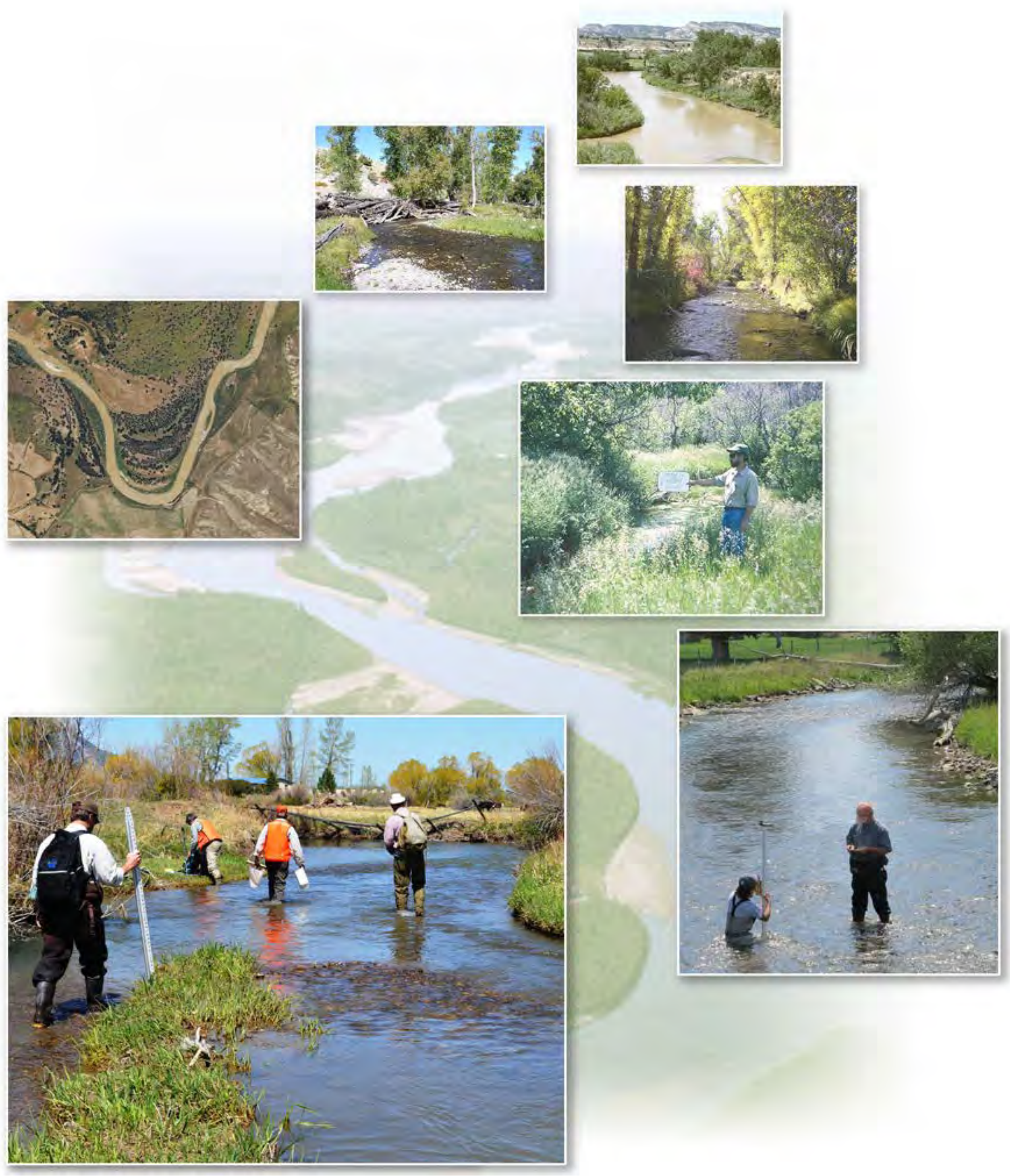
United States Department of Agriculture
NATURAL RESOURCES CONSERVATION SERVICE
Environment Technical Note No. MT-2 (Rev. 1)
November 2012

Riparian Assessment

Using the NRCS Riparian Assessment Method



"We must let the river teach us. Not just a few of us.
Let the river teach all of us."

Luna B. Leopold in a presentation on November 18, 1997.

If you would like additional copies of this document and/or have questions, please contact:

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Acknowledgements

Thanks go out to those who directly contributed to this document and to those whose use and comments have contributed to a better product since the NRCS Riparian Assessment Method was first issued in 2004.

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Revised November 2012

This report is also available on the Montana Natural Resources Conservation Service web site: http://www.mt.nrcs.usda.gov/technical/

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RIPARIAN ASSESSMENT

INTRODUCTION

Riparian/wetland zones provide some of the most productive natural resources found on public and private lands (CRZFSM, 2002). Proper interpretation of riparian functional status is key to providing suitable management recommendations. The NRCS Riparian Assessment Method is intended for use by trained field staff, consultants, and landowners for rapidly assessing the sustainability and function of a lotic (running water) riparian corridor (Wyman et al., 1999). Sustainability and function of riparian areas is fundamental to channel stability and ecologic integrity of stream corridors in most cases. This method provides an indexed rating useful for establishing priorities in treating riparian/stream corridor problems and for stratifying stream reaches for further evaluation.

The Assessment has direct applicability to Steps 1-4 and 9 of the NRCS planning process as outlined in the National Planning Procedures Handbook (NRCS, 2010). It is designed to serve as a starting point for identifying stream reaches requiring further study. The resulting ratings can be then be used to prioritize and direct resources where needed to prevent further degradation and where the greatest return for the investment exists. To help ensure that users have a common understanding of the meaning and context of the terms used in this basic method, a glossary of common terms is contained in Appendix 1.

The NRCS Riparian Assessment Method is a modification of "Assessing Health of a Riparian Site" originally developed by the staff of the Montana Riparian and Wetland Research Program at the University of Montana (Thompson et al., 1998) which has been used and tested in several states and Canada since 1992. "Assessing Health of a Riparian Site" was designed so that land owners and managers can complete their own assessment with minimal assistance and training. Interpretive elements of the Bureau of Land Management's TR-1737-15 "A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas" (USDI 1998) have also been incorporated in this assessment process.

A number of similar or associated riparian assessment tools have been developed and are in use in Montana and surrounding states. Generally, each method has a specific purpose and provides slightly different interpretations and types of information. Some tools require more or less time and user skill level. An excellent review of additional stream corridor inventory and assessment techniques is found at: ftp://ftp-fc.sc.egov.usda.gov/WSI/pdffiles/Stream_Corridor_Inventory_Techniques.pdf.

PURPOSE

What the assessment will tell you

The NRCS Riparian Assessment Method is designed to help users understand the physical attributes and processes that should occur in stream systems and their adjacent riparian areas. It is based on providing a "first cut" evaluation of stability and sustainability as a surrogate for riparian 'health'. The evaluation helps to characterize the physical and ecological attributes that represent thresholds for sustainability. Subsequent ratings over a period of time on the same stream reach can be used to evaluate trend and provide an assessment of conservation practice or management effectiveness. The ratings are only comparable to streams of the same type in the same local area (i.e., same hydrologic unit and having the same potential).

Potential is defined as the highest ecological status a riparian-wetland area can attain given no *significant* human constraints and is often referred to as the potential natural community (PNC). The evaluation also leads to identification of recovery strategies and management adjustments that may be used to reverse a downward trend.

What the assessment will not tell you

This assessment is not intended to give the user a quantitative and comprehensive analysis of all ecological and physical processes. Problems that are identified using this method can be further evaluated using more specific inventory or assessment techniques. The rating is not intended to provide an absolute numeric value that can be used to compare the reach to other riparian/wetland areas unless their potential is the same.

The assessment rating does not compare the existing condition with the site or reach's full ecological potential. For example, even if a riparian area receives a score of 100 percent, it may not be at the full ecological potential of the reach. This assessment is designed to evaluate stability and sustainability only, which can occur well before full ecological potential is achieved.

The NRCS Riparian Assessment Method is only suited to evaluate riparian systems associated with perennial and intermittent stream channels. Ephemeral streams, woody draws, or dry washes that do not exhibit the presence of vegetation dependent on free water in the soil associated with the drainages water table are excluded. These plants are generally classified as obligate (OBL) or facultative wetland (FACW) wetland species. Isolated pockets of riparian vegetation within a larger ephemeral drainage observed in the interrupted systems of Montana's prairie region are also not suited for assessment under this method. Interrupted systems have one or more riparian indicators missing across variable units of habitat (i.e., riffles, glides, and pools). Drainages without a defined channel feature and water table, such as woody draws in Eastern Montana, are not to be evaluated using this method. See the decision matrix in Appendix 2 for assistance in determining when the NRCS riparian assessment method is appropriate. Photos in Appendix 3 illustrate common examples and applications of the NRCS Riparian Assessment method.

True lentic (still water) wetlands should be assessed using tools developed for that specific purpose. An assessment procedure for standing water systems is presented in BLM Technical Reference TR-1737-16, "A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas" (BLM, 1999). Lentic/lotic complexes in drainage ways can be properly assessed with the NRCS riparian assessment method when the potential is adjusted accordingly. The functions and processes in true lentic systems primarily differ from lotic systems because of the energy provided by flowing water within lotic systems.

The NRCS riparian assessment provides relatively detailed information about the sustainability of riparian habitat. It does not address in detail the condition or ecological status of aquatic habitat within the stream channel and adjacent backwaters. When aquatic habitat is the focus of the assessment effort, consider using the Stream Visual Assessment Protocol, Version 2 (SVAP2) found in the National Biology Handbook (190-VI-NBH, Amend. 3, Dec. 2009: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044776.pdf). Although there is overlap between the two methods, SVAP2 emphasizes benthic aquatic habitat status while the NRCS Riparian Assessment emphasizes riparian habitat condition adjacent to the stream channel. Used together these methods provide a relatively complete picture of stream corridor health and stability.

