the same year have similar timing of use.

Pick Your Site

Start by walking or riding the length of stream or river you want to assess. This will give you the opportunity to make observations and choose sites to assess health. If time is available, or the stream length is short, you might want to consider assessing all of the stream length. If time and distance are impediments, you have a couple of choices:

- pick a "critical" site, one that may be sensitive, or already has some specific problems, for assessment; or
- choose a "representative" site that is typical of a much longer reach of stream and that will provide an overall impression of health.

To determine a site that is representative, become familiar with the entire length of stream and riparian area. What you are picking is a short reach that will represent the average condition of a long stretch of river or stream. Vegetation, use/utilization, channel characteristics and stream gradient in the representative reach should all reflect what is found in and is common to a longer reach. If there is too much variation, or a tributary joins, divide the stream into similar units and then select a representative piece from each unit.

The reasons for picking either or both critical and representative reaches are included in Table 6.

Table 6: Reasons for picking critical and representative reaches

CRITICAL	REPRESENTATIVE
• Problem spots indicating management concern	• Overall impression or average of riparian condition for a long stretch of stream
• Sensitive areas, including key habitats for plants, fish or wildlife	• Broader measurement of management actions or choices
• Places that may respond to management change quickly	• Broader measurement of vegetation characteristics, especially key indicators like woody vegetation, weeds or disturbance species
• Shorter reaches, easy to monitor	• Longer reaches for more comprehensive monitoring

Identify a Reach to Assess

A site is a spot on the ground to begin from; **a reach has length and width. A reach is the place to start pacing over, to measure and to complete a health assessment.**

Reach length
The first step is to determine the length of the reach. For measurements on smaller systems:

- the length of reach should be two channel meander cycles, especially on small streams. Review figure 8 to see how to use stream meanders to pick a reach length.

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. Scale will be a consideration in determining reach length. On smaller streams, a 200 m (650 ft) reach length will most often include two meander cycles. For rivers and streams 10 to 15 m (30 – 50 ft) wide, 200 m may be inadequate to do so.

- If it is impractical to assess a full meander cycle, you should assess a minimum of 200 m of river length.

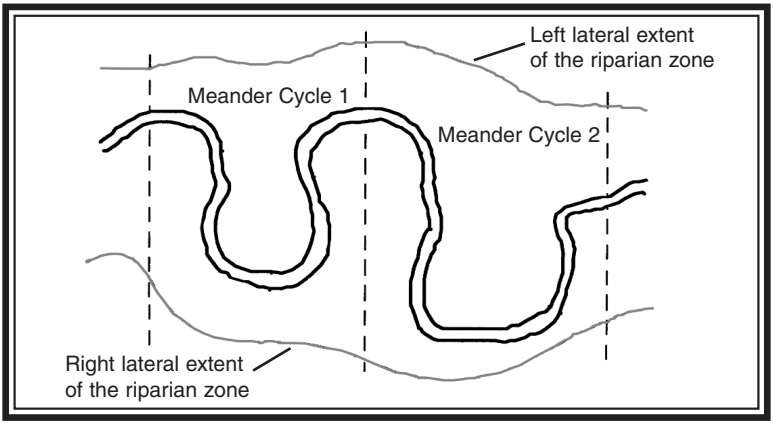


Figure 9: Reach length based on stream meanders

If you have defined your reach as "critical", a length should be picked that is appropriate to what you want to assess.

Reach width

The next step is to determine riparian area width, within the upstream and downstream reach boundaries. The area to be assessed starts at the water and may include that portion of the aquatic area (the wetted channel) where persistent emergent vegetation (plants growing in the water such as cattails and sedges) exists. This forms the inner edge of the riparian area. For those situations where there is no emergent vegetation, the aquatic area is not included in the assessment. Streams that go dry during the growing season have riparian areas and the channel may remain unvegetated after the water is gone. The non-vegetated channel is not included in the measurements; assume it has water in it, as a permanent stream would, and make all the same observations. The exception to this is a channel where the vegetation has been removed by human causes (e.g. grazing, logging, cultivation or construction). In these situations, the disturbed channel is considered as exposed soil surface (bare ground). Both sides of the stream channel should be assessed, unless the stream is a property boundary, each side has different management or the stream cannot be easily crossed by you or livestock.

That's the easy part. Now you have to find the outer edge of the riparian area. Review the definition of "riparian area" and Figure 1 again. The outer boundary of the riparian area exists where:

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

A combination of vegetation changes, topographic breaks and flood evidence (or local knowledge of flooding extent) will help you find the edge. The area between the aquatic and terrestrial zones will have vegetation dominated by water loving plants or plants that respond well to abundant moisture, the active floodplain, the streambanks and, sometimes, areas within the stream channel with emergent vegetation. When in doubt, it is better to overestimate the width or extent of the riparian zone than to underestimate it. Figure 10 will help you find the outer edge of the riparian area.

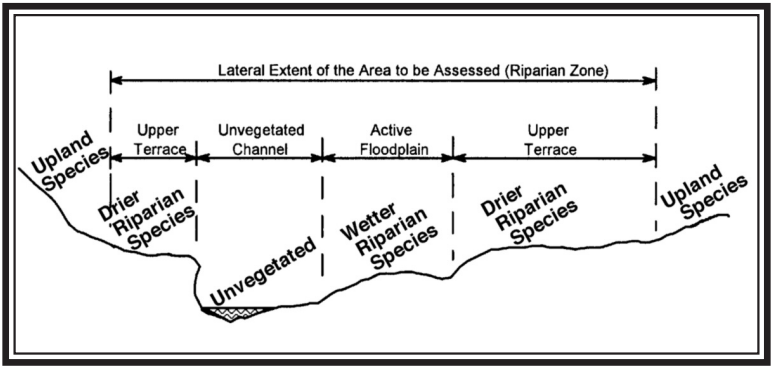


Figure 10: The width of a riparian area

In those cases where it just isn't obvious where the transition exists between riparian and upland areas, a simple estimation of the "floodprone" zone may be helpful. The floodprone zone is that area occupied by high water that escapes the stream channel on a regular basis (at least every 1 to 2 years on average). This zone often equates to the riparian area.

Try this:

- stand on the edge of the stream, at a riffle (shallow) area and establish a "bankfull" level; where high water will begin to escape the channel during floods. You can locate the bankfull level with the following observations:
  - the elevation at the top of depositional features like sand, silt or gravel bars;
  - the line of staining on boulders or rocks;
  - a major break in the slope of the banks;
  - a change in bank material from coarse substrate within an active channel to deposited material of a smaller size; and
  - exposed roots below an intact, vegetated soil layer indicating erosion.
- estimate what the maximum depth of the stream would be at that bankfull level.
- double your estimated depth, and then project that line, with your eye, across the floodplain. Where that line touches is the outer edge of the floodprone zone, and the area enclosed by that line is most of the riparian area. Use Figure 10 to guide you through this estimation of the outer edge of the riparian area.

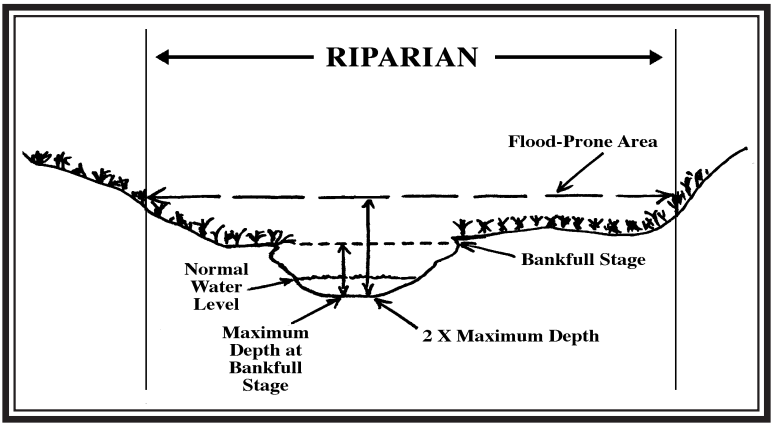


Figure 11: A simple estimation to find the outer riparian edge

Observations have confirmed that this is a useful guide for riparian area identification on most stream types. It is an indication of flood events and high water levels that have a consistent and recurring influence on riparian area structure and vegetation. Some streams, because of excessive downcutting and continual instability, may not have a floodplain, or the stream valley is only accessed by high water during extreme flood events (greater than 1:50 year events). Here, the riparian area will be very narrow.

Reach tips

Assessments generally should not cross fences, roads or areas with different management. If the stream to be assessed crosses more than one management unit (e.g. pasture), at least one reach should be assessed in each unit. Fences, roads and sometimes trails exert a strong influence on livestock movement, grazing patterns and other traffic. To eliminate this bias, locate your reaches at least 75 m (250 ft) from the influence of a fence or a road. An exception to this might occur where holdings are small, and where there are many fences, because these factors could also exert a major influence on overall riparian health. In these situations, you may want to measure the effect or influence of fences and roads on riparian condition: your reach selection will be done with this in mind. Before you start to do an assessment, record reach boundries (upstream and downstream) under site description on the field sheet. Include coordinates if GPS is available. Next year, or in a few years time, you may not be able to find them if you haven't penned a reminder to yourself. Link them with some visible landmark or measure the distance to them from that landmark. You might want to put in a couple of fence posts, rebar pounded flush with the ground or some other easily relocated item. Keep in mind that stream channels migrate and change. Your memory of the locations may be imperfect. Take a photograph to help jog your memory in the future and to document changes over time.

GETTING STARTED

There are 12 questions to answer that relate to components of the riparian reach you have selected. Many deal with the element of "coverage", that is, how much of the reach area is covered, influenced or affected by vegetation or structural impacts. The categories to choose from are expressed in percentages of the reach area. Start by pacing off the length and width of the reach, excluding the aquatic part. Calculate the area. Now you have some context to determine coverage for many of the questions (e.g. 10 m^2 of tree seedlings in a 1000 m^2 reach equals 1% coverage). As you become more practiced you can use the cover class standards shown in Figure 12.

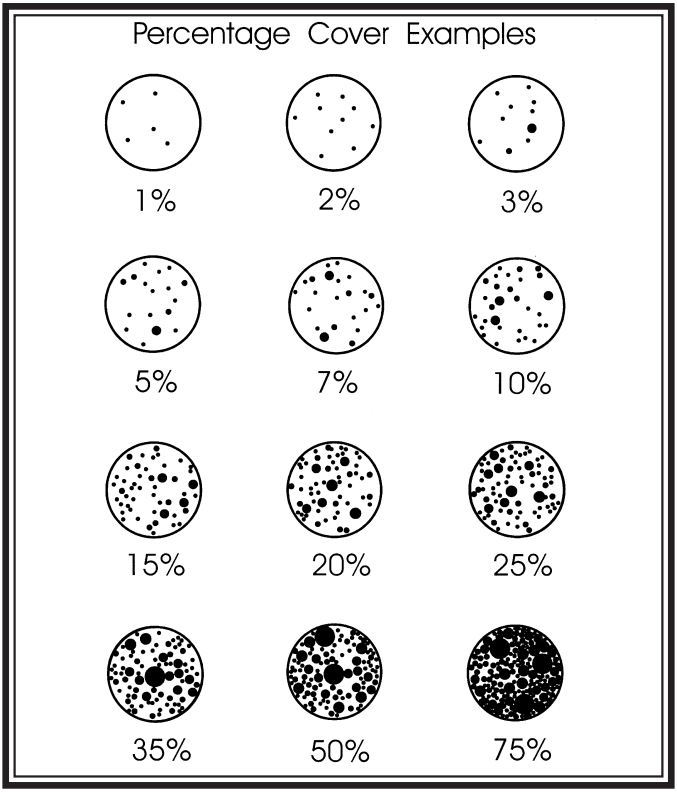


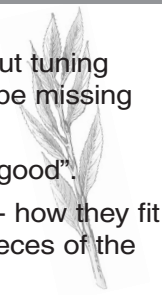
Figure 12: Cover class standards for judging vegetation canopy cover and bare soil

Most of the factors rated in this assessment are based on measurements using your eyes and your judgement. It may seem imprecise but with practice this method is repeatable and reasonably accurate. Extreme precision is not required for riparian health assessment since we are not attempting to determine an absolute value, only a broad impression of health.

RIPARIAN HINTS

Tuning your eye

- Riparian Health Assessment is about tuning your eye to see what pieces might be missing from a riparian system.
- It gets you beyond "if it's green, it's good".
- It helps you understand the pieces - how they fit together and how to rate the key pieces of the riparian area.



The maximum possible scores vary between the factors. This weighting system between the factors measured reflects the:

- relative importance of the factor;
- influence on or relationship to other factors; and
- significance of the factor to an ecological function or functions.

Things You Will Face

Move around

Don't stand in one place to do the assessment. You will need to move around the reach, evaluating factors and mentally accumulating observations that you will then sum up. If you stand in one spot you will end up with an assessment of only what you observed in a narrow sphere around you. This may not give you an accurate, unbiased assessment for the reach.

Consider riparian functions
If a question on a particular reach perplexes you, go back and reconsider "Riparian Functions". Ask yourself if the factor measured is contributing to ecological function. An example might be a site covered with weeds or disturbance species. Are these plants present on the reach during high water to reduce energy and trap sediment? Do these plants have the type of root systems that are deep and that bind streambank materials together? If the answer is no, then these plants do not contribute to ecological function and you should rate the site low for these categories.

Should it have wood or not?
Some questions on the assessment will not apply on all reaches. Reaches without potential for woody species (trees and shrubs) will not be rated on factors involving regeneration or utilization. On some prairie systems, on wet meadows with saturated soils, on severely disturbed riparian areas and on reaches with a history of chronic overuse, vegetation potential can be difficult to determine. To determine vegetation potential, where it is not immediately evident, you can:

- use the Classification and Management of Riparian and Wetland Sites;
- observe vegetation present upstream or downstream of the reach or search for stumps, snags (standing dead trees) or roots remaining on the site;
- consider vegetation present on similar reaches or nearby streams in the area;
- use archival photographs or pictures in family albums that indicate vegetation presence in previous times; and
- ask the elders of the community for their memories of woody species.