Understanding the process

Any analysis of a stream corridor's sustainability must consider the suite of physical and formative factors (i.e., soils, vegetation, and hydrology) affecting it for both ecological and management reasons. These physical processes, which must be present for the stream, riparian area, and flood plain to be considered stable and sustainable, must be understood and fully evaluated when completing a riparian assessment. Figure 1 depicts the appropriate parts of the stream corridor that are evaluated using the NRCS method. Sustainability is the capacity of a stream and its associated riparian area to perform specific physical and biological processes over time. Table 1 gives a list of possible attributes and processes that may be present in a riparian/wetland area.

When working properly, these processes contribute to the integrity, balance, and stability of the riparian area.

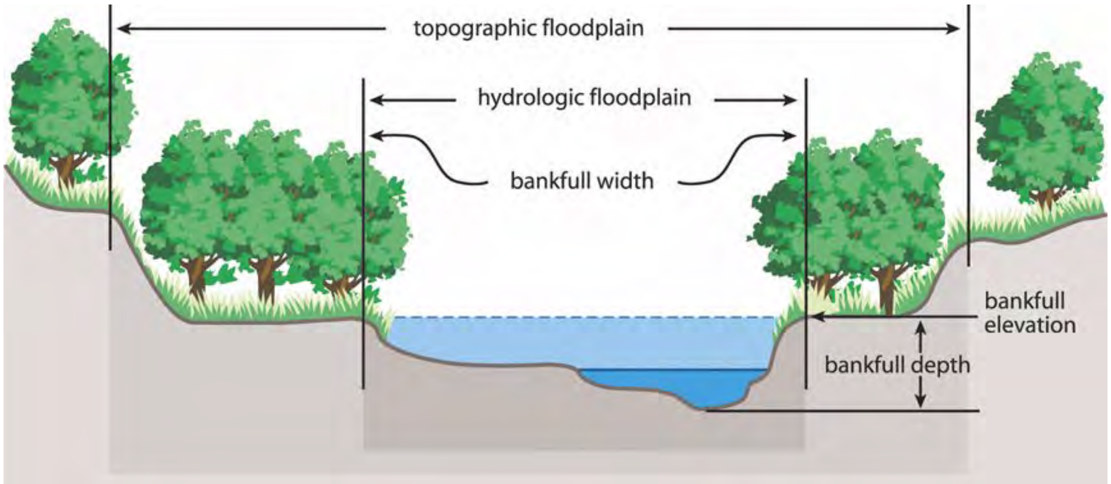


Figure 1. Channel cross-section. Depiction of the relative location of components of the stream corridor landform to be evaluated when using the NRCS riparian assessment method (Source: Adapted from FISRWG 1998).

Table 1. List of various attributes and processes that may be at work in riparian/wetland areas [1/]

Hydro-Geomorphic	Vegetation	Erosion/Deposition	Soils	Water Quality
Ground water recharge	Community type	Bank stability	Soil type	Temperature
Accessible flood plain	Plant species diversity	Bank angle	Soil depth/texture	Salinity/sodicity
Ground water discharge	Plant species abundance	Bed stability/transport rate	Soil water states	Nutrients
Bankfull width	Surface density	Deposition features	Soil chemistry	Dissolved oxygen
Width/depth ratio	Canopy cover	Erosion features	Aerobic/anaerobic	Sediment
Sinuosity	Recruitment/reproduction		Capillary action	
Gradient	Survival			
Flood plain storage	Root mass			

[1/] Source: Riparian Area Management TR-1737-15 1998.

The processes listed in Table 1 support critical riparian/flood plain functions including sediment trapping, energy dissipation, streambank building, water storage, aquifer recharge, biotic diversity, and primary biotic production. If the attributes and process important to the stream reach under assessment are not properly understood, the resulting interpretations will likely be incomplete and may lead to incorrect recommendations.

Stable stream systems are sustainable and can be managed to sustain desired values, such as wildlife habitat, water quality, and forage, over time. A stream and riparian area cannot be managed for values such as fisheries or water quality before they are stable; i.e., able to withstand a 10-20 year flow event with minimal damage and quick recovery. Many years may need to pass in a stable state before these advanced ecological processes are achieved.

GENERAL INSTRUCTIONS

Interdisciplinary Team

This riparian assessment is intended to be completed by an interdisciplinary (ID) team. The decision-maker (or representative) along with an engineer and vegetation specialist with knowledge of riparian systems can form an ID team. Realistically, these disciplines are not always available at a field office. Specialists from other NRCS offices or other cooperating agencies or organizations should be called on to help.

Stream Reaches

Riparian areas have unique dimensions and features that must be considered and incorporated into the evaluation. One feature concerns the selection of the size of the area to be assessed, that is, to identify the starting and stopping point of the rating. Stream courses are separated into *reaches* with similar attributes and processes. A reach may be considered similar to an ecological site, and is usually determined based on a number of stratifying factors.

A reach consists of a specific length of stream and its associated riparian area and flood plain. For purposes of the assessment, it should also include the associated flood-prone area. A reach may be selected by:

1. Stream channel type, or geomorphology (Rosgen, 1996); channel evolution (recovery) stage (Schumm et al., 1984); or ecological site;

2. Changes in management, land use, or ownership where differences are likely to occur;

3. A structure that impacts the stream/riparian area, such as a diversion, headgate, bridge, or culvert;

4. The confluence of two or more streams; or

5. A change in stream order (CRZFSM, 2002).

As a general rule, a minimum of at least 12-meander lengths or one quarter-mile length of the reach should be examined. Shorter sections may be used if necessary, but they must be carefully evaluated to be sure they are truly representative of the reach. As an example, avoid assessing areas near fencelines or other high disturbance points such as bridges, crossings, or watering points unless the disturbance truly represents the conditions throughout the reach. The area to be evaluated should include the entire flood plain zone. Stream terraces that are no longer in the flood plain zone are not be evaluated as part of the assessment area. Watershed conditions and characteristics, including upland stream terraces, should be noted and described in narrative comments, since changes in watershed and upland attributes are often reflected in the condition of the riparian area and stream channel.

Potential and Capability

Each reach must be evaluated relative to its own ***potential***. *Potential*, as used here, is considered to be the highest stable state possible, without significant human interference. *Potential* is a product of the natural interactions of hydrology, soils, and climate affecting the reach. Some examples of natural settings that affect reach *potential* are the influence of groundwater (losing or gaining), valley gradient and geologic controls, runoff-streamflow characteristics, salt-affected soils, and precipitation/temperature regimes. *Potential* is used to determine the maximum possible score for a given reach. This assessment measures the degree of similarity between existing conditions and the *potential* of the reach: the more sustainable the rating, the closer the reach is to its *potential* in terms of stability.

Capability is used to reflect limitations imposed by other than environmental interactions. *Capability* is also the highest stable state possible for a site, but that state is limited by political, social and/or economic constraints that are not readily altered. Examples of limitations imposed by *capability* are the influences of dams, highway or railroad fill, de-watering from irrigation withdrawals, excess water; i.e., as part of an inter-basin transfer where water is added to a stream system that is in excess of historic, natural flows, or a change in runoff patterns as a result of some activity in the watershed such as road construction or logging. Factors affecting *capability* may or may not be possible to change over time. Proper understanding of *capability* also puts the sustainability rating in context, and is helpful in setting priorities for further study or in evaluating restoration feasibility and practices.

Potential and *capability* may be the same for many undisturbed streams; however, this is not often the case in highly altered agricultural and urban landscapes. The following example is used to illustrate the difference between *potential* and *capability.* A given stream reach is expected to have cottonwood trees or willows present due to its climatic and landscape setting and soil moisture conditions. This condition represents the vegetative community's *potential*. However, because of an upstream hydrologic modifier; e.g., a dam, the flood events, sediment deposition, and other site conditions required for woody species re-establishment can no longer occur or occurs at a greatly diminished frequency. In other words, the stream reach no longer has the *capability* to re-establish cottonwoods and willows on a regular basis. This altered condition now represents the reach's capability and what decisionmakers can reasonably plan to achieve. The rating is based on the potential, however; restoration plans incorporate the reduced state due to the present capability to support cottonwoods.

As another example of vegetative *potential* and *capability*, an abundance of long-lived, invasive species (smooth brome, knapweeds, Kentucky bluegrass, timothy, etc.) negatively affects the *capability* of native species adapted to a site to sustain themselves. *Capability* may remain impaired for the foreseeable future until such time as these invasive species become naturalized or better controls are developed. The vegetative *potential* for the site, however, continues to be the native community adapted to the site.

Channel Type

Recognizing and understanding the stream channel type is crucial to this assessment. Channel types (those having standard characteristics in dimension, pattern, and profile) have unique features that can affect their response to disturbance (Montgomery, 2002). A schematic illustration of channel types according to Rosgen's classification system (1996) is contained in Appendix 4. Rosgen's system is one of several classification systems applicable to streams in the western U.S. It is provided to help users evaluate the assessment criteria with respect to the stream reach's channel type, physical attributes, and response to disturbance.

The nature of this response often greatly influences the stability rating. For instance, some steep gradient streams that have mainly bedrock or large boulder (Rosgen "A" and "B" channels) substrates generally do not need vegetation for sustainability. These types of streams should not receive low scores and low sustainability ratings due to limitations in vegetative attributes alone where vegetation limitations impact habitat values but not stability and sustainability.

Ecological Site

The ecological site description (ESDs) in Section II of the NRCS Field Office Technical Guide (FOTG) is the NRCS standard for evaluation of riparian ecological sites (note that not all ecological site descriptions for Montana have been completed at the date of this writing). The FOTG may be accessed online at: http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=MT.