If, at the end of this evaluation, you conclude the reach has no potential for tree and shrub growth, eliminate questions 4, 5 and 6 and readjust the maximum possible total score accordingly. If the site does have potential, but no woody species are currently present, answer question 4, but eliminate questions 5 and 6.

Other considerations and observations

- No measurement system can capture all of the variation you are likely to encounter, nor will the categories in the questions exactly resemble what you see on the stream reach. You will have to select the answer you think is the closest, or the best fit, for the condition you observe.
- Because there is a spread between the scores you may be tempted to pick a number that reflects an average. The only choices for scores are those indicated. Make your best estimate and enter the value in the "actual" column of the Field Sheet.
- You must consider only the conditions that you observe at the time of the assessment. Don't guess on what conditions might have been previous to the assessment or speculate on future conditions.
- Don't stop when you've completed the scores. Make observations in the "Comments" section. Use the comments section to:
    - expand on the information and measurements, especially if you are considering making management changes;
    - describe the reach in some detail and provide some characteristics of the vegetation types or plant distribution, especially weeds;
    - note your impressions of grazing use, wildlife use, wildlife and fish observations, water clarity and flow stage;

- summarize the flood history of the reach, making note of time of high water and when the last major flood occurred;
- note the vulnerability or sensitivity of some sites or reaches; and
- make note of things happening outside the reach or beyond the riparian area, especially land uses that contribute to current condition or could affect future condition.

Take a photograph that captures the condition of the reach at the time of your evaluation. Include, in that photograph, a recognizable landmark that will allow you to retake the photograph in subsequent years.

These observations can help you relate current condition to management, especially as you track reach health over time.

Notes:

RIPARIAN HEALTH ASSESSMENT QUESTIONS (1-12)

1. How Much of the Riparian Area is Covered by Vegetation?

Vegetation cover of the floodplain and streambanks

Vegetation reduces the erosive forces of raindrop impacts and the velocity of water moving over the floodplain or along the streambanks. Vegetation cover also:

- traps sediment and stabilizes banks;
- absorbs and recycles nutrients;
- reduces the rate of evaporation; and
- provides shelter and forage values.

Vegetation cover is visually estimated using the canopy cover method. Use Figures 13-15 to help you estimate canopy cover on the reach.

Sediment deposited on the reach is considered "bare ground" for this question.

Scoring:

6 = More than 95% of the reach soil surface is covered by plant growth (less than 5% bare soil).

4 = 85% to 95% of the reach soil surface is covered by plant growth (5-15% bare soil).

2 = 75% to 85% of the reach soil surface is covered by plant growth (15-25% bare soil).

0 = Less than 75% of the reach soil surface is covered by plant growth (greater than 25% bare soil).

Scoring Tip: Soil not covered by plants, litter, moss, downed wood, or rocks larger than 6 cm (2.5 in) is considered bare ground. Count standing rooted, dead or living plants as vegetative cover.

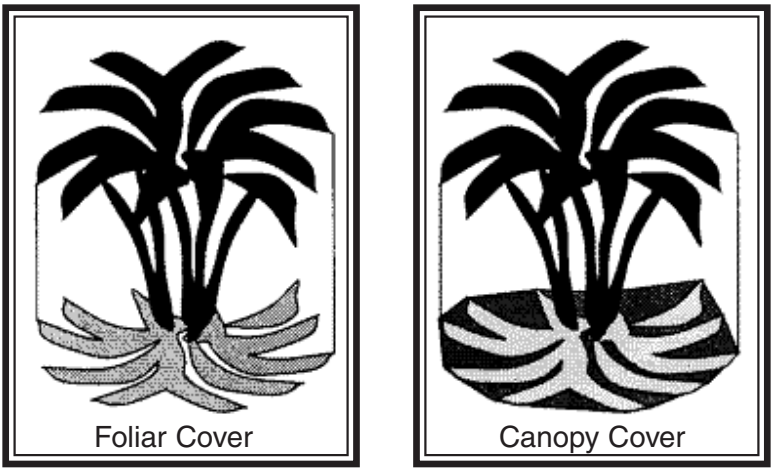


Figure 13: Foliar versus canopy cover

Imagine a line drawn about the leaf tips of the undisturbed canopies and project that coverage onto the ground. This projection is considered "canopy coverage".

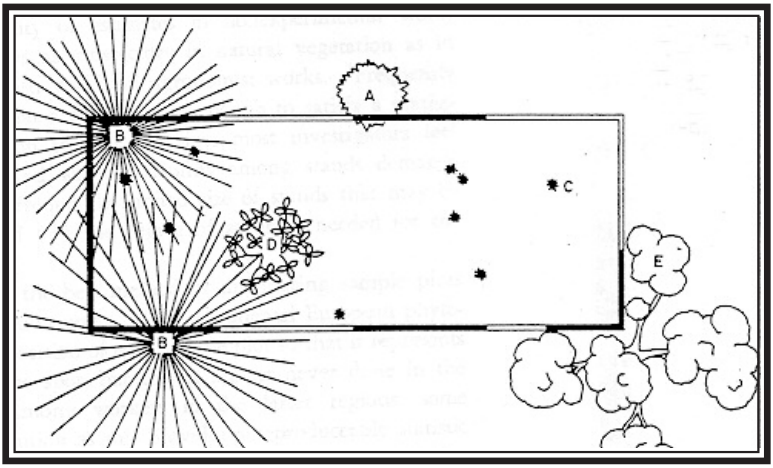


Figure 14: Estimation of vegetation canopy cover

Vegetation canopy cover is estimated for the riparian reach, in much the same way as for this plot frame. Imagine that you are observing the reach from above and estimate the vegetation canopy cover for all plant species combined. What percentage of the stream reach is covered by plant growth?

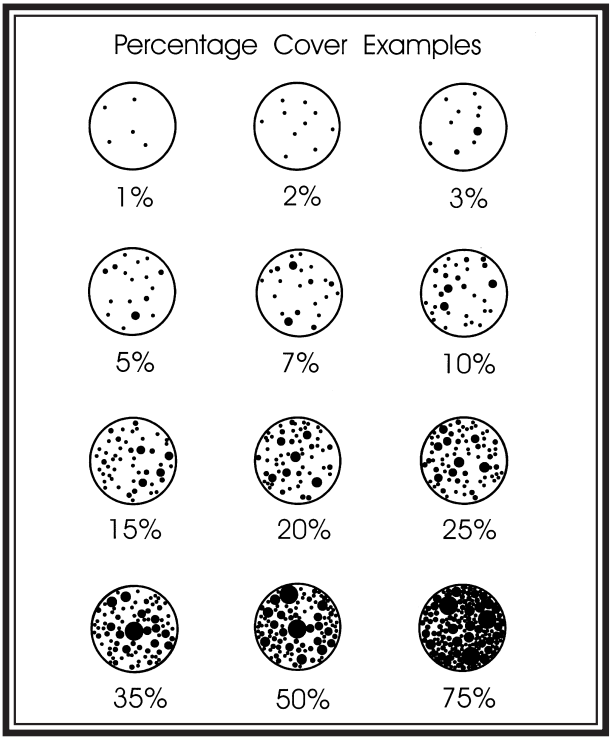


Figure 15: Cover standards from 1 t0 75% cover

RIPARIAN HINTS

Vegetation canopy protects soil

- Like a tent or umbrella, vegetation canopy protects streambanks and soil from the erosive impact of raindrops.
- It takes a lot of trees and shrubs to create this canopy over the ground.

2. How Much of the Riparian Area is Covered by Invasive Species?

Invasive species:

- are often introduced, i.e. non-native.
- are likely to cause economic and environmental harm.
- indicate a degraded ecosystem and are a general threat to riparian areas.
- may contribute to some riparian functions, but their negative impacts reduce the overall health of the riparian area.
- see Appendix 1 for more information about invasive species.

a) Canopy cover

The term canopy cover is used here to describe the area of the reach that is invaded by invasive plants and which therefore may be of concern to managers.

Record the name and canopy cover of each invasive plant species present throughout the reach. See Table 8 and Figure 16 for examples of invasive species and Appendix 2 for a complete list.

Scoring:

3 = No invasive plants on the reach.

2 = Invasive plants are present with a total canopy cover of less than 1% of the reach.

1 = Invasive plants are present with a total canopy cover of 1-15% of the reach.

0 = Invasive plants are present with a total canopy cover of more than 15% of the reach.

b) Distribution pattern

Use Table 7 to evaluate the distribution of invasive species throughout the reach.

Record the name and distribution pattern of each invasive plant species present throughout the reach. See Table 8 and Figure 16 for examples of invasive species and Appendix 2 for a complete list.

Scoring:

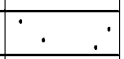
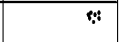
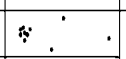
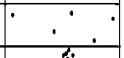
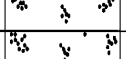
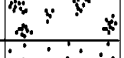
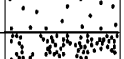
3 = No invasive plants on the reach.

2 = Invasive plants are present with a distribution pattern of 1-3.

1 = Invasive plants are present with a distribution pattern of 4-7.

0 = Invasive plants are present with a distribution pattern of 8 or higher.

Table 7: Score table of distribution patterns of invasive species

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

Scoring Tip 1: All invasive species are considered collectively, not individually.

Scoring Tip 2: Refer to Appendix 2 for a list of riparian invasive species in Saskatchewan.

Table 8: Examples of invasive species (see Appendix 2 for a complete list)

Common name	Latin name
common burdock	*Arctium minus*
smooth brome grass	*Bromus inermis*
nodding thistle	*Carduus nutans*
Canada thistle	*Cirsium arvense*
Russian Olive	*Elaeagnus angustifolia*
leafy spurge	*Euphorbia esula*
scentless chamomile	*Matricaria perforata*

Photo courtesy of Don Fontaine

Scentless chamomile

Photo courtesy of Don Fontaine

Leafy spurge

Photo courtesy of Steve Dewey, Utah State University, Bugwood.org

Canada thistle

Photo courtesy of Malin Hansen

Smooth brome

Figure 16: Examples of invasive species

RIPARIAN HINTS

What do invasive species tell us?

Invasive species normally provide a strong message about riparian health. Invasive species most often invade riparian areas where disturbance has resulted in available niche space such as bare soil or openings in the vegetation canopy. These micro-habitats are normally occupied by native plants, but are now available to invasive species due to over-grazing or some other land use or natural disturbance.

√ NO INVASIVE SPECIES
- Unable to establish, reach is well vegetated, no bare soil and no seed source

√ ONE INVASIVE SPECIES
- Potential for invasion, seeds are available

√ SEVERAL INVASIVE SPECIES
- Present threat for quick invasion
- Space is available for them to move in

√ MANY INVASIVE SPECIES
- System is degraded

3. How Much of the Riparian Area is Covered by Disturbance-caused Vegetation?

A large cover of disturbance-caused, undesirable herbaceous species, either native or introduced, indicates alteration of the normal plant community that would occur on the site.

- Like invasive species, disturbance-caused species are well adapted to an environment of continual stress, where the competitive advantage of better riparian species has been diminished.
- Their presence or abundance may indicate a long history of heavier grazing use.

These species may have some grazing value but tend:

- to be shallow rooted and less productive; and
- have limited value for bank binding and erosion prevention, especially if they are annuals.

Invasive species considered in the previous question **are not** reconsidered here.

- See Table 9 and Figure 17 for examples of disturbance-caused, undesirable herbaceous species.
- The species list in Appendix 2 will help you identify disturbance-caused, undesirable herbaceous species.

Scoring:

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

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

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

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

Table 9: Examples of disturbance-caused, undesirable herbaceous species (see Appendix 2 for a complete list).

Common name	Latin name
quack grass	*Elytrigia repens*
foxtail barley	*Hordeum jubatum*
Kentucky bluegrass	*Poa pratensis*
perennial sow-thistle	*Sonchus arvensis*
commom dandelion	*Taraxacum officinale*
stinkweed	*Thlaspi arvense*
clovers	*Trifolium* spp.

RIPARIAN HINTS

What are disturbance-caused species?

- Plants which are absent, or present in low amounts, in undisturbed areas but that invade reaches with continuous use.

Why are they a concern?

- They do a poor job of binding the soil and preventing erosion.
- They show a history of overuse.

Photo courtesy of Malin Hansen

Foxtail barley

Photo courtesy of Steve Dewey, Utah State University, Bugwood.org

Perennial sow-thistle

Photo courtesy of Malin Hansen

Common dandelion

Photo courtesy of Dean Wm. Taylor

Kentucky bluegrass

Figure 17: Examples of disturbance-caused undesirable herbaceous species

4. Is Woody Vegetation Present and Maintaining Itself?

Preferred tree and shrub establishment and regeneration

Most, but not all, riparian areas can support woody vegetation (trees and shrubs). Where trees and shrubs exist, they play an important role in riparian condition. Their root systems generally are excellent bank stabilizers and play a key role in the uptake of nutrients that could otherwise degrade water quality. The canopies formed by trees and shrubs protect soil from erosion, provide shelter to wildlife and livestock, and modify the riparian environment. Even when dead, the trunks provide erosion protection and structural complexity which play a role in modifying stream valleys. A good indicator of ecological stability of a riparian reach is the presence of woody plants in all age classes, especially young age classes. Without signs of regeneration of preferred woody plants (those species that contribute most to riparian condition and stability) the long-term stability of the reach is compromised.

Not all trees and shrubs are equally important, useful or desirable for maintaining ecological function. Several species of woody vegetation are excluded from this evaluation of establishment and regeneration. See Table 10 for a list of these species.

Why are they excluded?

- These species often reflect long-term disturbance of the reach.
- They tend to increase and predominate under long-term, heavier grazing pressure.
- There is rarely a problem in maintaining their presence on a reach.
- They are far more abundant on disturbance sites than are preferred woody species.
- Their abundance masks the ecological significance of the smaller amount of preferred species.

- They are generally small in height and have less shelter value.
- Their root systems may not be as capable of stabilizing banks and reducing erosion as those of preferred species.
- They are less palatable to browse users.
- In particular, for example, Russian olive and salt cedar are aggressive, invasive, undesirable exotic species.

For this question, first determine the total canopy cover of all preferred woody vegetation on the reach. Then estimate what percentage of the total canopy cover is composed of seedlings and saplings (the youngest age classes) following these guidelines:

For trees:
- consider seedlings to be up to 1.5 m (5 ft) tall with a stem diameter of up to 2.5 cm (1 in); and
- tree saplings could be greater than 1.5 m tall with a stem diameter up to 12.5 cm (5 in).

For shrubs:
- seedlings and saplings can be quite variable so consider relative heights to obvious mature plants; look for recent growth that is below your knee in height; these age classes will generally have stems less than the diameter of your thumb; they will be pliable compared with mature growth.

For woody plants in general:

- sometimes heavy browse use produces a plant with short stature; don't confuse these mature plants with seedling/sapling age classes; and
- growth and size of seedlings/saplings may be enhanced on some sites where growing conditions are ideal; look less at height and observe stem diameter and the pliable nature of the stems.

Scoring:

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 trees/shrubs is seedlings and saplings.

0 = Preferred tree/shrub seedlings or saplings absent.

Scoring Tip 1: If you have established that the reach has no potential for preferred woody vegetation (see page 33-34), replace the actual score and possible score with N/A and readjust the total score accordingly.

Scoring Tip 2: It takes a lot of seedlings/saplings to equal the canopy of one mature tree or shrub.

Table 10: Do not include these species when evaluating a reach for regeneration

Common Name	Latin Name	Category
snowberry/buckbrush	*Symphoricarpos* spp.	Shrub
rose	*Rosa* spp.	Shrub
hawthorn	*Crataegus* spp.	Shrub
shrubby cinquefoil	*Potentilla fruticosa*	Shrub
Russian olive	*Elaeagnus angustifolia*	Tree/Shrub
tamarisk/salt cedar	*Tamarix* spp.	Shrub
caragana	*Caragana* spp.	Shrub
European/common buckthorn	*Rhamnus cathartica*	Shrub

RIPARIAN HINTS

How to know if trees and shrubs belong here

- Use the Classification and Management of Riparian and Wetland Sites (Available online at www.swa.ca under stewardship publications).
- Look upstream or downstream at the next field or neighbouring property.
- Look at other similar stream reaches or streams nearby.
- Check for historical photos or in family albums.
- Ask the elders in the community for their memories of woody species.

Table 11: Examples of preferred trees and shrubs

Common Name	Latin Name	Category
green alder	*Alnus crispa*	Shrub
saskatoon	*Amelanchier alnifolia*	Shrub
bog birch/dwarf birch	*Betula glandulosa*	Shrub
birch	*Betula* spp.	Tree
red osier dogwood	*Cornus stolonifera*	Shrub
beaked hazelnut	*Corylus cornuta*	Shrub
honeysuckle	*Lonicera* spp.	Shrub
spruce	*Picea* spp.	Tree
balsam poplar	*Populus balsamifera*	Tree
cottonwood	*Populus deltoides*	Tree
aspen	*Populus tremuloides*	Tree
pin cherry	*Prunus pensylvanica*	Shrub
chokecherry	*Prunus virginiana*	Shrub
northern gooseberry	*Ribes oxyacanthoides*	Shrub
wild red raspberry	*Rubus idaeus*	Shrub
willows	*Salix* spp.	Shrub
buffaloberry	*Shepherdia* spp.	Shrub
common cranberry	*Vaccinium oxycoccus*	Shrub

5. Is Woody Vegetation Being Used?

Utilization of preferred trees and shrubs

Because woody species have such an important role to play in riparian health, measurements of the level of use helps us understand whether they will persist in the reach. Livestock will often browse woody plants, especially in late summer and fall. Wildlife, including beaver, make use of woody plants year-round. Woody plants can sustain low levels of use but heavier browsing can:

- deplete root reserves;
- inhibit establishment and regeneration;

- lead to replacement by less desirable woody species;
- cause the loss of preferred woody species; and
- lead to invasion by disturbance-caused or invasive species.

Not all woody species are palatable or used by animals. Some species do not contribute significantly to riparian condition and stability although some utilization may occur. Other species may persist under high use but are not good indicators to evaluate the effect of utilization. These species are excluded from this evaluation of utilization. See Table 12 on the next page for a list of these species.

To establish the amount of utilization:

- first, randomly pick 2 to 3 plants of each of the preferred woody species found on the reach. See Table 11 for a list of preferred species;
- for each plant, select a branch that would be available or accessible to browsing animals;
- count the total number of leaders (twigs) on the branch;
- now count only the older leaders (2nd year growth and older) that have been clipped off by browsing;
- determine the percentage of utilization by comparing the number of leaders browsed with the total number of leaders available on the branch; and
- do not count current year's use since an estimate in mid-season does not accurately reflect actual use, because browsing can continue year-round.

Scoring:

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 - Figure 18).

1 = Moderate (25% to 50% of available second year and older leaders of preferred species are browsed - Figure 18).

0 = Heavy (more than 50% of available second year and older leaders of preferred species are browsed - Figure 18).

Scoring Tip 1: If you have established that the reach has no potential for preferred woody vegetation (see page 33-34), replace the actual score and possible score with N/A and readjust the total score accordingly.

Scoring Tip 2: Beaver or people may cut an entire tree or shrub. If beaver cut stems are encountered, measure these as "heavy" utilization.

Scoring Tip 3: Long-term heavy use by livestock may result in umbrella-shaped shrubs. Count those as heavy utilization.

Table 12: Woody species excluded for utilization evaluation

Common Name	Latin Name	Category
snowberry/buckbrush	*Symphoricarpos* spp.	Shrub
rose	*Rosa* spp.	Shrub
hawthorn	*Crataegus* spp.	Shrub
shrubby cinquefoil	*Potentilla fruticosa*	Shrub
Russian olive	*Elaeagnus angustifolia*	Tree/Shrub
tamarisk/salt cedar	*Tamarix* spp.	Shrub
caragana	*Caragana* spp.	Shrub
European/common buckthorn	*Rhamnus cathartica*	Shrub

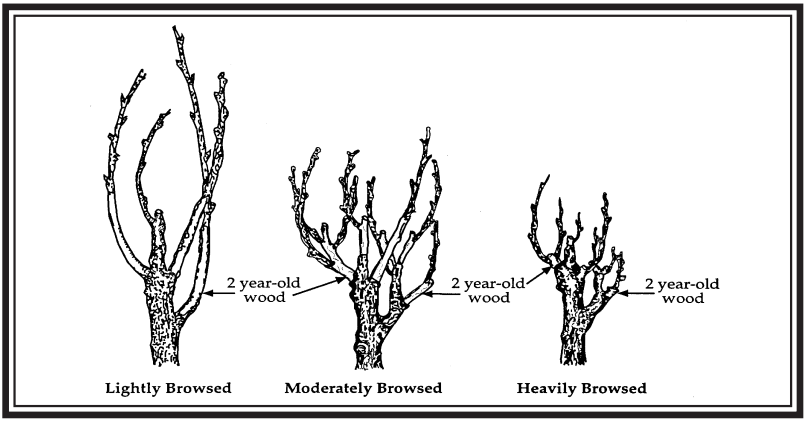


Figure 18: Browser utilization samples

RIPARIAN HINTS

Use affects woody plant vigour

- Light to moderate use helps plants maintain vigour
- Heavy use reduces vigour
- Long-term, heavy use eliminates the best woody plants

**** Like the old stockman's saying:***
"If you keep down the shoot, you kill the root."

6. How Much Dead Wood is There?

Standing decadent and dead woody material

The amount of decadent and dead wood can be a signal of declining health of a reach. The term decadent is used in the broader sense to include not only mature trees slowly dying but also younger age classes of woody vegetation affected by a number of factors:

- large amounts of decadent and dead wood may indicate a change in water flow through the system due to either human or natural causes;
- de-watering of a reach, if severe enough, can dry the reach, changing vegetation potential from riparian to upland species;
- flooding of a reach, or a persistent high water table, from beaver dams, crossings that restrict flow or man-made dams, can kill and eliminate some riparian species;
- chronic overuse of browse can stress woody plants resulting in their eventual death;
- physical damage from rubbing and trampling, if chronic, can result in the death of woody vegetation; and
- climatic impacts (drought), weather (severe winters), disease and insect infestations can affect woody vegetation.

In all these cases, a high percentage of decadent and dead wood reflects declining vegetation health which can lead to reduced streambank integrity, increased channel incisement, excessive bank erosion and reduced shelter values. Consider these categories:

- dead trees (snags) and shrubs that are still standing; and
- decadent trees and shrubs that show clear signs of stress with 30% or more dead branches in the upper canopy.

Healthy trees and shrubs will have some dead branches in their canopies, but are not considered in this question.

For this question, first assess the amount of **woody** canopy cover on the reach. Then estimate how much of that woody cover is **decadent** or **dead**. Figure 19 will help guide your estimation.

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 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.

Scoring Tip 1: If you have established that the reach has no potential for woody vegetation (see page 33-34), replace the actual score and possible score with N/A and readjust the total score accordingly.

Scoring Tip 2: Only standing decadent and dead material is included, not material lying flat on the ground.

Scoring Tip 3: Consider individual trees and shrubs, not the entire woody canopy, to answer this question.

Scoring Tip 4: Standing dead trees are important to cavity nesting birds, such as woodpeckers and chickadees.

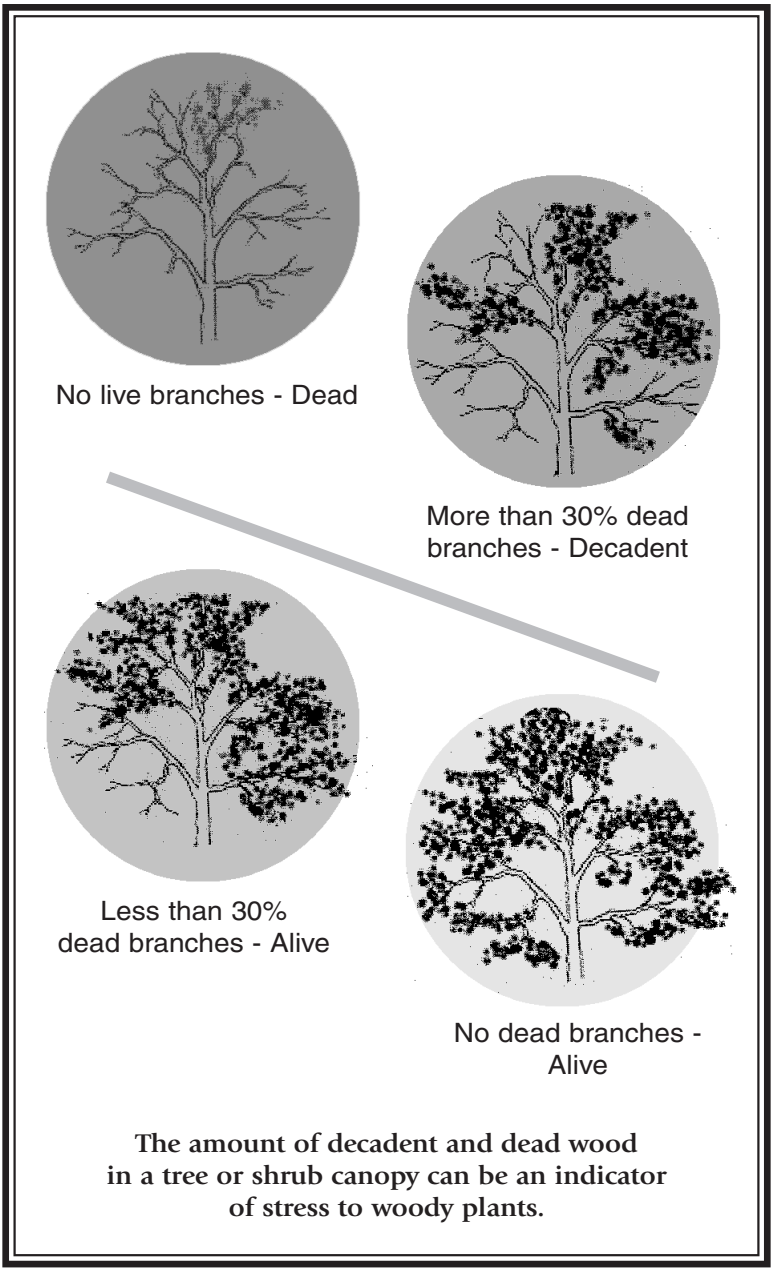


Figure 19: Amount of decadent and dead wood

7. Are the Streambanks Held Together With Deep-rooted Vegetation?

Streambank root mass protection

The role of streamside vegetation is to maintain the integrity and structure of the streambank by dissipating energy, resisting erosion and trapping sediment to build and restore banks. The root systems of plants bind substrate particles together and provide the "glue" that stabilizes the zone where stream flow and energy have the most consistent, regular effect. Vegetation with deep and binding roots best accomplishes this function, especially if there is a diversity of these species found on the reach. Review Figure 20 to distinguish the belowground attributes of streambank vegetation.

Most tree and shrub species provide deep roots. Herbaceous annuals, on the other hand, have shallow roots that will not bind substrate well. Perennial plants provide support to a varying degree. Some rhizomatous species, such as sedges, are excellent streambank stabilizers while others, such as Kentucky bluegrass and timothy, have shallow root systems and do not fulfill this key role. To consider the relative value of the vegetation present to perform this key function, you will need to consider the size of the stream, the gradient, soil/substrate makeup and flow/flood patterns. Table 13 will help you measure streambank root mass protection for the system you are assessing.