Evaluations of riparian functional and ecological attributes and processes must distinguish between natural changes and those that may be outside the range of normal variability for the ecological site. When ESDs are not available for the areas being evaluated, other sources for comparison such as reference areas or other classification documents such as Classification and Management of Montana's Riparian and Wetland Sites (Hansen et al., 1995) should be used. Riparian ecological sites are strongly associated with the respective stream channel type. A new ecological site will also be evaluated each time the channel type changes. Ecological condition (i.e., Similarity Index) can be evaluated as management changes are assessed if desired. Because of the inherent complexity of riparian areas, a reach may contain two or more ecological sites. This occurs often and using a complex is a common and acceptable way to handle this situation.

The Worksheet

The worksheet is used to evaluate the riparian attributes and processes integral for sustainability. Instructions and supporting information are provided for each rating criterion. Each criterion will require some judgment by the evaluation team. Each question can be quantified, if needed, by using a standard data collection technique. Similar questions have been grouped into three areas for consideration: geomorphic, vegetative and functional.

There is no need for absolute precision when doing this assessment. The method is designed and intended to provide a general overview of the sustainability and function of the riparian area and stream corridor relatively quickly and inexpensively for large areas. When used properly, this assessment will provide useful information about overall riparian "health" and assist with prioritizing future efforts.

Do not interpolate between the score values provided for each question. The numbers (scores) assigned to each question already represent a range of values and are the values that should be used. These numbers represent guidelines and are not exact. To use a more precise scoring system than that provided for each question, implies a level of precision that cannot be supported by the science inherent in this method. Interpolation also reduces consistency between users.

Recognize Potential and Capability. Complete the worksheet in the field based on actual conditions for each applicable criterion observed (*Actual* blank). Also, record a score in the *Potential* blank for each applicable criterion based on the *potential* that the team determines is appropriate for the reach. For instance, in most stream types, the maximum score represents the *potential*, however in some exceptional cases, the stream or reach *potential* may be less than the maximum score. For example, in an intermittent stream, the *potential* for extensive hydrophytic vegetation may be reduced due to the less than optimum soil moisture conditions. When this situation occurs, the team must clearly document the rationale and supporting data to justify the change.

In addition, some criteria may not apply (use N/A) to all stream types and this should be documented when appropriate. The final score is calculated by dividing the *actual* score by the *potential* score. Use the chart on the worksheet to categorize the rating as either "Sustainable," "At-Risk," or "Not Sustainable." The liberal use of notes, photos, and comments helps when scores and ratings are evaluated and analyzed. Comprehensive notes provide documentation for future evaluation of trend over time and will be invaluable to those who follow you.

Evaluators need to be aware of any recent extreme climatic events; e.g., a flood or drought. Several years of "normal" flooding may be necessary to move excess sediment from some stream reaches that were degraded due to a large flood. These factors must be considered when completing the worksheet.

An ArcPad application for the Montana Riparian Assessment score sheet has been developed which allows the user to enter scoring, notes, and geographic features or the reach directly into a portable data collection device such as the Archer unit NRCS presently uses. Please contact the

GIS Coordinator or Specialist at the Bozeman, NRCS state office to get the application or for more information.

Cross Check Scores for Related Attributes and Processes. Many questions are related and must be compared as the worksheet is being completed. For example, if question 1 is given a low score reflecting the lack of active flood plain, then question 10 should be scored accordingly. Questions 5 and 10 also should be compared. They are both answered relative to the channel type and vegetative cover. Only in rare situations should they both be answered N/A. There are only a couple of stream channel types that do not need either vegetative cover or flood plain features for protection against high flows (Rosgen "A" and "B" channel types or other types occurring in bedrock formations). Prompts are given in the instructions where comparisons are appropriate.

Helpful Hints

There are a number of references that will help the user understand the riparian and channel function processes that are being evaluated. These are listed under "References". Appendix 5 contains a table that provides relative stability ratings of various riparian plant communities which will be useful when answering the vegetation questions, particularly numbers 5 and 10.

Questions 5, 6, and 7 are based on a percentage of the riparian area. Appendix 6 contains two aids to assist users in estimation of percent coverage, composition, or frequency of occurrence.

Comments

The ID team should assign one member to record comments and notes in association with the team's observations. Provide clarification for the rational for individual criterion scores and the rating, including comments regarding potential and actual characteristics. It is a good idea to document the team's observations with photographs, preferably digital (slides acceptable), and global positioning system (GPS) coordinates (latitude/longitude or Universal Trans Mercator [UTM]) for future reference.

Use *comments* and notes to describe any limitations that affect the reach's *capability*. This is especially important when the potential and capability are different.

Trend or Change Over Time

The ID team should attempt to determine and note whether key elements of the processes and attributes noted in answering Questions 1 through 10 are improving or declining. Usually, there will be obvious indicators of improvement or conversely, of declining conditions. No specific terms are required, but the interpretation and a short rationale should be recorded in the Comments Section of the Worksheet Summary. Interpretation of trend is particularly useful by decisionmakers to implement the recommendations resulting from the assessment, evaluating management performance, and in setting priorities.

Using the Ratings

Three ratings are used with this assessment. "*Sustainable*" means the stream can access its flood plain, transport its sediment load, build banks, store water, and dissipate flood energy in conjunction with a healthy riparian zone. When working properly, these processes contribute to a stable system.

"Not Sustainable" means that the stream and riparian area are clearly lacking adequate vegetation and/or functional characteristics and will not be able to dissipate energy, trap sediment, build banks or any of the other processes that are expected for a given potential. A 10- to 20-year flood event will cause extensive alteration to banks and flood plain characteristics that may take years to recover from.

Between “Sustainable” and “Not Sustainable” is the "At Risk" category. Generally, a stream and riparian area is "At Risk" if *most* of the attributes and processes are in place and working. What is lacking, however, is critical to the stability and function of the area. For example, most questions receive a good score except that vegetative cover (Question 5) or flood plain characteristics (Question 10) are determined to be inadequate to protect the area from high flows. Thus, this reach should receive an "At Risk" rating.

The assessment helps prioritize the need for additional information and proper allocation of limited technical and financial resources. Reaches receiving an “At-Risk” rating normally are given priority for additional planning and treatment, although “At Risk” reaches that are noted to be in an upward or improving trend may also not be prioritized for immediate treatment. However, reaches that are “Not Sustainable” often threaten other reaches, both up- and down-stream. In this case, a "Not Sustainable" reach might be considered a high priority for planning and application. Additionally, “Not Sustainable” reaches that are not so degraded that some treatment may still be beneficial, should be prioritized for treatment to prevent further degradation.

The application of specific practices or resource management systems is usually indicated by examination of individual and group criterion scores. Vegetation is used as an indicator of many of the processes since it is readily observed. Many riparian areas depend heavily on vegetation for sustainability and function. Prescribed grazing (density, duration, timing, and frequency) is always appropriate for grazing lands, and many times will be what is needed to begin moving a riparian area towards recovery.

Understanding the individual criteria scores is crucial to ensure treatment of the cause of the reduced function(s), rather than treating just treating symptoms. Stream reaches in a watershed can be grouped by their respective assessment ratings. Decision makers may use this information to prioritize treatment needs and develop objectives. For example, if the questions dealing with vegetative conditions tend to score low as a category, vegetative inventory needs and/or management changes can be prioritized and implemented. In some cases, the need for more detailed assessment may be indicated before moving to the planning and implementation stage. Likewise, reaches may be grouped by similar criterion scores to develop treatment strategies that address specific deficiencies.

The assessment also provides insight into interruptions in processes that will affect recovery efforts. Changes in soils and hydrology have significant impacts on riparian systems. Changes in their morphological components are often more difficult to fix than vegetative changes. For example, extensive incisement of a stream channel usually lowers the water table of the riparian area, thus changing the ecological site and *potential* vegetative community. A Riparian Subirrigated ecological site (Montana) typically has a permanent water table within three to four feet of the surface and a plant community that is dominated by willows. If stream incisement lowers the water table to 6 feet below the surface, the *potential* for that site to maintain a viable willow community has been lost. Restoring the previously existing hydrology becomes difficult, expensive, impractical, or impossible.

The impact of permanent human alterations or disturbance on *capability* must be considered when making use of the ratings to set priorities and guide restoration efforts. A reach or site that has been affected in a manner that it cannot return to its *potential* within a reasonable time frame should not receive a high priority, particularly when there is a low likelihood that further human intervention can accelerate the recovery process. For this reason, it is very important to describe capability limitations in the comments or notes section. Streams that have an altered hydrology due to water export or import have a diminished capability that may make restoration infeasible or impractical under the current situation. Trying to turn an irrigation ditch into a blue ribbon trout stream is rarely successful regardless of the amount of time and money expended.

COMPLETING THE WORKSHEET

Question 1. Stream Incisement (Downcutting)

Vertical stability is a critical component for maintaining a viable riparian area. A riparian corridor having a stream that incises (downcuts) loses most of its important attributes such as water table and flood plain, energy dissipation, flood-water retention/storage, sediment trapping, and bank building. In addition, a stream that has incised has generally lost many of its values, such as fish and wildlife habitat.

The intent of this question is to evaluate whether a stream has incised or is currently in the process of incising. This becomes a critical threshold for management or treatment. Early detection and stopping the process of downcutting in a stream system is often cheaper and usually more successful than trying to treat an area that has downcut and has to go through the recovery stages (Schumm's Evolution Model, see Figure 2).