- Walk or observe both sides of the stream reach.
- Evaluate vegetation species from the toe of the slope (at the water's edge during normal low flow) to a variable distance beyond the top of the bank, onto the floodplain.

- The zone to consider extends from the normal low flow stage to where the water level would be at during flooding. On very high cutbanks, the zone to be evaluated does not extend into the upland, but rather measure root mass protection in the riparian area (this may only be near the bottom of tall cliffs). Plants that have deep, binding root mass should be present over that range:

  - on small rivers, evaluate up to 10 m (30 ft) on the floodplain;

  - on large streams, evaluate up to 5 m (15 ft) on the floodplain;

  - on small streams, evaluate up to 3 m (10 ft) on the floodplain; or

  - on intermittent drainages, evaluate up to 1 m (3 ft) on the floodplain.

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.

The following table is based on a large number of observations over a broad range of stream types.

Table 13: Streambank root mass protection

System Size	Trees	Preferred Shrubs	Other Shrubs	Native Grasses Forbs	Introduced Grass	Disturbance Species	Invasive Species
Small River	E	E/G	F/P	F/P	P	P	P
Large Stream	E	E	F/P	F	P	P	P
Small Stream	E	E	G	G	P	P	P
Intermittent Stream	E	E	E	E	G/F	P	P

Legend for Table:

E. Excellent - *these species have all the necessary properties of deep, binding and large root mass appropriate to stream size.*

G. Good - *species meet most of the requirements for holding streambank materials together.*

F. Fair - *marginal ability to perform stabilizing function based on high density of plants or presence of other preferred species.*

P. Poor - *vegetation unable to hold streambanks together under normal circumstances.*

Trees e.g.- *cottonwoods, aspen, poplar, conifers, birch*

Preferred Shrubs e.g.- *willows, saskatoon, dogwood, alder, silverberry, chokecherry, cranberry*

Other Shrubs e.g.- *rose, snowberry (buckbrush), shrubby cinquefoil*

Perennial Grasses, Forbs e.g.- *sedges, cattails, tufted hairgrass, other bunch grasses and sod-forming grasses*

Introduced Grasses e.g.- *Kentucky blue grass, timothy, smooth brome, quack grass*

Disturbance-caused species - *see Appendix 2*

Invasive species - *see Appendix 2*

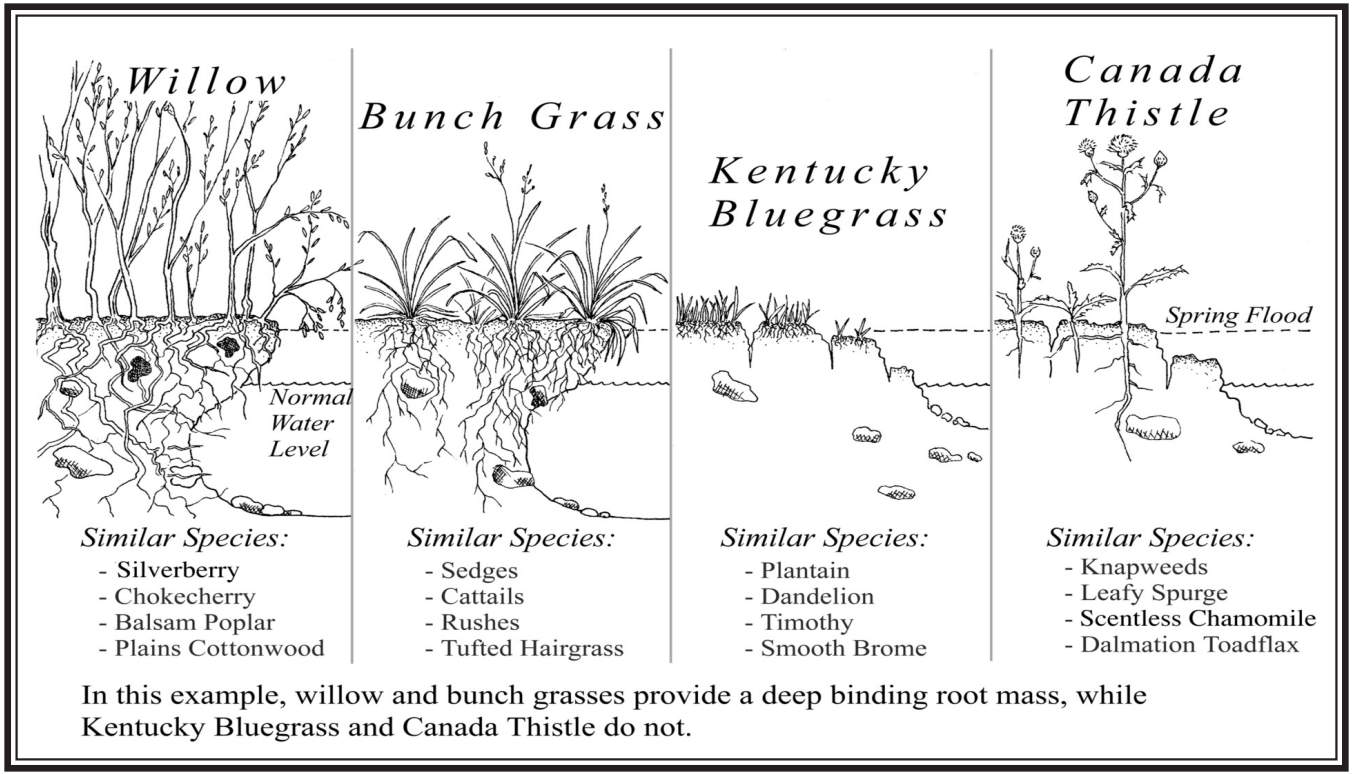


Figure 20: Below-ground attributes of streambank vegetation

8. How Much of the Riparian Area Has Bare Ground Caused by Human Activity?

Human-caused bare ground

Soil not covered by plants, litter, moss, downed wood or rocks larger than 6 cm (2.5 in) is considered bare ground. Bare ground is unprotected soil that is capable of being eroded by raindrops, overland flow or wind. Bare ground can exist under a tree or shrub canopy and still be subject to erosion from overland flow. It represents an opportunity for erosion and invasion by disturbance-caused or invasive species.

- Significant bare ground caused by human activity indicates a deterioration of riparian health.
- Bare ground resulting from natural events or processes, including erosion, deposition, landslides, wildlife, saline/alkaline areas and unvegetated channels in ephemeral streams, is excluded from this question.
- Human land uses causing bare ground include livestock grazing, cultivation, recreation, urban development (pavement, concrete), roads/trails, timber harvest and industrial activities.

Consider the entire riparian reach in this question. Estimate what percentage of the reach has human-caused bare ground using the cover standards illustration as a guide.

Scoring:

6 = Less than 1% of the reach is human-caused bare ground.

4 = 1% to 5% of the reach is human-caused bare ground.

2 = 5% to 15% of the reach is human-caused bare ground.

0 = More than 15% of the reach is human-caused bare ground.

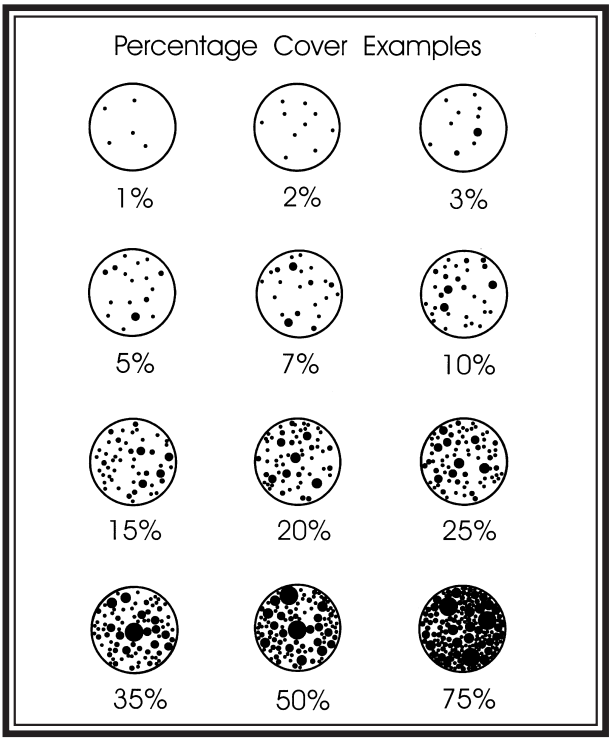


Figure 21: Cover standards for estimating percent bare ground

RIPARIAN HINTS

Estimating human-caused bare ground

- Vegetation canopy and bare ground measurements are interrelated. Before judging bare ground, go back and check your vegetation canopy estimate (see Question 1). Example: High vegetation canopy means low bare ground and low vegetation canopy may mean high bare ground.
- Human-caused bare ground does not include recent sediment deposition.

9. Have the Streambanks Been Altered by Human Activity?

Streambanks structurally altered by human activity

Stable streambanks maintain channel configuration, integrity and bank shape. When streambanks are physically altered, erosion can increase mobilizing channel and bank materials, water quality can deteriorate, and instability can increase within the reach and downstream.

- Bank alteration can result from livestock hoof shear, livestock trails/watering sites, recreational trails, flood/erosion control methods, irrigation diversions/ return flows, timber harvest, crossings/fords, bridges/ culverts, landscaping and channelization/drainage.
- Include pugging and hummocking on the banks (see definition on page 63 and Figure 24)
- Consider those direct **human** activities that have resulted in cracking, slumping, shearing, removal or reconfiguration of streambank materials that leave the streambank altered in shape, unstable or vulnerable.
- **Natural** slides, slumps and eroding banks are not considered in this question.

In rating this question, consider the bank area from the water's edge up to 0.5 m (20 in) 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. Include both sides of the stream reach.

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. Are Streambanks Subject to Active Lateral Cutting?

Streambank erosion

Lateral cutting refers to streambank erosion in which the stream is actively eroding the outside curves. Lateral cutting is, therefore, more common along meandering reaches than along straight reaches. Lateral erosion is evident by the presence of bare soil or rock.

A certain amount of active cutting and deposition is considered healthy, but excessive cutting indicates altered hydrology, altered vegetation or physical disturbance. Any lateral cutting occurring during the past year is considered active, however, cutbanks with vegetation establishing are considered healing and the cutting is no longer active.

Scoring:

6 = 5% or less of the reach displays active lateral cutting

4 = 5 -15% of the reach displays active lateral cutting

2 = 15 - 35 % of the reach displays active lateral cutting

0 = 35% or more of the reach displays active lateral cutting

Scoring Tip 1: Consider only one streambank in determining the total stream length which displays active lateral cutting.

Scoring Tip 2: Do not count deeply undercut, but stable, banks as active lateral cutting.

Photo courtesy of Tom Harrison

Figure 22: Example of lateral cutting

11. Is the Reach Compacted, Bumpy or Rutted From Use?

Human physical alterations to the reach (beyond the banks)

Changes in floodplain profile, shape, contour and soil structure due to human activities will alter infiltration of water, increase soil compaction and change the amount of sediment contributed to the waterbody. These changes reduce the water-holding abilities of the soil (the riparian "sponge"), thus impacting water storage and aquifer recharge (Figure 23). Filtration, nutrient uptake, floodplain maintenance and primary productivity may be altered as a result.

Soil compaction may be difficult to evaluate and is influenced by soil type. Include all physical alterations, such as pugging, hummocking, rutting, man-made surfaces (eg. compacted paths, pavement, buildings), constructed watercourse changes (eg. ditches, diversions, berms), soil tillage, addition of material (eg. fill, rip rap), landscaping, construction or other physical alterations. **Do not assess streambanks**, as they are assessed in Question 9.

Scoring:

3 = Less than 5% of the reach has been physically altered by human activity.

2 = 5% to 15% of the reach has been physically altered by human activity.

1 = 15% to 25% of the reach has been physically altered by human activity.

0 = More than 25% of the reach has been physically altered by human activity.

Hummocking and **pugging** (Figure 24) results from livestock hoof action (occasionally people or rarely wild ungulates). Pugs are the depressions hooves or feet leave in soft soil; hummocks are the raised humps of soil 15 cm (6 in) or higher that result from the soil being pushed up from the pug.

Rutting is considered compacted trails or ruts, usually 5 cm (2") or greater, from people, vehicles or livestock or highly managed ungulate populations (compacted and compressed soil is present).

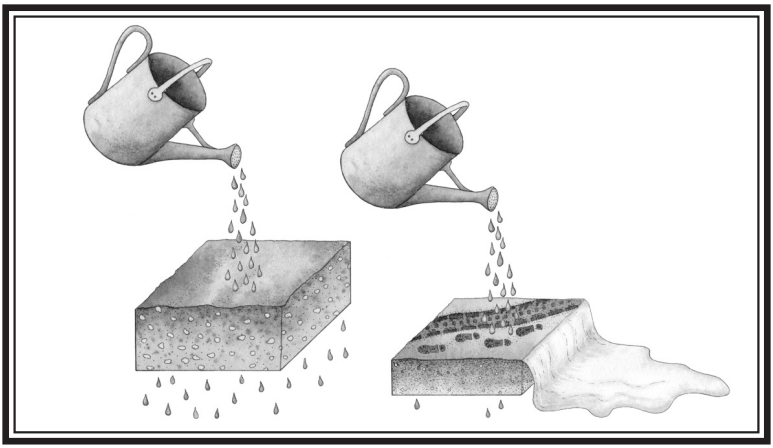


Figure 23: Compressing a sponge reduces the amount of water that can soak in. This principal applies to riparian areas as well.

Figure 24: Example of hummocking and pugging

12. Can the Stream Access its Floodplain?

Stream channel incisement (vertical stability)

Floodplains, the riparian area that lies beyond the stream channel, provide a safety valve that allows water in excess of what the channel can hold to escape into a wider area. Floodplains provide temporary storage for high water, slows down the water and reduces it's energy. Incisement, or downcutting, can limit the ability of the stream to access its

floodplain during high water events. Streams are incised when down-cutting has significantly lowered the channel so that the average two-year flood cannot escape the existing channel.