Certain stream channel types such as mountain and steep gradient foothill types (e.g., Rosgen "A" and steeper "B" types (see Appendix 2) will be naturally entrenched and vertically stable (Rosgen, 1996). Natural entrenchment should not be confused with incisement or downcutting. Natural entrenchment generally takes place in erosion resistant materials such as bedrock or large boulders. On the other hand, many eastern Montana prairie stream systems have incised into relatively soft alluvium at some time in the past and are now in various stages of recovery (Stages III and IV, Schumm's Model, see Figure 2). As a result, it may now take a 10-year plus flood event for streamflow to access the previous flood plain.

If this question receives a lower score (0 to 4), current management practices and objectives should be evaluated and changed as appropriate. A positive change in management will usually help accelerate stabilization. The presence of active headcuts should nearly always keep the stream reach from being rated sustainable.

> Vertical stability is also one of the more difficult attributes to determine in the field. There are five indicators of vertical stability that may help with field identification:
>
> - Active headcuts present (including tributaries).
> - Cultural features such as previously buried pipe that's now exposed, exposed bridge footings, or excessive drop at a culvert outlet.
> - Lack of sediment and exposure of bedrock.
> - A low, vertical edge (scarp) at the toe of the streambank, particularly on the inside of a meander.
> - Bankfull flow indicators show that the flood plain is not accessed in a 1 to 3-year frequency flow event.

QUESTION #1 SCORING

8 = channel stable, no active downcutting occurring; or, old downcutting apparent but a new, stable riparian area has formed within the incised channel. There is perennial riparian vegetation well established in the riparian area (Stage 1 and 5, Schumm's Model, see Figure 2).

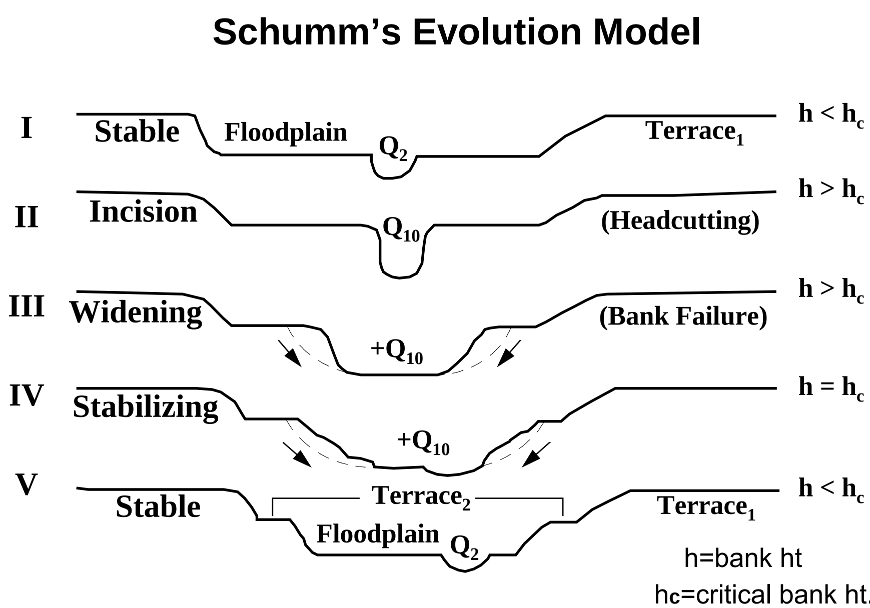
6 = channel has evidence of old downcutting that has begun stabilizing, vegetation is beginning to establish, even at the base of the falling banks, soil disturbance evident (Stage 4, Schumm's Model, see Figure 2).

4 = small headcut, in early stage, is present. Immediate action may prevent further degradation (Early Stage 2, Schumm's Model, see Figure 2).

2 = unstable, channel incised, actively widening, limited new riparian area/flood plain, flood plain not well vegetated. The vegetation that is present is mainly pioneer species. Bank failure is common (Stage 3, Schumm's Model, see Figure 2).

0 = channel deeply incised, resembling a gully, little or no riparian area, active downcutting is clearly occurring. Only occasional or rare flood events access the flood plain. Tributaries will also exhibit downcutting or signs of downcutting (Stage 2, Schumm's Model, see Figure 2).

Figure 2. Recovery Stages (from Schumm et al., 1984); used in Question 1



Schumm's Evolution Model

Stage	Score	Description
I	8	**Stable**. The channel carries a frequently occurring discharge (1-3 year event). That is a flood event that occurs at a frequency of at least once every 1 to 3 years. Might be equivalent to the runoff from a 2-year storm in a 24-hr period (1.5 inch, near Broadus to 1.2 inches near Bozeman). Flood plain is accessible for energy dissipation indicating the watershed and channel are in equilibrium. The "h<hc" indicates that the height of the channel banks is less than the critical height where slope failures begin to occur.
Early II	4	**Unstable**. The channel is starting to downcut. Channel carries greater than bankfull flows but less than 3-year event.
II	0	**Unstable**. The channel is downcutting to incised or more incised condition. Only occasional or rare flood events access the flood plain.
III	2	**Unstable**. The channel is widening. The height of the channel banks becomes greater due to downcutting and exceeds the critical height causing bank failure and channel widening. Flood flows cannot move as much sediment, as when the channel was deep and narrow in Stage II. Sloughed material that falls to the base of the failing banks are flushed away with each flood and permanent establishment of vegetation is difficult.
IV	6	**Unstable, but stabilizing**. Bank failure is not as common as Stage III or no longer occurring. The channel has widened enough so the flows can spread out and are not as deep. The sloughed materials are not flushed away with each flood and they begin to become stabilized with vegetation. Having vegetation established at the base of the failing banks signals the start of Stage IV. Through time, a new low capacity channel forms in the bottom of the deepened and widened channel.
V	8	**Stable**. Stage V begins when a new low flow channel forms, and the stream has reached equilibrium (stable) conditions with a new lower base elevation flood plain within the Stage IV channel. The active flood plain of Stage I is now at a greater height above the channel and exists as a terrace in Stage V.

Question 2. Streambanks with Excessive (Human Caused) Lateral Cutting

This question deals with all lateral erosion occurring within the channel, however, stream balance must be considered when completing this question. The intent of this question is to evaluate current lateral stability in relation to potential stability for the specific stream type. For the purpose of this worksheet, active lateral cutting can be identified by the lack of vegetative cover and exposed soil, particularly at the toe of the streambank at the bankfull elevation. Accelerated or excessive erosion is considered to be directly or indirectly due to the impacts of human activity or manipulation. An example of a direct impact is channel straightening or riparian vegetation removal; an indirect impact is alteration of upland ground cover that affects infiltration rate, discharge peak, and sediment yield. Excessive erosion is usually the result of chronic, long-term response to erosive energy as opposed to occasional high flow events that cause short-term bank destabilization.

A natural, single thread stream in balance is a channel that migrates laterally by erosion of one bank, maintaining on the average, a constant channel cross section by deposition on the opposite bank. The form of the channel cross-section is stable; i.e., more or less constant, but the position of the channel (within its valley) is not (Leopold, 1994). In other words, there is a state of equilibrium between erosion and deposition. When lateral erosion is occurring on an outside bend, the associated point bar/inside bend should be increasing and vegetating at the equivalent rate. The channel dimension and cross-section should remain approximately the same, or narrower. In most cases, erosion on both banks of the stream or on straight sections is indicative of excess or accelerated lateral erosion.

The stream channel type and its potential natural sinuosity must be recognized and evaluated. Lateral erosion will occur as part of the stream's natural process of maintaining or re-establishing its sinuosity. Natural rates of channel migration will vary according to stream morphology and bed/substrate materials. For example, high gradient mountain streams may have their banks protected by bedrock or boulders and would be expected to be relatively straight. Meandering meadow streams such as Rosgen "E"-type channels (see Appendix 2) are expected to be very sinuous.

Accelerated or excessive lateral bank erosion results in a wider and shallower channel; e.g., a higher width to depth ratio than is characteristic of the stream type. This change in channel dimension limits the mechanics of the stream to transport its sediment load and provide habitat for fish and other aquatic organisms. For example, inadequately controlled livestock grazing can change a narrow, very sinuous type "E" channel with a width-to-depth ratio less than 12, to a type "C" channel (and ultimately a type "F" channel) with a width-to-depth ratio much greater than 12.

Some stream systems, particularly those reaches below dams, may also have a lack of sediment and higher velocity which are *capability* issues (see Questions 1 and 3). A stream having a significant amount of lateral bank erosion occurring along straight sections may be exhibiting a lack of sediment and higher erosive velocity.

Indicators of excessive lateral cutting are:

- Long, unvegetated point bars indicating an imbalance between erosion and deposition;
- Erosion on both banks and on straight sections; and
- A wide, shallow channel.

QUESTION #2 SCORING (Inspect banks on both sides of the stream)

8 = lateral bank erosion is in balance with the stream and its setting.

5 = there is a minimal amount of human-induced, active lateral bank erosion occurring, primarily limited to outside banks.

3= there is a moderate amount of human-induced active lateral bank erosion occurring on either or both outside and inside banks.

0 = there is extensive human-induced lateral bank erosion occurring on outside and inside banks and along straight sections.

<u>Question 3</u>. The Stream is in Balance with the Water and Sediment Supplied by the Watershed

The primary function of a stream system is to transport water and sediment from the watershed. Streams do this constantly. A stable stream is in a dynamic equilibrium with its setting. It will adjust to the flow of water and sediment load being supplied by the watershed. A stable stream is capable of transporting water and sediment with no evidence of excess disturbance from erosion, incisement, deposition, or aggradation although some stream types are inherently more sensitive to these forms of disturbance than other types.

If a stream is out of balance with the amount of water and sediment being supplied by its watershed, it has lost its primary functionality and becomes unstable. Excess sediment/bedload material can be used as evidence of a stream that is out of balance and typically also indicates other problems. Excess sediment/bedload often results in a significant change in channel dimension, shape, or in some cases, even channel type. Changes in streamflow and channel gradient are usually balanced by changes in sediment load and bedload material size.

The intent of this question is to identify those stream channels that are not in balance and are aggrading or have excess sediment or bedload as evidenced by significant deposits of material within the channel. Excess sediment often results in widening and the formation of islands and mid-channel bars and leads to development of a braided stream.

There are situations where stream braiding is natural. In this situation, a score of 6 should be used. An example is a stream that goes from a high energy; e.g., Rosgen “A” type, to a lower energy system; e.g., Rosgen “C” type, with no transition zone between. A second example of a naturally braided stream type is a stream that originates directly from a glacier. Another example is found in arid landscape streams where sand is the dominant bed material.

If the excess sediment originates from outside of the channel (e.g., the rocks will be angular rather than rounded), this should be noted as part of the assessment for future inventory and planning. This may indicate that a change in management or treatment in another part of the watershed is necessary.

The width/depth (w/d) ratio is the key to understanding the distribution of available energy within a channel and the ability of various discharges occurring within the channel to move sediment. The distribution of energy within wide and shallow channels is such that stress is placed within the near bank region. As the channel grows wider and shallower, the hydraulic stress against the banks also increases and bank erosion is accelerated. The accelerated bank erosion increases the sediment supply to the over-widened channel, which has lost its ability to efficiently transport the sediment. Deposition occurs, which further accelerates bank erosion, and the cycle continues.

The stream width and mean depth are determined by bankfull, which is the point where the high flow normally reaches on the bank and is most easily determined on straight channel sections where the "scoured" channel meets the "permanent" vegetation. Look for characteristics such as terracing, soil changes (rock to soil), presence/absence of vegetation or debris lines.

Sinuosity, entrenchment ratio, pool frequency and depth, and sediment deposition should also be considered along with the W/D ratios to determine if a stream is in balance with the water and sediment being supplied to the stream. The entrenchment ratios, W/D ratio and sinuosity are used to characterize the following stream types (see Rosgen Protocols in Appendix 2 for additional information).

Common indicators of sediment and water supply imbalance are:

- A higher width/depth ratio than expected for the stream type.
- Common bank erosion on inside bends and straight segments.
- Sediment and bedload deposition common including frequent mid-channel bars.
- Large depositional deltas at the mouth of tributaries.

Table 2. General Characteristics of Rosgen's Stream Types

Stream Type	W/D Ratio	Comments
A	<12	Steep with high sediment transport. The influx of large organic debris can often influences the overall channel stability.
B	>12	Rapids dominated bed morphology. Should have low streambank erosion rates and scour pools.
C	>12 "Often increased by disturbance"	Riffle/pool spacing is usually 5-7 bankfull widths and often occurs every ½ meander wavelength. The channel rate of aggradation/degradation is dependent on stability of streambank and upstream watershed conditions.
D	>40	Unstable braided channel with high sediment load.
DA	NA	Multiple stable channels.
E	<12	High meandering stable systems that are highly sensitive to disturbance.
F	>12	Often re-establishing a functional flood plain inside the confines of a channel that was often historically entrenched and widened by disturbance.
G	<12	Deeply incised with high bank erosion and is often caused by disturbance.

QUESTION #3 SCORING

6 = The width to depth ratio appears to be appropriate for the stream type and its geomorphic setting. There is no evidence of excess sediment removal or deposition. There are no indications that the stream is widening or getting shallower. There may be some well-washed gravel and cobble bars present. Pools are common. Rosgen "B" and naturally occurring "D" channel types are exceptions.

4 = The stream has widened and/or has become shallower due to disturbances that have caused the banks to become unstable or from dewatering which reduces the amount of water and energy needed to effectively move the sediment through the channel. *(Note: Sediment sources may also be from offsite sources.)* Point bars are often enlarged by gravel with silt and sand common, and new bars are forming. Pools are common, but may be shallow. Rosgen “B” and naturally occurring “D” channel types are exceptions.

2 = The width to depth ratio exceeds what is appropriate for the stream type. Point bars are enlarged by gravel with abundant sand and silt, and new bars are forming that often force lateral movement of the stream. Mid channel bars are often present. For prairie streams there is often a deep layer of sediment on top of the gravel substrate. The frequency of pools is low. Rosgen “B” and naturally occurring “D” channel types are exceptions.

0 = The stream has poor sediment transport capability which is reflected by poor channel definition. The channel is often braided having at least three active channels. Naturally occurring Rosgen “D” channels types are exceptions. Pools are filled with sediment or are not existent.

<u>Question 4</u>. Streambank with Vegetation (Kind) having a Deep, Binding Root Mass

Note: For A and B or bedrock controlled stream types where riparian vegetation is not required for sustainability, this question can be skipped and given an N/A, with an explanatory note or comment. Be sure to adjust the <u>potential</u> *score if this question is skipped.*

The intent of this question is to determine whether the <u>*kinds*</u> of plants present along both streambanks have root systems capable of binding soil particles together so the bank is protected from erosion. Plants with deep, binding root systems also add to the functionality of a system by their ability to trap sediment, hold moisture in the soil, and reduce some of the erosive energy of the stream. For this question, all native, woody riparian plants are considered to have deep, binding root systems (stability rating ≥ 6). Most perennial native riparian grasses and sedges also have deep, binding root systems. Tables from *Monitoring Vegetative Resources in Riparian Areas* (Winward, 2000) are reproduced in Appendix 3 to provide stability ratings for most riparian species and communities common to Montana. Plants with deep, binding root masses are those with a stability rating of ≥ 6 in the Tables in Appendix 3.

NRCS Ecological Site descriptions for the appropriate precipitation zone and MLRA may help identify species that should potentially be present. Note the potential plant community on the score sheet as well as the present community, if different. The evaluators should include observations from both banks outward to determine if there is adequate protection by plant roots should the streambanks erode.

Again, remember this value is based on the <u>*kinds*</u> of plants: *potentially* present and *actually* present. Representative sampling can be used for longer reaches, provided the plant communities sampled truly represent the reach. The species composition of each plant community is compared to the ratings in Appendix 3. Riparian areas dominated by shallow rooted annuals and introduced perennials such as Kentucky bluegrass, smooth brome, "Garrison" creeping meadow foxtail, timothy, or redtop should receive a lower score. They should also receive a lower score for Question 7, Introduced/Exotic Undesirable Plants.

- How many desired, native plants with a deep, binding root mass (rating ≥ 6 are present in the reach?
- Don't count invasive species like Russian olive, even if adapted to the site conditions.
- Presence generally means more than one or two individuals in the reach.
- Be sure to list the species that are credited under this criterion in the Comments section of the score sheet.

The conclusion is not to say that riparian vegetation does not play an important environmental role and provide important ecological benefits. This criteria, however, is intended to solely weigh vegetative contribution to stability.

Note Exception: Some unique wetland/riparian communities (usually wet meadows with an E channel type) are naturally dominated by 1 or 2 sedge species. These wet meadow communities should receive a high score when the appropriate species are present because this situation can represent their full ecological potential.

QUESTION #4 SCORING

6 = The streambank vegetative communities are comprised of at least four plant species with deep, binding root masses.

4 = The streambank vegetative communities are comprised of at least three plant species with deep, binding root masses.

2 = The streambank vegetative communities are comprised of two plant species with deep, binding root masses.

0 = The streambank vegetative communities are comprised of one or no plant species with deep, binding root masses.

<u>Question 5</u>. Riparian/Wetland Vegetative Cover (Amount) in the Riparian/Flood Plain Area

Note: For A, B, and bedrock controlled stream types where riparian vegetation is not required for sustainability, this question can be skipped and given an N/A with an explanatory note or comment on the score sheet. Be sure to adjust the <u>potential</u> score if this question is skipped.

Good vegetative cover is crucial to maintaining the riparian functions of many stream systems. Vegetation helps protect streambanks, reduces water velocity and soil erosion, captures and stores sediment and nutrients, and provides diverse wildlife habitats. The amount and kind of vegetative cover is often a direct indicator of the sustainability of a stream and riparian area. Riparian/wetland vegetative cover reflects the ability to withstand and to recover after a moderate to large flood event (e.g., 10–20 year event, or greater).

This question also needs to be answered in the context of the stream channel type and its potential. Most high gradient mountain streams, foothill streams, and others with mainly bedrock or boulder channel bottoms (Rosgen Stream Types "A" and "B," subclasses 1-3) do not necessarily depend on vegetation for sustainability or function. When evaluating those kinds of stream systems, it is appropriate to skip this question with an N/A, and document the reasons.

Having the right kinds of plants present is important (Question 4), but if adequate density and distribution is lacking, the riparian area and stream channel are still subject to potential damage and degradation. A lack of sufficient quantity of cover may be enough to keep a reach from being rated "Sustainable."

While Question 4 asks about the kinds of plants that are present, the intent of Question 5 is to determine if there is sufficient (***amount or quantity)*** effective cover of native plants for the riparian area and active flood plain to either recover or maintain its sustainability and function. Do not include terraces and uplands in the evaluation. Compare this score with the score for Questions 4 and 10.

Winward (2000) identified sustainability thresholds for riparian/wetland plant cover on various sites (see the Appendix A: Key to Greenline Capability Groups). The scoring ranges below represent an approximation of these thresholds. To answer this question, the major plant communities and species occurring in the riparian and flood plain areas (consider parallel and perpendicular to the channel) are identified and the percentage of each is estimated (or measured) for the reach being evaluated. To help answer this question, an approach similar to the Greenline Method (Winward, 2000) is a recommended technique. The major plant communities on both sides of the stream are identified and the percentage of each is estimated (eyeball method) or measured for the reach. Representative sampling can be used for longer reaches, provided the plant communities sampled truly represent the reach. The percent composition of each plant community type is determined, aggregated, and compared to the ratings in Appendix 3. For a score of 6, the desired plant community should also be at least as wide as the bankfull channel width unless unique soil or hydrologic conditions prevail to preclude the full width.