Incisement can result from:

- watershed-scale, cumulative effects of vegetation removal, drainage and roading which affect runoff.
- local drainage-scale changes including vegetation removal, dams, water additions, roading and culvert installations occurring upstream of the reach (and sometimes downstream).
- reach-scale changes including vegetation removal, beaver dam removal, channelization and culverts.
- natural events including landslides, beaver dam wash-outs and extreme flood events.

Incisement can result in:

- a reduced water table that affects current vegetation and the potential of the reach for some types of vegetation.
- increased stream energy with more erosion, sediment, and unstable banks which can persist downstream of the reach and potentially upstream as the stream readjusts.
- reduced water storage and retention leading to lower flows or flow ceasing during parts of the year.
- impairment in the ability of the reach to rebound from natural and human caused impacts.
- decreased productivity, forage, shelter and biodiversity values.

Incisement stages have been categorized by Rosgen (1996) (Appendix 5). His textbook or field guide may be useful materials to assist you in classifying your reach. These incisement stages range from unincised channels where high flow regularly spills onto the floodplain, to entrenched channels where water rarely escapes, possibly only during extreme flood events. Intermediate stages have slightly incised channels where the floodplain can be accessed but is relatively narrow. These intermediate stages represent streams in transition, either improving or degrading.

To rate the reach you are standing on you will need to:

- carefully consider the descriptions of the various stages.
- review Figures 26-31 and try to determine which stage best fits your reach, but remember that rarely will your reach look exactly like these figures.
- reflect on past flood history, not the extreme events, but the normally occurring high water events and levels.
- do some estimates of how much floodplain is available relative to the channel width of the stream.

The stages are often distinguished from one another based on the amount of floodplain width available relative to the stream channel width, at the bankfull stage. Bankfull is the point at which water begins to spill onto the floodplain. Review the instructions on page 29. Do the same eye estimates to establish the floodprone zone. What you will be comparing is the width of the stream channel, at the bankfull stage, with the width of the floodplain, from the bankfull edge to the outer edge of the floodprone zone on both sides of the stream. This estimation will help you understand if the floodplain is less than, equal to or greater than the bankfull channel width. The wider the floodplain is relative to the channel width, the greater the opportunity to store water and energy during high water events.

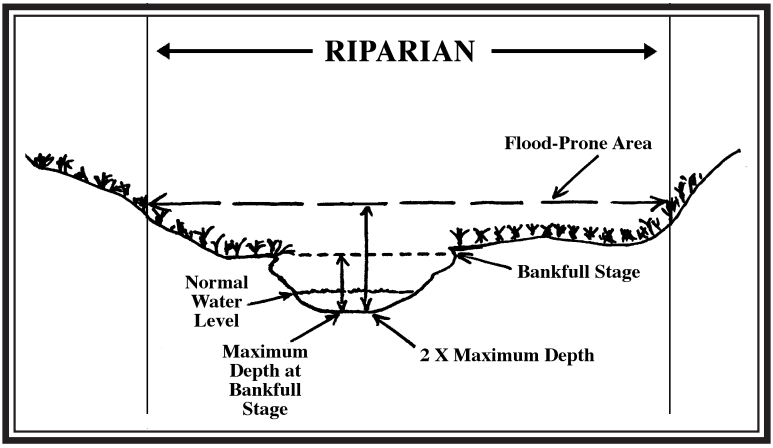


Figure 25: The floodplain area accessible to a stream.

If you are evaluating an intermittent or ephemeral stream with no visible, defined channel consider the following:

- these are systems that only flow for a few days (rarely weeks) in the spring or after a rain storm.
- the volume of flow is insufficient to create a visible, unvegetated channel.
- for these systems, if the width of the riparian area is vegetated with perennial forms, rate them as being vertically stable and unincised.

If you are evaluating a river with substantial flows and a wide channel, this question becomes difficult to answer. For systems of that size you should use the large river form to evaluate riparian health.

Scoring:

9 = **Stages 1a, 1b and 1c**. Channel vertically stable and not incised; 1-2 year flows access a flood-plain appropriate to stream size and flow volume. Active down cutting not evident. Any old incisement is now characterized by a broad floodplain inside which perennial riparian plant communities are well established.

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

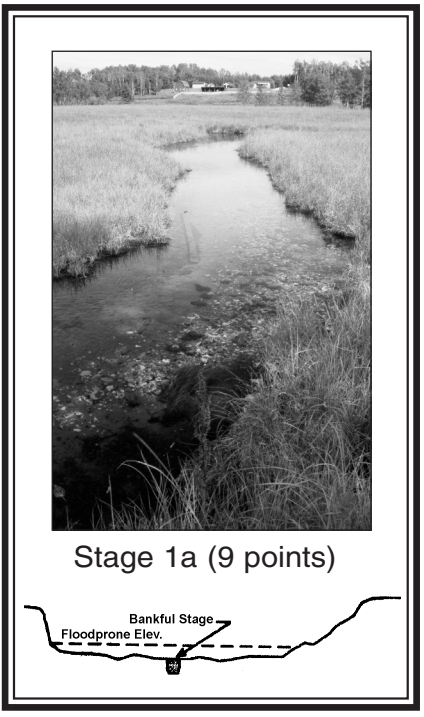


Figure 26: Stable meadow channel

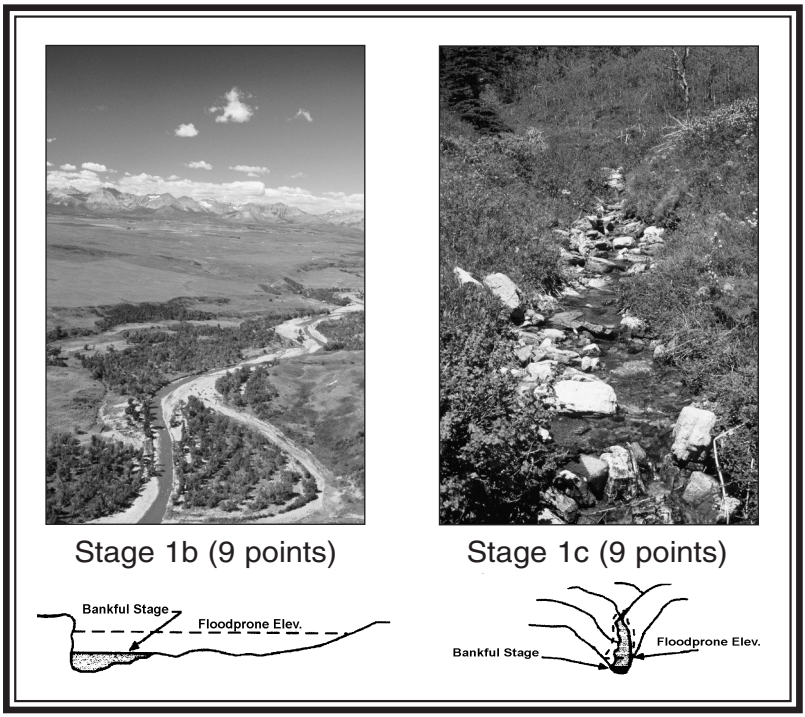


Figure 27: Stable wide valley channel and stable foothill channel

Stage 1b. A fairly stable, unincised, wide valley bottom channel with broad curves and point bars. These systems typically cut laterally on the outside of curves and deposit sediment on inside point bars, but bankfull flows (1-2 year events) still have access to a floodplain more than twice the bankfull channel width.

Stage 1c. A stable, unincised mountain or foothill channel with limited sinuosity (see glossary in Appendix 3 for definition) and slopes greater than 2%. These channels are well armored with bedrock, boulders and cobble and are not prone to downcutting. Although bankfull flow stage is reached every 1-2 years, the floodplain is often narrower than twice the bankfull channel width. Overflow conditions will not be as obvious as in 1a or 1b but armoring maintains the channel.

6 = Stage 2. Channel slightly incised. The 1-2 year high flow event can access only a narrow flood-plain less than or equal to twice the bankfull channel width. Perennial riparian vegetation is well established. This stage includes: (a) an improving phase that resembles 1a or 1b reestablishing in a narrower floodplain at a new, lower level; or (b) a degrading phase where a 1a is beginning to downcut into the existing floodplain.

3 = Stage 3. Channel moderately incised. The 1-2 year flows may not access the floodplain but higher flows (less than a 5-10 year event) can access a narrow floodplain less than twice the bankfull channel width. This stage includes: (a) deep incisements that are starting to heal. New floodplain development is present but is very limited. Channels are wide and shallow and unable to regularly (1-2 year event) access a floodplain. Some pioneer plants are beginning to establish on new sediment surfaces; or (b) an incisement that continues to downcut and cannot regularly access a floodplain.

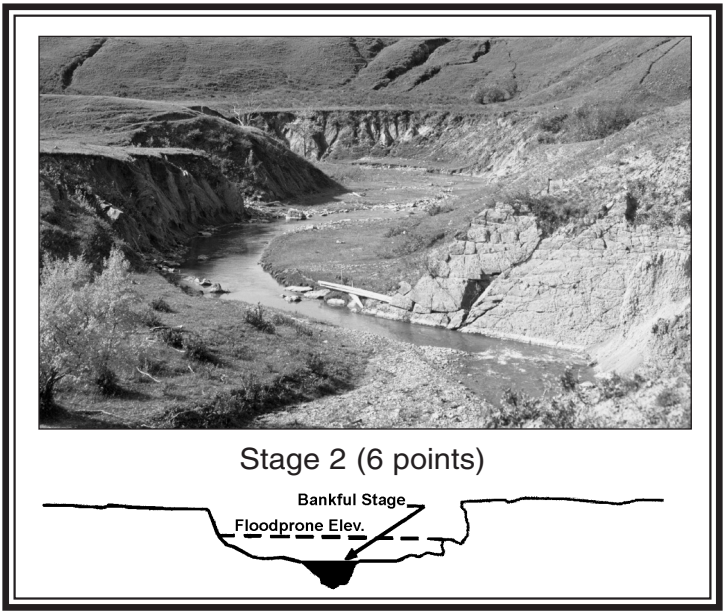


Figure 28: Slightly incised channel

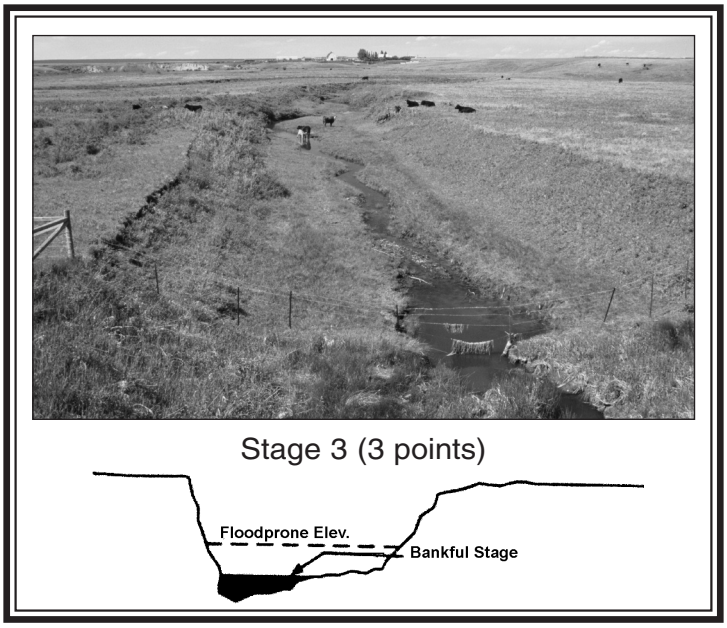


Figure 29: Moderately incised channel

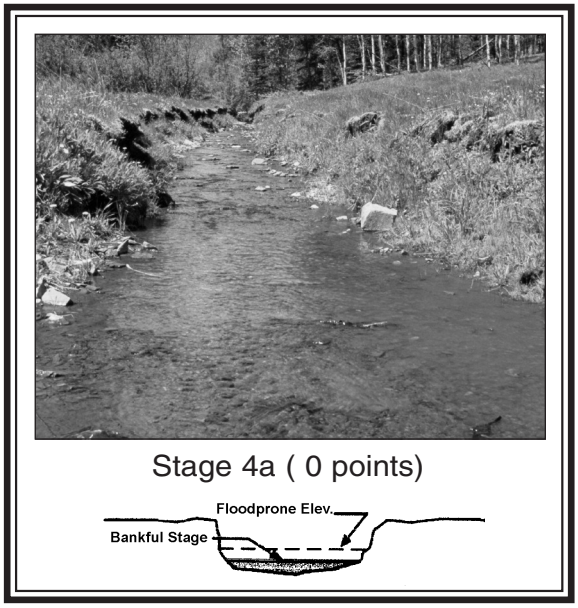


Figure 30: Deeply incised stream with a wide and shallow channel

0 = Stages 4a and 4b. Channel vertically unstable and deeply incised. Resembles a ditch or gully. Active downcutting is likely ongoing. Only extreme floods overtop the banks, and no floodplain development has begun.

Stage 4a. A deeply incised stream with a wide, shallow channel. Commonly found in fine substrates (sand, silt and clay). Banks are very erodible. Only limited vegetation, primarily pioneer species, is present.

Stage 4b. A narrow, deep "gully" system, downcut to the point where only the most extreme flood overtops the banks. Banks consist of fine materials which are constantly eroded. Vegetation is rarely present.

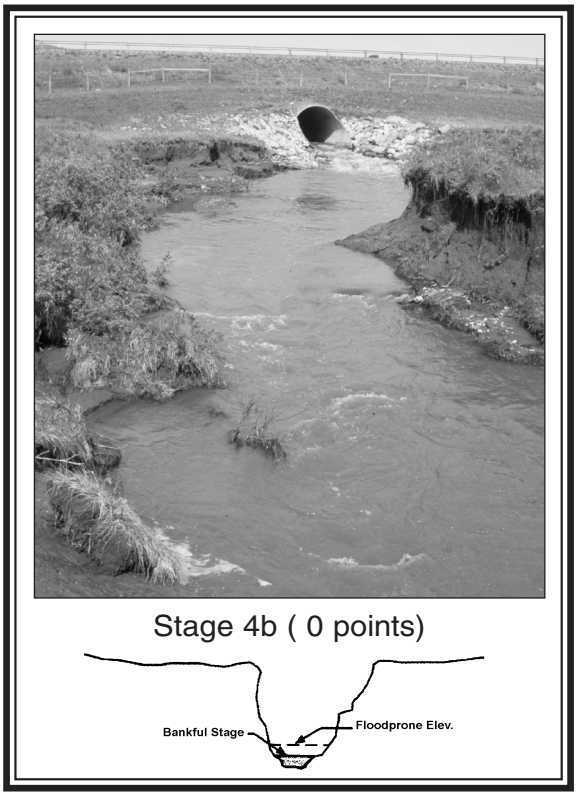


Figure 31: Severely incised channel with slumping streambanks

Riparian Health Assessment notes:

HOW TO USE THE FIELD SHEET

The following section includes a number of field sheets for you to record the results of your training exercise or to apply the riparian health assessment on your own land base (Additional field sheets can be obtained from www.pcap-sk.org and www.swa.ca). The field sheet provides a permanent record for future reference and monitoring. In addition to health scores, space is also available to record specific details of what you have observed.

For example:

- if preferred woody species are being browsed, note the species that show the heaviest use levels.
- list the species of invasive species or disturbance-caused species that you have observed and where they are located.
- extra space is provided on the back of the sheet for more detailed comments on any of the 12 questions.
- there is also space to make a small sketch of where the stream reach occurs in a particular pasture and to note where photographs may have been taken.
- another very important step is to consider the current management of the field you are in. This information should also be recorded and attached to the field sheet:
    - what is the current grazing intensity in the pasture (heavy, moderate, light)?
    - how long is the pasture grazed each year?
    - when are rest periods provided?
    - what livestock distribution tools are being used (salt, off-stream water, supplemental feed)?
    - if this is a cropped field, how is it managed?

Make sure to take several pictures of the reach and the streambank, as it will make it easier to remember the site and see changes over time.

How Do I Use the Results?

The field sheet knits together the 12 separate questions into one measure of riparian health. Go to the section "Interpreting Results" on page 85 to learn what the health scores tells you. Then you can take the first steps to apply the results of the health rating to your management practices.

RIPARIAN HINTS

What do healthy riparian areas do?
Key ecological functions

- Trap sediment
- Build and maintain streambanks
- Store flood water and energy
- Recharge the aquifer
- Filter and buffer water
- Reduce and dissipate stream energy
- Maintain biodiversity
- Create primary productivity

RIPARIAN HEALTH ASSESSMENT - FIELD SHEET

Landowner/lessee:_____ **Date:** _____ **Reach No:** _____

Stream/River: _____

Site Description:_____

_____

	Scores or N/A	
	Actual	*Possible*
1. Vegetative Cover of Floodplain and Streambanks		
6 4 2 0	____	____
2. Invasive Plant Species		
3 2 1 0 (cover)	____	____
3 2 1 0 (density)	____	____
3. Disturbance-increaser Undesirable Herbaceous Species		
3 2 1 0	____	____
4. Preferred Tree and Shrub Establishment and Regeneration		
6 4 2 0	____	____
5. Utilization of Preferred Trees and Shrubs		
3 2 1 0	____	____
6. Standing Decadent and Dead Woody Material		
3 2 1 0	____	____
7. Streambank Root Mass Protection		
6 4 2 0	____	____
8. Human-Caused Bare Ground		
6 4 2 0	____	____
9. Streambank Structurally Altered by Human Activity		
6 4 2 0	____	____
10. Streambank Subject to Active Lateral Cutting		
6 4 2 0	____	____
11. Reach Structurally Altered by Human Activity (excl. banks)		
3 2 1 0	____	____
12. Stream Channel Incisement (vertical stability)		
9 6 3 0	____	____
TOTAL	____	____

Health Score = Total actual score / Total possible score = _____

%	0-59	60-79	80-100
	← Unhealthy →	← Healthy With Problems →	← Healthy →

RIPARIAN HEALTH ASSESSMENT - FIELD SHEET

Comments

1. Vegetative Cover of Floodplain and Streambanks

2. Invasive Plant Species

3. Disturbance-Increaser Undesirable Herbaceous Species

4. Preferred Tree and Shrub Establishment and Regeneration

5. Utilization of Preferred Trees and Shrubs

6. Standing Decadent and Dead Woody Material

7. Streambank Root Mass Protection

8. Human-Caused Bare Ground

9. Streambank Structurally Altered by Human Activity

10. Streambank Subject to Active Lateral Cutting

11. Pugging, Hummocking and/or Rutting

12. Stream Channel Incisement (vertical stability)

Sketch stream reach here	*Show photo locations*

RIPARIAN HEALTH ASSESSMENT - FIELD SHEET

Landowner/lessee:_____ **Date:**_____ **Reach No:**_____

Stream/River: _____

Site Description:_____

_____

	Scores or N/A	
	Actual	*Possible*
1. Vegetative Cover of Floodplain and Streambanks		
6 4 2 0	____	____
2. Invasive Plant Species		
3 2 1 0 **(cover)**	____	____
3 2 1 0 **(density)**	____	____
3. Disturbance-increaser Undesirable Herbaceous Species		
3 2 1 0	____	____
4. Preferred Tree and Shrub Establishment and Regeneration		
6 4 2 0	____	____
5. Utilization of Preferred Trees and Shrubs		
3 2 1 0	____	____
6. Standing Decadent and Dead Woody Material		
3 2 1 0	____	____
7. Streambank Root Mass Protection		
6 4 2 0	____	____
8. Human-Caused Bare Ground		
6 4 2 0	____	____
9. Streambank Structurally Altered by Human Activity		
6 4 2 0	____	____
10. Streambank Subject to Active Lateral Cutting		
6 4 2 0	____	____
11. Reach Structurally Altered by Human Activity (excl. banks)		
3 2 1 0	____	____
12. Stream Channel Incisement (vertical stability)		
9 6 3 0	____	____
TOTAL	____	____

Health Score = Total actual score / Total possible score = _____

%	0-59	60-79	80-100
	← Unhealthy →	← Healthy With Problems →	← Healthy →

RIPARIAN HEALTH ASSESSMENT - FIELD SHEET

Comments

1. Vegetative Cover of Floodplain and Streambanks

2. Invasive Plant Species

3. Disturbance-Increaser Undesirable Herbaceous Species

4. Preferred Tree and Shrub Establishment and Regeneration

5. Utilization of Preferred Trees and Shrubs

6. Standing Decadent and Dead Woody Material

7. Streambank Root Mass Protection

8. Human-Caused Bare Ground

9. Streambank Structurally Altered by Human Activity

10. Streambank Subject to Active Lateral Cutting

11. Pugging, Hummocking and/or Rutting

12. Stream Channel Incisement (vertical stability)

Sketch stream reach here	*Show photo locations*

RIPARIAN HEALTH ASSESSMENT - FIELD SHEET

Landowner/lessee:_____ **Date:**_____ **Reach No:**_____

Stream/River: _____

Site Description:_____

_____

	Scores or N/A	
	Actual	*Possible*
1. Vegetative Cover of Floodplain and Streambanks		
6 4 2 0	____	____
2. Invasive Plant Species		
3 2 1 0 **(cover)**	____	____
3 2 1 0 **(density)**	____	____
3. Disturbance-increaser Undesirable Herbaceous Species		
3 2 1 0	____	____
4. Preferred Tree and Shrub Establishment and Regeneration		
6 4 2 0	____	____
5. Utilization of Preferred Trees and Shrubs		
3 2 1 0	____	____
6. Standing Decadent and Dead Woody Material		
3 2 1 0	____	____
7. Streambank Root Mass Protection		
6 4 2 0	____	____
8. Human-Caused Bare Ground		
6 4 2 0	____	____
9. Streambank Structurally Altered by Human Activity		
6 4 2 0	____	____
10. Streambank Subject to Active Lateral Cutting		
6 4 2 0	____	____
11. Reach Structurally Altered by Human Activity (excl. banks)		
3 2 1 0	____	____
12. Stream Channel Incisement (vertical stability)		
9 6 3 0	____	____
TOTAL	____	____

Health Score = Total actual score / Total possible score = _____

%	0-59	60-79	80-100
	← Unhealthy →	← Healthy With Problems →	← Healthy →

RIPARIAN HEALTH ASSESSMENT - FIELD SHEET

Comments

1. Vegetative Cover of Floodplain and Streambanks

2. Invasive Plant Species

3. Disturbance-Increaser Undesirable Herbaceous Species

4. Preferred Tree and Shrub Establishment and Regeneration

5. Utilization of Preferred Trees and Shrubs

6. Standing Decadent and Dead Woody Material

7. Streambank Root Mass Protection

8. Human-Caused Bare Ground

9. Streambank Structurally Altered by Human Activity

10. Streambank Subject to Active Lateral Cutting

11. Pugging, Hummocking and/or Rutting

12. Stream Channel Incisement (vertical stability)

Sketch stream reach here	*Show photo locations*

RIPARIAN HEALTH ASSESSMENT - FIELD SHEET

Landowner/lessee:_____ **Date:**_____ **Reach No:**_____

Stream/River: _____

Site Description:_____

_____

	Scores or N/A	
	Actual	*Possible*
1. Vegetative Cover of Floodplain and Streambanks		
6 4 2 0	____	____
2. Invasive Plant Species		
3 2 1 0 (cover)	____	____
3 2 1 0 (density)	____	____
3. Disturbance-increaser Undesirable Herbaceous Species		
3 2 1 0	____	____
4. Preferred Tree and Shrub Establishment and Regeneration		
6 4 2 0	____	____
5. Utilization of Preferred Trees and Shrubs		
3 2 1 0	____	____
6. Standing Decadent and Dead Woody Material		
3 2 1 0	____	____
7. Streambank Root Mass Protection		
6 4 2 0	____	____
8. Human-Caused Bare Ground		
6 4 2 0	____	____
9. Streambank Structurally Altered by Human Activity		
6 4 2 0	____	____
10. Streambank Subject to Active Lateral Cutting		
6 4 2 0	____	____
11. Reach Structurally Altered by Human Activity (excl. banks)		
3 2 1 0	____	____
12. Stream Channel Incisement (vertical stability)		
9 6 3 0	____	____
TOTAL	____	____

Health Score = Total actual score / Total possible score = _____

%	0-59	60-79	80-100
	← Unhealthy →	← Healthy With Problems →	← Healthy →

RIPARIAN HEALTH ASSESSMENT - FIELD SHEET

Comments

1. Vegetative Cover of Floodplain and Streambanks

2. Invasive Plant Species

3. Disturbance-Increaser Undesirable Herbaceous Species

4. Preferred Tree and Shrub Establishment and Regeneration

5. Utilization of Preferred Trees and Shrubs

6. Standing Decadent and Dead Woody Material

7. Streambank Root Mass Protection

8. Human-Caused Bare Ground

9. Streambank Structurally Altered by Human Activity

10. Streambank Subject to Active Lateral Cutting

11. Pugging, Hummocking and/or Rutting

12. Stream Channel Incisement (vertical stability)

Sketch stream reach here	*Show photo locations*

RIPARIAN HEALTH ASSESSMENT - FIELD SHEET

Landowner/lessee:_____ **Date:**_____ **Reach No:**_____

Stream/River: _____

Site Description:_____

_____

	Scores or N/A	
	Actual	*Possible*
1. Vegetative Cover of Floodplain and Streambanks		
6 4 2 0	____	____
2. Invasive Plant Species		
3 2 1 0 **(cover)**	____	____
3 2 1 0 **(density)**	____	____
3. Disturbance-increaser Undesirable Herbaceous Species		
3 2 1 0	____	____
4. Preferred Tree and Shrub Establishment and Regeneration		
6 4 2 0	____	____
5. Utilization of Preferred Trees and Shrubs		
3 2 1 0	____	____
6. Standing Decadent and Dead Woody Material		
3 2 1 0	____	____
7. Streambank Root Mass Protection		
6 4 2 0	____	____
8. Human-Caused Bare Ground		
6 4 2 0	____	____
9. Streambank Structurally Altered by Human Activity		
6 4 2 0	____	____
10. Streambank Subject to Active Lateral Cutting		
6 4 2 0	____	____
11. Reach Structurally Altered by Human Activity (excl. banks)		
3 2 1 0	____	____
12. Stream Channel Incisement (vertical stability)		
9 6 3 0	____	____
TOTAL	____	____

Health Score = Total actual score / Total possible score = _____

%	0-59	60-79	80-100
	← Unhealthy →	← Healthy With Problems →	← Healthy →

RIPARIAN HEALTH ASSESSMENT - FIELD SHEET

Comments

1. Vegetative Cover of Floodplain and Streambanks

_____

2. Invasive Plant Species

_____

3. Disturbance-Increaser Undesirable Herbaceous Species

_____

4. Preferred Tree and Shrub Establishment and Regeneration

_____

5. Utilization of Preferred Trees and Shrubs

_____

6. Standing Decadent and Dead Woody Material

_____

7. Streambank Root Mass Protection

_____

8. Human-Caused Bare Ground

_____

9. Streambank Structurally Altered by Human Activity

_____

10. Streambank Subject to Active Lateral Cutting

_____

11. Pugging, Hummocking and/or Rutting

_____

12. Stream Channel Incisement (vertical stability)

_____

Sketch stream reach here	*Show photo locations*

INTERPRETING RESULTS
What to Do When You Finish the Assessment

What does the health score mean?