QUESTION #5 SCORING

6 = More than 85% of the riparian/wetland canopy cover has a stability rating $\geq$ 6.

4 = 75%-85% of the riparian/wetland canopy cover has a stability rating $\geq$ 6.

2 = 65%-75% of the riparian/wetland canopy cover has a stability rating $\geq$ 6.

0 = less than 65% of the riparian/wetland canopy cover has a stability rating $\geq$ 6.

Question 6. Noxious Weeds in the Riparian Area

The presence or occurrence of noxious weeds usually indicates a downward trend in ecological condition and riparian health. The long-term implications of noxious weed infestation of the riparian zone are the crowding out of native plant communities. As weed infestations spread, this will lead to the eventually instability of both the biological (biodiversity and habitat) and physical (streambank stability) health of the stream corridor. Infestations of noxious weeds pose significant short-term and long-term economic impacts to individual landowners and entire communities.

The intent of this question is to quantify and score the extent or scope of noxious weed infestations in the riparian area. The weed species present should be noted on the assessment form. Locating the infestation, either on a map or using a GPS unit, also provides important information that can be used later.

Plant species that are considered noxious weeds must include those on both the current state and county noxious weed lists (including category 1, 2, and 3 plants). Check the current state list online at: http://agr.mt.gov/agr/Programs/Weeds/PDF/weedList2010.pdf. Section 1G of the FOTG also contains the current Noxious Weed list.

Noxious weed occurrence may be noted at the same time as when evaluating the preceding questions. As the team moves through the area, note species and distribution to estimate how much of the area is occupied by noxious weeds. It isn't necessary to evaluate density or canopy cover. They are either there or not. Comment notes should be used to indicate the degree of spread or scope of the infestation.

> Noxious weeds commonly found in riparian communities are:
>
> Canada thistle, common tansy, hounds tongue, burdock, poison hemlock, leafy spurge, spotted and Russian knapweed, perennial pepperweed, whitetop, salt cedar (tamarix), and St. Johnswort.

QUESTION #6 SCORING

3 = None of the riparian area has noxious weeds present.

2 = up to 5% of the riparian area has noxious weeds (a few are present).

1 = up to 10% of the riparian area has noxious weeds present (abundant).

0 = over 10% of the riparian area has noxious weeds (very apparent and extensive distribution).

<u>Question 7</u>. Introduced/Exotic Undesirable Plants in the Riparian Area

Exotic, undesirable species to be considered for this question typically are less adapted to wet conditions but can be aggressive invaders in riparian areas where they eventually crowd out a significant percentage of the native plant community. The introduction and spread of these plants are often caused by a disturbance to the stream corridor that may include heavy livestock grazing use, excessive wildlife browse, riparian clearing, urban development, and channel incisement. While some of these plants function to retain sediment and provide effective ground cover, their presence is a concern because they usually limit the attainment of other important riparian functions such as wildlife habitat and forage production.

Whereas, most species considered as part of the potential natural riparian community are either obligate or facultative-wet, the disturbance induced and introduced species are more generally facultative or facultative-upland (i.e., Kentucky and Canada bluegrass, smooth brome) with some being facultative-wet (i.e., redtop and curly dock). Undesirable woody species to consider for this question include Russian olive and salt cedar. These species commonly indicate that a significant disturbance has occurred that has caused the loss or decline of the more desirable, later seral plants. If this question receives a low score, the team should document the nature of the disturbance that caused the change in plant composition.

The plant species considered in this item have a potential to be changed with management. Noxious weeds that were identified for question 6 are *not* recounted in this item.

QUESTION #7 SCORING

3 = 5% or less of the riparian area with undesirable plants (very few present).

2 = 5-10% of the riparian area with undesirable plants (few are present).

1 = 10-15% of the riparian area with undesirable plants (commonly distributed).

0 = over 15% of the riparian area with undesirable plants (abundant over much of the area).

<u>Question 8</u>. Woody Species Establishment and Regeneration

NOTE: Skip this question and give an N/A on the worksheet if the site does not have woody species as a major component of the Historic Climax Plant Community, as indicated in the Ecological Site Description or riparian community classification (Hansen et al., 1995). Question 9 should also be completed the same way. Be sure to adjust the total <u>potential</u> score if these questions are skipped.

The intent of this question is to determine if multiple-age classes of native woody species are present, reflecting the *potential* of the site for maintenance and/or recovery. For many riparian areas, woody species are an important component and are often largely responsible for sustainability and function. The presence of all age classes (Table 3) indicates a generally healthy condition and ecological diversity. Such areas will have natural resistance to impacts such as disease and insects, and will exhibit a resiliency to other disturbances. The production and delivery of large woody debris to the stream system is also an important biotic and stability function in many river systems (Rosgen "B" and "C" channels).

Lack of multiple-age classes may indicate excessive interference from stressors such as livestock and wildlife grazing or hydrologic alteration. In some cases on intermittent, stable prairie streams, cottonwood stands are naturally even-aged, so evaluation must consider specie's potential to occur in multiple-aged communities. When the NRCS Ecological Site Description is not available to help determine woody plant species *potential*, the I.D. team should examine similar nearby stream corridors for clues.

Age classes of shrubs are based on relative height and stem size by species. Shrubs are generally considered in three age classes: 1) seedling/sapling; 2) mature; and 3) dead/decadent. Plants with stems up to 1 inch diameter and/or are no more than half as tall as the tallest individuals of that species at the site are considered seedling/sapling age. Mature native shrubs generally have stems larger than 1 inch in diameter, or those with reproductive structures. Dead and decadent are the same as shown in Table 3 below.

Age classes of trees are based on species and size, with the exception of Rocky Mountain juniper. It does not have a typical or consistent size, age, or growth form as compared to other coniferous trees. The evaluation team will have to estimate age classes of junipers based on relative size, reproductive ability, and overall appearance and vigor. As aggressive, exotic species, Russian olive and salt cedar are not counted as desirable woody species in this question.

Table 3. Table for Determining Age Classes of Trees

Age Class	Conifers and Cottonwoods	Other Broadleaf Species [1/]
Seedling	< 4.5 feet tall **or** < 1.0 inch dbh [1/]	< 3.0 feet tall
Sapling	≥ 4.5 feet tall **and** 1.0 to < 5 in. dbh	≥ 3.0 feet tall **and** < 3.0 in. dbh
Pole	≥ 5.0 inch to < 9.0 inch dbh	≥ 6.0 feet tall **and** ≥ 3.0 to < 5.0 inch dbh
Mature	≥ 9.0 inch dbh	≥ 5.0 inch dbh
Decadent	≥ 30% of the canopy is dead	≥ 30% of the canopy is dead
Dead	100% of the canopy is dead	100% of the canopy is dead

1/ green ash, box elder, peachleaf willow, quaking aspen and American elm
2/ diameter at breast height

- For purposes of this criterion, *presence* of a particular species in a reproductive class is indicated by the density of at least 10 individuals/reach.
- Do not count seedlings of the year until at least 1 year old as they may not live past the first winter.

QUESTION #8 SCORING

8 = all age classes of desirable woody riparian species present (see Table 3).

6 = one age class of desirable woody riparian species is clearly absent, all others well represented. Often, it will be the middle age group(s) absent. For sites with potential for both trees and shrubs there may be one age class of each absent. Having mature individuals and at least one younger age class present indicates the potential for recovery.

4 = two age classes (seedlings and saplings) of native riparian shrubs and/or two age classes of native riparian trees are clearly absent, or the stand is comprised of mainly mature species. Other age classes well represented.

2 = disturbance induced, (i.e., facultative, facultative upland species such as rose, or snowberry) or non-riparian species dominate. Woody species present consist of decadent/dying individuals. (Refer back to Question 1 if this is the situation. The channel may have incised.)

0 = a few woody species are present (<10% canopy cover), but herbaceous species dominate (at this point, the site potential should be re-evaluated to ensure that it has potential for woody vegetation). OR, the site has at ≥ 5% canopy cover of Russian olive and/or salt cedar. On sites with long-term manipulation or disturbance, woody species potential is easily underestimated.

<u>Question 9</u>. Utilization of Trees and Shrubs

NOTE: Skip this question and give an N/A on the worksheet if the site does not have woody species as a major component of the Historic Climax Plant Community, as indicated in the Ecological Site Description or riparian community classification (Hansen et al., 1995). Question 8 should also be completed the same way. Be sure to adjust the total <u>potential</u> score if these questions are skipped.