The riparian health score is a cumulative measure of the 12 factors that you have considered on the reach you selected. If you picked a critical reach, the score is the condition for a short stretch of stream you thought might have problems, be sensitive to use or had some other values. If you picked a representative reach, the score is the average condition for a long stretch of the stream, within one pasture or management unit. Note that the questions can have different possible scores. This gives questions a different weighting factor depending on what they are considered to contribute to a healthy functioning system.

When you have added up the scores for the individual questions to get a total score, calculate what the percentage is, based on the total possible score. The range on the bottom of the score sheet will help you to do this. The score you have derived for the reach falls into one of those categories. These categories (healthy, healthy but with problems, and unhealthy) describe the reach condition and the reach's ability to perform riparian functions.

What do the health categories tell me?

- A health score of 80% or greater means the reach has scored in the top category called "**healthy**". This tells you that all riparian functions are being performed and the reach exhibits a high level of riparian condition. Healthy, functioning riparian areas are resilient, provide a long list of benefits and values, and are stable.
- A health score between 60 and 79% puts the reach in the "**healthy but with problems**" category. Many riparian functions are still being performed, but some clear signs of stress are apparent. The reach may not be as capable of rebounding from floods and use,

it may be vulnerable to erosion and some of the potential of the riparian area has been lost. This is like an amber warning light that there could be problems ahead and management changes should be actively considered. At the same time, with effective management changes, it is likely that a return to a healthier condition is within your grasp.

- A health score of less than 60% means the reach is in an "**unhealthy**" category. Most riparian functions are severely impaired or have been lost. The reach has lost most of its resiliency, stability is compromised and much of the potential of the riparian area has been sacrificed. At this point, red lights are flashing and we need to stop and reflect on current management. Immediate changes are necessary to keep the reach from declining further and to begin the process of healing and restoration.

What should our goals be for riparian area health? Clearly, we all want these landscapes to be resilient and stable, and provide us with a long list of ecological services, whether we are livestock producers, farmers, anglers, bird watchers, hikers or downstream water drinkers. Riparian health can vary across the province, from stream to stream and within single drainages, ranging from healthy to unhealthy. Some of this variation relates to how riparian landscapes have evolved. Natural disturbances like floods, grazing from native ungulates, fire, drought, beavers and landslides have always affected riparian condition. The results of these disturbances meant health could vary over time and from reach to reach. Because of the natural resilience of these systems, however, it is likely that ecological function was restored relatively quickly. Our use of these landscapes represents an additive and cumulative effect which has often compromised resilience. That could be a consequence of what has happened on the reach or what has happened upstream or downstream of the reach. Additional variation in health conditions can be attributed to our use of riparian areas and, in some cases, that use has lead to a decline in condition.

Consider these general goals for riparian area health:

- we need to quickly stabilize the number and length of reaches in an "unhealthy" category and actively restore them to a better condition.

There may always be a small percentage of sites in this category. The occasional crossing site, pressure point or naturally unstable bank may not contribute to an overall decline in reach health or make the reach more vulnerable to floods and other disturbance events. When these sites are the exception and not the general average for a stream, the resilient tendency of the reach compensates.

- We want to carefully watch and actively manage those reaches in a "healthy but with problems" category.

This category could include the majority of Saskatchewan's riparian areas. The economic, environmental and social values of these areas are high and we don't want to become complacent about their condition. Active management implies monitoring. We should ensure that the trend over time is positive, indicating improvement in reach conditions.

- We must keep "healthy" reaches intact, learn from the management that maintains them and apply that knowledge to other areas that are not in as good a condition.
- We need to recognize the most powerful restoration tool we have at our disposal is the natural resilience of these riparian systems, especially the vegetation components.

If we can recognize the stresses, reduce the pressures, be patient and let the system rebound, condition will improve, assuming most of the key pieces are still intact. If some of those key pieces (like woody vegetation) have gone missing restoration will be difficult and time consuming.

- We not only need to consider the reaches we stand on, we also need to look upstream and downstream.

Often, we can improve or maintain health with reach management but sometimes, because of distant effects, we need to work with our neighbours, within our communities and at a watershed level to reach our goals.

Using health scores to plan management objectives

Take time to review the overall health score and the rating for each of the 12 questions.

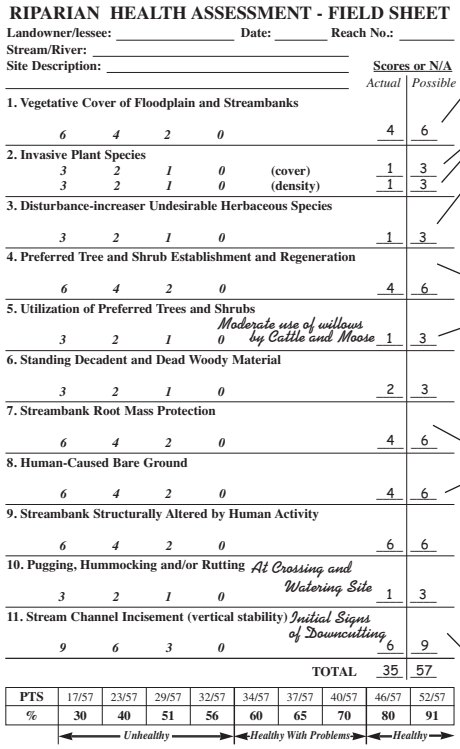
- The total score will tell you if riparian health is good (healthy), if there is cause for concern (healthy but with problems) or if there exists a need for urgent action (unhealthy).
- The scores for individual questions will help you to recognize the riparian "pieces" that have gone missing from the riparian reach.

Sedge Wren
Illustration by Chris Jordison

A sample field sheet

This sample reach on the Smith Ranch receives an overall rating of 61% based on an actual score of 35 points out of a possible score of 57 points (35/57 x 100 = 61%). This score puts the stream reach in the "healthy but with problems" category – most riparian functions are being performed, but signs of stress are evident.

- In this example, all questions apply and have been scored.
- Review the captions on the example worksheet to see what each score tells you about riparian health.



RIPARIAN HEALTH ASSESSMENT - FIELD SHEET

Landowner/lessee: _____ **Date:** _____ **Reach No.:** _____

Stream/River: _____

Site Description: _____

	Scores or N/A	
	Actual	*Possible*
1. Vegetative Cover of Floodplain and Streambanks		
6 4 2 0	4	6
2. Invasive Plant Species		
3 2 1 0 (cover)	1	3
3 2 1 0 (density)	1	3
3. Disturbance-increaser Undesirable Herbaceous Species		
3 2 1 0	1	3
4. Preferred Tree and Shrub Establishment and Regeneration		
6 4 2 0	4	6
5. Utilization of Preferred Trees and Shrubs		
3 2 1 0 — *Moderate use of willows by Cattle and Moose*	1	3
6. Standing Decadent and Dead Woody Material		
3 2 1 0	2	3
7. Streambank Root Mass Protection		
6 4 2 0	4	6
8. Human-Caused Bare Ground		
6 4 2 0	4	6
9. Streambank Structurally Altered by Human Activity		
6 4 2 0	6	6
10. Pugging, Hummocking and/or Rutting — *At Crossing and Watering Site*		
3 2 1 0	1	3
11. Stream Channel Incisement (vertical stability) — *Initial Signs of Downcutting*		
9 6 3 0	6	9
TOTAL	35	57

PTS	17/57	23/57	29/57	32/57	34/57	37/57	40/57	46/57	52/57
%	30	40	51	56	60	65	70	80	91
	← *Unhealthy* →				← *Healthy With Problems* →			← *Healthy* →	

Vegetation canopy is reduced (question 1) and weeds and disturbance species (questions 2 & 3) have increased in abundance on the site

Shrub species are regenerating quite well (question 4) but utilization of these species may be getting too high to sustain regeneration in the future (question 5)

Questions 7 and 8 show the early stages of decline in deep binding root mass and an increase in human-caused bare ground and potential for erosion

Livestock are exerting physical impact at crossings and watering points (question 10). The stream is still able to access its flood plain (question 11) but early signs of down-cutting are apparent

If the stress on this reach continues, there is a risk of losing several riparian functions.

Riparian health scores and grazing management

The most important aspect of riparian health assessment is to use the scores to help you formulate management changes. A few examples are provided here.

- **Example 1** A wintering site may score very low on question 4 (woody regeneration) and question 5 (woody utilization), yet have mid-range to high scores for all other questions. This result alerts the manager to the loss of woody species that are so critical for bank binding, yet so vulnerable to winter browsing. Can changes be made to grazing season or the use and placement of supplemental feeds to help woody species regenerate? (see **Streambank Stewardship: Your guide to caring for Riparian areas in Saskatchewan available from www.swa.ca**)
- **Example 2** A pasture scores in the "healthy but with problems" category, with the score for question 9 (stream bank alteration) and question 11 (pugging and hummocking) receiving the lowest scores. With generally higher scores in other categories, this may alert the manager to the fact that livestock use of the riparian area is mostly for water. Stock impact is, therefore, mostly confined to physical pressure with little effect on vegetation from grazing. Perhaps off-stream water can be supplied to reduce the physical impacts.

Figure 32: Example of off-stream water supply

RIPARIAN HINTS

What do the health scores tell me?
Is my crick sick? Take a reading...

If the score is 80 or higher . . .

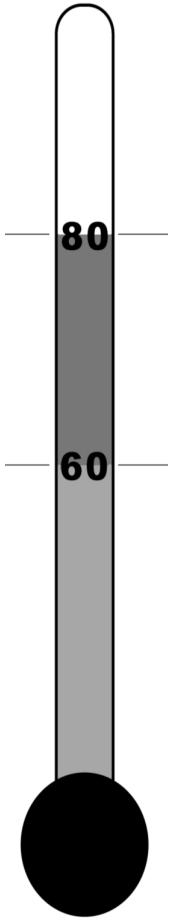
- Congratulations!
- This score means that your riparian area is performing the functions you want it to.
- You should make a record of your present management practices for future reference and share that information with others.

If the score is between 60 and 80 . . .

- Many riparian functions are still being performed, but your riparian area is showing signs of stress.
- Time to start paying attention to management practices on this site.

If the score is less than 60 . . .

- This riparian area needs attention!
- Who can you contact for advice? See contact list in Appendix 4.
- What are the main areas of concern? - Woody species, weeds, bare soils?
- What can you do to change management? - More rest, off-stream water, rotational grazing, fencing?



CREDITS

Illustrations on pages 54 and 57 by Elizabeth Saunders, Sandpiper Environmental Consultants, Monarch, Alberta.

Illustrations on pages 3, 10, 12, 13, 14, 15, 23, 35, 88 and 92 by Chris Jordison, Coventry Design, Regina, Saskatchewan.

Illustration on page 74 by Rhondi Taylor-Davis.

Figures on pages 26, 28, 51, 65, 67, 68, 69, 70 and 71 adapted from: Hansen et al. 2000.

Figure concept on page 29 and 61 by Lorne Fitch, ASRD (Alberta Sustainable Resource Development), Lethbridge, Alberta.

Figures on pages 31, 39 and 56 by Colin Stone, Public Lands Division, ASRD, Peace River, Alberta.

Figures on page 38, reprinted from: Daubenmire, R. 1959. **A canopy-coverage method of vegetational analysis.** Northwest Science 33: 43-64.

Figure on page 41 by Darlene Moisey, Public Lands Division, ASRD, Lethbridge, Alberta.

Field sheet concepts on pages 75 to 84 by Barry Adams, ASRD, Lethbridge, Alberta.

APPENDIX 1

Invasive and Disturbance-caused Species in Riparian Areas

This riparian health assessment workbook distinguishes between invasive species and disturbance-caused species.

1. Invasive species are considered a larger threat to agricultural and natural systems than disturbance-caused species since they are likely to rapidly invade native vegetation, crop or pastures once established. Invasive species are divided into noxious and non-noxious species. Noxious species are regulated by the *Saskatchewan Noxious Weeds Act*, (accessible online at: www.qp.gov.sk.ca/documents/English/Statutes/Statutes/N9-1.pdf), which states that "Every owner or occupant of land shall destroy noxious weeds on his land and prevent the spread of noxious weeds to other lands."

2. Disturbance-caused species are undesirable plants that are promoted by disturbance and often indicate human-caused alteration of the natural plant community. Some disturbance-caused species are considered noxious and regulated by the *Noxious Weeds Act*. Disturbance-caused species may not invade, but are often very persistent and highly competitive and therefore often prevent desirable species from colonizing. In addition, disturbance-caused species often have shallow roots and do not provide deep-binding root mass for bank protection. These species are, therefore, linked to reduced riparian function and health.

Species list

The species list (Appendix 2) contains plant species that are considered invasive or disturbance-caused in Saskatchewan. In order to accurately determine the health of a riparian area the assessor needs to be familiar with the species on the list. It is, therefore, essential to consult the list before conducting an assessment. The designation of weeds differs among provinces and among habitats, so it is imperative to use this list if conducting riparian assessments in Saskatchewan.

How to use the species list
The list of designated weeds is based on Saskatchewan Ministry of Environment and Saskatchewan Ministry of Agriculture weed regulations and the *Saskatchewan Noxious Weeds Act*. The list is the most current list as of 2007, but since the list is updated on an ongoing basis it is a good practice to contact a local agricultural representative or ecologist to confirm weed designations before conducting an assessment.

To simplify the use of the species list, species have been divided into invasive and disturbance-caused plant species:

I: Invasive plant species. These species are likely to invade native vegetation and alter ecological functions, and should be treated as invasive plant species when conducting assessments.

D: Disturbance-caused plant species. These species indicate disturbed vegetation and altered ecological functions, and should be treated as disturbance-caused plant species when conducting assessments.

The species list also indicates if species are noxious:

N: Noxious plant species. These species are regulated under the *Saskatchewan Noxious Weeds Act* and should be treated as invasive plant species when conducting assessments.