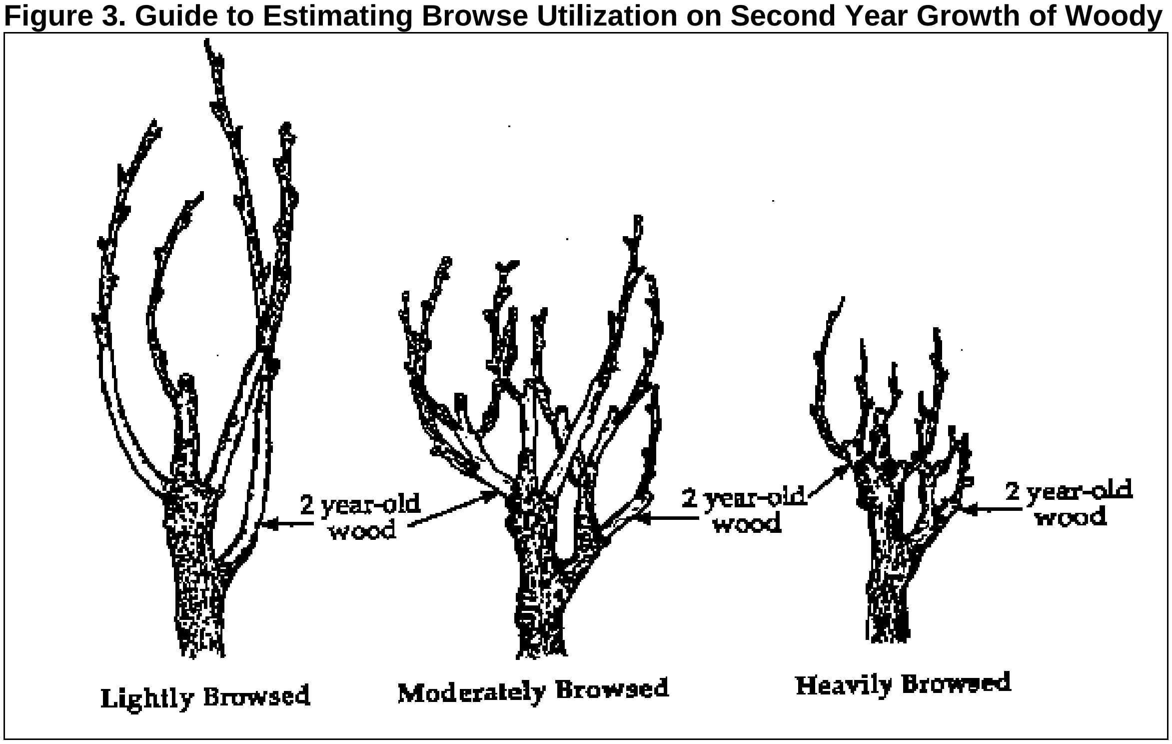
This question relates to vigor of woody riparian vegetation. Excessive use and damage can be by either domestic or native ungulates. The amount of use and/or mechanical damage can be an indicator of plant vigor. Excessive browsing or trampling of woody species eventually reduces their vigor and consequently their ability to increase or remain on the site. Sites that require woody species for sustainability and function will remain in a lower ecological condition as well as a weakened state for recruitment of new individuals as long as the excessive use or damage occurs.

The intent of this question is to determine if the degree of use and/or mechanical damage of the woody plants on a site are severe enough to limit their potential for recovery or maintenance of the riparian area. Generally, if there is much browsing of shrubs and trees where the older growth is consumed; there will be an eventual change in growth form. Such plants develop either a “highlined” or a “clubbed” appearance. Physical trampling and rubbing of shrubs and trees can also create “umbrella-shaped” specimens with the lowermost limbs removed. Appendices 5 and 6 depict the architecture or growth form of trees and shrubs described by Keigley and Frisina (1998) relative to browse condition and history.

Excessive use can prevent establishment and impede or halt natural succession on a riparian site. Eventually, the desirable native species are eliminated from a site and are replaced by undesirable invasive species, or herbaceous vegetation. Consider second-year or older twigs of species normally eaten by wildlife or livestock when estimating the extent of use. Figure 3 is provided as a guide to illustrate the appearance of degrees of browse utilization. Current year’s growth use should not be considered because it may lead to an underestimation since most of these evaluations are done during the growing season and some browsing continues all-year.

Significant use (i.e., 10% or more) of species normally not browsed can indicate other problems such as a lack of any other desirable forage. If this condition is clearly occurring, many of the other questions should have received low scores (i.e., plant cover, dominance by weeds, and/or undesirable plant species, etc.). Conditions during the previous summer or winter may have caused livestock to utilize some shrubs they normally would not. Part of the intent of this question is to determine if the heavy utilization is a yearly occurrence. Livestock and wildlife use should be noted as appropriate.

Figure 3. Guide to Estimating Browse Utilization on Second Year Growth of Woody Plants



Source: USDI, 1996. Utilization Studies and Residual Measurements

QUESTION #9 SCORING

4 = 0-5% of the available second year and older stems are browsed.

3 = 5%-25% of the available second year and older stems are browsed (lightly).

2 = 25%-50% of the available second year and older stems are browsed (moderately).

1 = more than 50% of the available second year and older stems are browsed (heavily). Many of the shrubs have either a “clubbed” growth form, or they are high-lined or umbrella shaped.

0 = there is noticeable use (10% or more) of unpalatable and normally unused woody species.

Question 10. Flood Plain Characteristics for Dissipating Energy and Capturing Sediment

Energy dissipation and sediment capture are important functions of flood plain areas and the included riparian area. The physical features of a riparian zone and flood plain commonly slow or re-direct flows. Important stream corridor features that dissipate high-flow energy and capture water-borne sediment include: 1) ready access to the adjacent flood plain (see Question 1); 2) dense stands of healthy riparian/flood plain vegetation (see Questions 4 and 5); and 3) the presence of overflow or flood channels, large rock, and/or large woody material, as appropriate for the stream type. These three attributes also provide suitable conditions for the establishment of new plants.

The examiner needs to consider the existence and impacts to flood plain function *capability* from human-built restrictions and alterations to the flood plain such as dikes, diversion and check structures, retaining walls, flood plain logging, clearing and snagging, channelization, and elevated roads or irrigation laterals.

Consider the nature of the channel and stream type with regard to what is “sufficient” in dissipating energy and capturing sediment. On eastern Montana prairie streams and low gradient, low energy streams elsewhere (Rosgen “E”-type channel), this ‘roughness’ characteristic that serves to dissipate energy may be provided by either herbaceous or woody (individual or in combination) riparian vegetation on the flood plain. Thunderstorm driven eastern Montana prairie streams typically do not exhibit the same level of flood plain flow frequency as do snowmelt driven mountain and foothill streams. Flood events of 10- to 25-year storm frequency may be required to access the flood plain.

Conversely, streams in the foothills and mountains typically require large rock, woody vegetation and/or debris on the flood plain to dissipate energy and capture sediment. Streams of Rosgen channel type “F” and “G” with bedrock substrate can be N/A for this question since flood plain functions are handled by the resistance of the rock. All other channel types should be evaluated as described.

The basic intent of this question is to determine if these flood plain characteristics are present and functioning. If so, at what level of stability or risk? Use comments to describe the *potential* and *actual* level of function based on the indicator descriptions below. Compare to your score for Question 1 - incisement.

QUESTION #10 SCORING

8 = Active flood or overflow channels exist in the flood plain. Large rock, woody debris, and/or riparian vegetation appropriate for the setting are sufficient to adequately dissipate stream energy and trap sediment on the flood plain. There is little evidence of excessive erosion or disturbance that reduces energy dissipation and sediment capture on the flood plain. There are no headcuts where either overland flow and/or flood channel flows return to the main channel.

6 = The flood plain meets the characteristics of the description in eight above, but demonstrates slight limitations in the kind and amount of large rock, woody debris, and/or riparian vegetation present. Riparian vegetation structure is below that required to dissipate energy. There may be occasional evidence of surface erosion and disturbance, but generally not extensive enough to have affected channel development.

4 = Rock, woody material, and/or riparian vegetation is present, but generally insufficient (quality or quantity) to fully dissipate stream energy. Some sediment may be captured, but greater evidence of incipient erosion and/or headcut is readily present.

2 = Inadequate rock, woody debris, and/or riparian vegetation available for dissipation of energy or sediment capture. There is very little evidence of sediment capture. There is some streambank erosion due to human disturbance or alterations, and occasional headcuts where overland flows or flood channel flows return to the main channel.

0 = Flood plain area reflects the following conditions: 1) The flood plain area is very limited or not present and is inadequate to dissipate energy; 2) flood or overflow channels do not exist; and 3) large rock, woody debris, and/or riparian vegetation is not adequate to dissipate stream energy and capture sediment on the flood plain. Streambank and/or flood plain erosion and/or evidence of human alteration are common. “G“- and “F”-type channels (Rosgen) typically reflect these conditions.

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RIPARIAN ASSESSMENT WORKSHEET

NAME OF STREAM:__________ **REACH LOC OR ID:**__________

DATE:__________ **ID TEAM/OBSERVERS:**__________

LENGTH OF REACH:__________ **LAT/LONG - BEGIN/END:**__________

MAP OR QUAD NAME:__________ **PHOTO #S:**__________ **PRIMARY LAND USE:**__________

PLANT COMMUNITY:__________ **ROSGEN CHANNEL TYPE:**__________ **BFDEPTH:**__________ **BFWIDTH:**__________

WIDTH/DEPTH RATIO:__________ **CHANNEL SUBSTRATE :**__________

Geomorphic Considerations

Question 1. Stream Incisement (Downcutting)

8 = Channel stable, no active downcutting occurring; or, old downcutting apparent but a new, stable riparian area has formed within the incised channel. There is perennial riparian vegetation well established in the riparian area (Stage 1 and 5, Schumm's Model Figure 2).

6 = Channel has evidence of old downcutting that has begun stabilizing, vegetation is beginning to establish, even at the base of the falling banks, soil disturbance evident (Stage 4, Schumm's Model Figure 2).

4 = Small headcut, in early stage, is present. Immediate action may prevent further degradation (Early Stage 2, Schumm's Model Figure 2).

2 = Unstable, channel incised, actively widening, limited new riparian area/flood plain, flood plain not well vegetated. The vegetation that is present is mainly pioneer species. Bank failure is common (Stage 3, Schumm's Model Figure 2).

0 = Channel deeply incised, resembling a gully, little or no riparian area, active downcutting is clearly occurring. Only occasional or rare flood events access the flood plain. Tributaries will also exhibit downcutting or signs of downcutting (Stage 2, Schumm's Model Figure 2).

The presence of active headcuts should nearly always keep the stream reach from being rated Sustainable.