Photo courtesy of Patrick Breen, Oregon State University, Bugwood.org

Russian olive (Invasive) *Elaeagnus angustifolia*

Photo courtesy of Don Fontaine

Russian knapweed (Invasive) *Acroptilon repens*

APPENDIX 2

Invasive & Disturbance-caused Species List

Scientific Name	Common Name	Growth Form	Category	Noxious
Abutilon theophrasti	velvet-leaf	annual forb	D	
Acroptilon repens	Russian knapweed	perennial forb	I	N
Agropyron cristatum	crested wheatgrass	perennial graminoid	I	
Agrostemma githago	purple cockle	annual forb	D	N
Amaranthus retroflexus	red-root pigweed	annual forb	D	
Anthemis cotula	mayweed	annual forb	D	
Arctium minus	common burdock	biennial forb	D	
Artemisia absinthium	absinth	perennial forb	I	
Avena fatua	wild oat	annual graminoid	D	N
Bassia hyssopifolia	five-horn smother-weed	annual forb	D	
Brassica juncea	Chinese mustard	annual forb	D	
Brassica rapa	bird rape	annual forb	D	N
Bromus inermis	smooth brome grass	perennial graminoid	I	
Bromus japonicus	Japanese brome	annual graminoid	I	N
Bromus tectorum	downy brome	annual graminoid	I	N
Butomus umbellatus	flowering rush	aquatic plant	I	
Camelina microcarpa	small-seeded false flax	annual forb	D	N
Campanula rapunculoides	creeping bellflower	perennial forb	D	
Capsella bursa-pastoris	shepherd's purse	annual forb	D	
Caragana arborescens	caragana	shrub	I	
Cardaria chalepensis	hoary cress	perennial forb	I	
Cardaria draba	heart-podded hoary cress	perennial forb	I	N
Cardaria pubescens	globe-podded hoary cress	perennial forb	I	
Carduus nutans	nodding thistle biennial	forb	I	N
Centaurea diffusa	diffuse knapweed	annual forb	I	N
Centaurea maculosa	spotted knapweed	biennial forb	I	N
Centaurea solstitialis	yellow star-thistle	annual forb	I	
Cerastium vulgatum	common mouse-ear chickweed	perennial forb	D	
Chenopodium album	lamb's quarters	annual forb	D	
Chenopodium murale	nettle-leaf goosefoot	annual forb	D	
Chorispora tenella	common blue-mustard	annual forb	D	
Cirsium arvense	Canada thistle	perennial forb	I	N
Cirsium vulgare	bull thistle	biennial forb	I	

Scientific Name	Common Name	Growth Form	Category	Noxious
Conium maculatum	poison hemlock	biennial forb	I	
Conringia orientalis	hare's-ear mustard	annual forb	I	N
Convolvulus arvensis	field bindweed	perennial forb	I	N
Crepis tectorum	narrow-leaved hawk's beard	annual forb	D	
Cynoglossum officinale	hound's-tongue	biennial forb	I	
Dactylis glomerata	orchard grass	perennial graminoid	D	
Daucus carota	wild carrot	biennial forb	D	
Descurainia sophia	flixweed	annual forb	D	
Echinochloa crus-galli	barnyard grass	annual graminoid	D	
Echium vulgare	viper's-bugloss	biennial forb	I	
Elaeagnus angustifolia	Russian olive	shrub	I	
Elytrigia repens	quack grass	perennial graminoid	D	N
Eragrostis cilianensis	stinkgrass	annual graminoid	D	
Erodium cicutarium	stork's bill	biennial forb	I	
Erucastrum gallicum	dog mustard	annual forb	D	
Euphorbia cyparissias	cypress spurge	perennial forb	I	
Euphorbia esula	leafy spurge	perennial forb	I	N
Fagopyrum tataricum	tartary buckwheat	annual forb	D	N
Galeopsis tetrahit	hemp-nettle	annual forb	D	
Galium aparine	cleavers	annual forb	I	N
Galium spurium	false cleavers	annual forb	I	
Gypsophila paniculata	baby's breath	perennial forb	I	
Hesperis matronalis	dame's rocket	perennial forb	D	
Hibiscus trionum	flower-of-an-hour	annual forb	D	
Hordeum jubatum	foxtail barley	annual graminoid	D	
Hordeum vulgare	common barley	annual graminoid	D	
Hyoscyamus niger	black henbane	biennial forb	D	
Hypochaeris radicata	spotted cat's-ear	perennial forb	D	
Knautia arvensis	blue buttons	perennial forb	I	
Kochia scoparia	kochia	annual forb	D	
Lactuca serriola	prickly lettuce	annual forb	D	
Lamium amplexicaule	henbit	annual forb	D	
Lappula echinata	bluebur	annual forb	D	N
Lepidium perfoliatum	clasping pepper-grass	annual forb	D	
Leucanthemum vulgare	oxeye daisy	perennial forb	I	
Linaria dalmatica	dalmatian toadflax	perennial forb	I	N

Scientific Name	Common Name	Growth Form	Category	Noxious
Linaria vulgaris	yellow toadflax	perennial forb	I	N
Lolium persicum	Persian darnel	annual graminoid	I	N
Lythrum salicaria	purple loosestrife	perennial forb	I	N
Malva parviflora	small whorled cheeseweed	annual forb	D	
Malva rotundifolia	round-leaved mallow	annual forb	D	N
Marrubium vulgare	common hoarhound	perennial forb	D	
Matricaria perforata	scentless chamomile	annual / biennial forb	I	N
Medicago lupulina	black medic	perennial forb	D	
Melilotus alba	sweet clover (white)	biennial forb	D	
Melilotus officinalis	sweet clover (yellow)	biennial forb	D	
Myriophyllum spicatum	Eurasian water milfoil	perennial aquatic	I	
Neslia paniculata	ball mustard	annual forb	D	N
Odontites serotina	late-flowering eyebright	annual forb	I	
Phleum pratense	timothy	perennial graminoid	D	
Plantago lanceolata	English plantain	biennial forb	D	
Plantago major	common plantain	perennial forb	D	
Poa annua	annual bluegrass	annual graminoid	D	
Poa compressa	Canada bluegrass	perennial graminoid	D	
Poa pratensis	Kentucky bluegrass	perennial graminoid	D	
Polygonum convolvulus	wild buckwheat	annual forb	D	N
Polygonum persicaria	lady's thumb	annual forb	D	
Polypogon monspeliensis	annual rabbit-foot grass	annual graminoid	I	
Potamogeton crispus	curly pondweed	perennial aquatic	D	
Potentilla recta	sulfur cinquefoil	perennial forb	D	
Ranunculus acris	tall buttercup	perennial forb	I	
Raphanus raphanistrum	wild radish	annual forb	D	
Rhamnus cathartica	European common buckthorn	shrub	I	
Ribes rubrum	cultivated red currant	shrub	I	
Salsola kali	Russian thistle	annual forb	D	N
Saponaria officinalis	bouncing-bet	perennial forb	I	
Scleranthus annuus	knawel	annual forb	D	
Senecio vulgaris	old-man-in-the-spring	annual forb	D	
Setaria viridis	green foxtail	annual graminoid	D	N
Silene cserei	smooth catchfly	biennial forb	D	
Silene latifolia ssp. Alba	white cockle	biennial/perennial forb	D	N

Scientific Name	Common Name	Growth Form	Category	Noxious
Silene noctiflora	night-flowering catchfly	annual forb	D	N
Silene vulgaris	bladder campion	perennial forb	D	N
Silybum marianum	blessed milk-thistle	annual / biennial forb	I	
Sinapis arvensis	wild mustard	annual forb	D	N
Sisymbrium altissimum	tumble mustard	annual forb	I	N
Sonchus arvensis	perennial sow-thistle	perennial forb	D	N
Sonchus oleraceus	annual sow-thistle	annual forb	D	N
Spergula arvensis	corn spurry	annual forb	D	
Stellaria media	common chickweed	annual forb	D	
Syringa vulgaris	common lilac	shrub	I	
Tamarix chinensis	salt cedar	shrub	I	
Tanacetum vulgare	common tansy	perennial forb	I	
Taraxacum officinale	common dandelion	perennial forb	D	N
Thlaspi arvense	stinkweed	annual forb	D	N
Tragopogon dubius	goat's-beard	biennial forb	D	
Trifolium hybridum	alsike clover	perennial forb	D	
Trifolium pratense	red clover	biennial forb	D	
Trifolium repens	white clover	perennial forb	D	
Ulmus pumila	Siberian elm	shrub	I	
Vaccaria hispanica	cow cockle	annual forb	D	N
Verbascum thapsus	common mullein	biennial forb	D	

Photo courtesy of Lynn Sosnoskie, University of Georgia, Bugwood.org

Wild buckwheat (Disturbance caused) *Polygonum convolvulus*

Photo courtesy of Mary Ellen (Mel) Harte, Bugwood.org

Stinkweed / field penny cress (Disturbance caused) *Thlaspi arvense*

APPENDIX 3

Glossary

Canopy cover - the ground area covered by vegetative growth. Different plant species can provide varying degrees of cover depending on their overall size and abundance.

Critical site - one that may be sensitive, or already has some specific problems, for assessment.

Disturbance-caused undesirable herbaceous species - native or introduced non-woody plant species that are well adapted to disturbance or an environment of continual stress.

Deep binding roots - the type of plant roots that hold together most of the shore or banks, in the face of regular waves, runoff and flooding.

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

Invasive plant species - are likely to invade native vegetation, crop or pastures once established. May alter ecological functions. Some invasive species are classified as noxious species and are regulated by the Saskatchewan Noxious Weeds Act.

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

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

Pioneer species - plant species that are early or first to establish on recently made available habitat (eg. bare soil patch). Often these are annual weeds, but some native wildflower species, such as fireweed (not actually a weed) are also pioneer species.

Pugging and hummocking - the depressions (pugs) and raised mounds of soil (hummocks) resulting from large animals walking through soft or moist soil.

Reach - a stretch of shore assessed for riparian health, with width based on the extent of the riparian area (from open water to the upland) and with length based on selecting a representative or critical site within one management (and ownership) unit.

Representative site - a site that is typical of a much longer stretch of shore and that will provide an overall impression of health for that longer area.

Rutting - the compacted trails or ruts from people, vehicles or livestock, with trails compressed more than 5 cm (2 in) deep.

Sinuosity - the ratio of the channel length between two points on a channel to the straight-line distance between the same two points (ie: a measure of meandering).

Snags - dead standing trees

Structural alteration - physical changes to the shape or contour of the shore or banks caused by human influences. Some examples are livestock trampling, riprap and excavation.

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

Tree and shrub utilisation - browse (eating by animals), rubbing off, or cutting/removal of woody growth on trees and shrubs (only utilisation of second year and older growth included in riparian health assessment).

Watershed - the area of land that drains into a single waterbody. While a small wetland will usually have a small watershed or drainage basin, a large river (eg. North Saskatchewan River) will have a very large watershed, composed of many smaller watersheds of other waterbodies.

Woody plant species - refers to trees and shrubs. These plants serve different riparian functions than grasses and broad-leaf plants, since they are typically more resilient and longer-lived, with deeper root systems.

APPENDIX 4

Contact List

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Web site: www.swf.sk.ca

APPENDIX 5

Reference Material

Many of the publications below can be accessed by contacting the Saskatchewan Watershed Authority or by downloading them from ww.swa.ca. The publications can be found under stewardship publications.

Ambrose, N., G. Ehlert, K. Spicer-Rawe. 2004. Riparian health assessment for lakes, sloughs, and wetlands –field workbook. Modified from Fitch, L., B.W. Adams and G. Hale. 2004. Riparian health assessment for streams and small rivers – field workbook. Cows and Fish Program. Lethbridge, Alberta.

Fitch, L., B.W. Adams and G. Hale. 2004. Riparian health assessment for streams and small rivers – field workbook. Cows and Fish Program. Lethbridge, Alberta.

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Huel, D. 2002. Streambank stewardship: your guide to caring for riparian areas in Saskatchewan. Saskatchewan Watershed Authority. Regina, Saskatchewan.

Lahring, H. 2003. Water and wetland plants of the prairie provinces: a field guide for Alberta, Saskatchewan, Manitoba and the northern United States. Canadian Plains Research Centre. Regina, Saskatchewan.

Soulodre, E. Streambank Stewardship Directory. Saskatchewan Watershed Authority. Regina, Saskatchewan.

Thompson, W. and P, Hansen, 2001. Classification and management of riparian and wetland wites of the Saskatchewan prairie ecozone and parts of adjacent subregions. Saskatchewan Watershed Authority, Regina, Saskatchewan.

Riparian areas fact sheets

Beaver: Creator or Destroyer? Saskatchewan Watershed Authority. Regina, Saskatchewan.

Economics of Riparian Grazing Management. Saskatchewan Watershed Authority. Regina, Saskatchewan.

Farming Along the Stream. Saskatchewan Watershed Authority. Regina, Saskatchewan.

Health of Riparian Areas in Southern Saskatchewan. Saskatchewan Watershed Authority. Regina, Saskatchewan.

Living on the Edge: Wildlife Along the Stream. Saskatchewan Watershed Authority. Regina, Saskatchewan.

Ranching Along the Stream. Saskatchewan Watershed Authority. Regina, Saskatchewan.

What makes a Healthy Riparian Area? Saskatchewan Watershed Authority. Regina, Saskatchewan.


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Saskatchewan
Prairie Conservation
Action Plan

Cows and Fish

PCAP Greencover Partners

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

SRC
smart science solutions

Saskatchewan Ministry of Agriculture

Saskatchewan Watershed Authority

Saskatchewan Ministry of Environment

Saskatchewan STOCKGROWERS Association

Nature Conservancy Canada

Conservation Nature Canada

Ducks Unlimited Canada
Conserving Canada's Wetlands

Nature Saskatchewan

SAMA

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Funding provided by
Agriculture and Agri-Food Canada's Greencover Canada Program,
Ducks Unlimited Canada, and
Saskatchewan Watershed Authority

Re-printing of this Project was undertaken
with the financial support of the Government of Canada
provided through the Department of the Environment.

Canada

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