SCORE: Potential__________ **Actual**__________

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:__________

Question 2. Streambanks with Active Lateral Cutting (inspect banks on both sides of the stream)

8 = Lateral bank erosion is in balance with the stream and its setting.

5 = There is a minimal amount of human-induced, active lateral bank erosion occurring, primarily limited to outside banks.

3= There is a moderate amount of human-induced active lateral bank erosion occurring on either or both outside and inside banks.

0 = There is extensive human-induced lateral bank erosion occurring on outside and inside banks and straight sections.

SCORE: Potential__________ **Actual**__________

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:__________

NAME OF STREAM:________________________________ **REACH ID:**________________ **DATE:**____________________

Question 3. The Stream is in Balance with the Water and Sediment Supplied by the Watershed

6 = The width to depth ratio appears to be appropriate for the stream type and its geomorphic setting. There is no evidence of excess sediment removal or deposition. There are no indications that the stream is widening or getting shallower. There may be some well-washed gravel and cobble bars present. Pools are common. Rosgen "B" and naturally occurring "D" channel types are exceptions.

4 = The stream has widened and/or has become shallower due to disturbances that have caused the banks to become unstable or from dewatering which reduces the amount of water and energy needed to effectively move the sediment through the channel. *(Note: Sediment sources may also be from offsite sources.)* Point bars are often enlarged by gravel with silt and sand common, and new bars are forming. Pools are common, but may be shallow. Rosgen "B" and naturally occurring "D" channel types are exceptions.

2 = The width to depth ratio exceeds what is appropriate for the stream type. Point bars are enlarged by gravel with abundant sand and silt, and new bars are forming that often force lateral movement of the stream. Mid channel bars are often present. For prairie streams there is often a deep layer of sediment on top of the gravel substrate. The frequency of pools is low. Rosgen "B" and naturally occurring "D" channel types are exceptions.

0 = The stream has poor sediment transport capability which is reflected by poor channel definition. The channel is often braided having at least 3 active channels. Naturally occurring Rosgen "D" channels types are exceptions. Pools are filled with sediment or are not existent.

SCORE: Potential____________________ **Actual**________________________

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:____

Vegetative Considerations

Question 4. Streambank with Vegetation (Kind) having a Deep, Binding Root Mass

Note: For stream types where riparian vegetation is not required for sustainability, this question can be skipped and given an N/A, with an explanatory note or comment. Be sure to adjust the potential score if this question is skipped. (See Appendix I for stability ratings for most riparian, and other, species.) Presence generally means more than one or two, healthy individuals of a species in the reach.

6 = The streambank vegetative communities are comprised of at least four plant species with deep, binding root masses.

4 = The streambank vegetative communities are comprised of at least three plant species with deep, binding root masses.

2 = The streambank vegetative communities are comprised of two plant species with deep, binding root masses.

0 = The streambank vegetative communities are comprised of one or no plant species with deep, binding root masses.

SCORE: Potential____________________ **Actual**________________________

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:____

Question 5. Riparian/Wetland Vegetative Cover (Amount) in the Riparian/Flood plain Area

Note: For stream types where riparian vegetation is not required for sustainability, this question can be skipped and given an N/A, with an explanatory note or comment. Be sure to adjust the potential score if this question is skipped.

6 = More than 85% of the riparian/wetland canopy cover has a stability rating $\geq$ 6

4 =75%-85% of the riparian/wetland canopy cover has a stability rating $\geq$ 6

2 =65%-75% of the riparian/wetland canopy cover has a stability rating $\geq$ 6

0 = Less than 65% of the riparian/wetland canopy cover has a stability rating $\geq$ 6

NOTE: A low score for this item may be enough to keep the stream reach from being rated Sustainable

SCORE: Potential____________________ **Actual**________________________

RIPARIAN ASSESSMENT WORKSHEET--continued

NAME OF STREAM:____ **REACH ID:**____________________ **DATE:**______________________

Question 5--continued

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:____

Question 6. Noxious Weeds in the Riparian Area

3 = None of the riparian area has noxious weeds present.

2 = Up to 5% of the riparian area has noxious weeds (a few are present).

1 = Up to 10% of the riparian area has noxious weeds present (abundant).

0 = Over 10% of the riparian area has noxious weeds (very apparent and extensive distribution).

SCORE: Potential_________________________ **Actual**________________________________

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments (<u>NOTE--List all noxious weed species</u>):____

Question 7. Disturbance-Caused Undesirable Plants in the Riparian Area

3 = 5% or less of the riparian area with undesirable plants (very few present).

2 = 5-10% of the riparian area with undesirable plants (few are present).

1 = 10-15% of the riparian area with undesirable plants (commonly distributed).

0 = Over 15% of the riparian area with undesirable plants (abundant over much of the area).

SCORE: Potential_________________________ **Actual**________________________________

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments (<u>NOTE--List all nuisance weeds and undesirable plants</u>):____

Question 8. Woody Species Establishment and Regeneration

Note: For stream types where riparian vegetation is not required for sustainability, this question can be skipped and given an N/A, with an explanatory note or comment. Be sure to adjust the <u>potential</u> score if this question is skipped. At least 10 individuals in a class should be present in the reach to count. Count only 1+ years of age. Do not count seedlings of the year as mortality is very high the first year.

8 = All age classes of desirable woody riparian species present (see Table 3).

6 = One age class of desirable woody riparian species is clearly absent, all others well represented. Often, it will be the middle age group(s) absent. For sites with potential for both trees and shrubs there may be one age class of each absent. Having mature individuals and at least one younger age class present indicates the potential for recovery.

4 = Two age classes (seedlings and saplings) of native riparian shrubs and/or two age classes of native riparian trees are clearly absent, or the stand is comprised of mainly mature species. Other age classes well represented.

2 = Disturbance induced, (i.e. facultative, facultative upland species such as rose, or snowberry) or non-riparian species dominate. Woody species present consist of decadent/dying individuals. (Refer back to Question 1 if this is the situation. The channel may have incised.)

0 = A few woody species are present (<10% canopy cover), but herbaceous species dominate (at this point, the site potential should be re-evaluated to ensure that it has potential for woody vegetation); or, the site has at ≥ 5% canopy cover of Russian olive and/or salt cedar. On sites with long-term manipulation or disturbance, woody species potential is easily underestimated.

RIPARIAN ASSESSMENT WORKSHEET--continued

NAME OF STREAM:____________________ **REACH ID:**__________ **DATE:**__________

Question 8. Woody Species Establishment and Regeneration--continued

SCORE: Potential____________ **Actual**____________

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:________________________________

Functional Considerations

Question 9. Utilization of Trees and Shrubs
Note: For stream types where riparian vegetation is not required for sustainability, this question can be skipped and given an N/A, with an explanatory note or comment. Be sure to adjust the potential score if this question is skipped.

4 = 0-5% of the available second year and older stems are browsed.

3 = 5%-25% of the available second year and older stems are browsed (lightly).

2 = 25%-50% of the available second year and older stems are browsed (moderately..

1 = More than 50% of the available second year and older stems are browsed (heavily). Many of the shrubs have either a "clubbed" growth form, or they are high-lined or umbrella shaped.

0 = There is noticeable use (10% or more) of unpalatable and normally unused woody species

SCORE: Potential____________ **Actual**____________

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:________________________________

Question 10. Flood plain Characteristics for Dissipating Energy and Capturing Sediment

8 = Active flood or overflow channels exist in the flood plain. Large rock, woody debris, and/or riparian vegetation appropriate for the setting are sufficient to adequately dissipate stream energy and trap sediment on the flood plain. There is little evidence of excessive erosion or disturbance that reduces energy dissipation and sediment capture on the flood plain. There are no headcuts where either overland flow and/or flood channel flows return to the main channel.

6 = The flood plain meets the characteristics of the description in Question 8 above, but demonstrates slight limitations in the kind and amount of large rock, woody debris, and/or riparian vegetation present. Riparian vegetation structure is below that required to dissipate energy. There may be occasional evidence of surface erosion and disturbance, but generally not extensive enough to have affected channel development.

4 = Large rock, woody debris, and/or riparian vegetation is present, but generally insufficient (quality or quantity) to fully dissipate stream energy. Some sediment may be captured, but greater evidence of incipient erosion and/or headcuts is readily present.

2 = Inadequate Large rock, woody debris, and/or riparian vegetation is available for dissipation of energy or sediment capture. There is very little evidence of sediment capture. There is some streambank erosion due to human disturbance or alterations, and occasional headcuts where overland flows or flood channel flows return to the main channel.

0 = Flood plain area reflects the following conditions: 1) The flood plain area is very limited or not present and is inadequate to dissipate energy; 2) flood or overflow channels do not exist; and 3) large rock, woody debris, and/or riparian vegetation is not adequate to dissipate stream energy and trap sediment on the flood plain. Streambank and/or flood plain erosion and/or evidence of human alteration are common. "G"- and "F"-type channels (Rosgen) typically reflect these conditions.

SCORE: Potential____________ **Actual**____________

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:________________________________

NAME OF STREAM:________________________ REACH ID:____________________ DATE:____________

SUMMARY

		SCORE POTENTIAL	SCORE ACTUAL	POSSIBLE
QUESTION 1:	Stream Incisement	____	____	0, 2, 4, 6, 8
QUESTION 2:	Lateral Cutting	____	____	0, 3, 5, 8
QUESTION 3:	Stream Balance	____	____	0, 2, 4, 6
QUESTION 4:	Deep, Binding Rootmass	____	____	N/A, 0, 2, 4, 6
QUESTION 5:	Riparian/Wetland Vegetative Cover *	____	____	N/A, 0, 2, 4, 6
QUESTION 6:	Noxious Weeds	____	____	0, 1, 2, 3
QUESTION 7:	Undesirable Plants	____	____	0, 1, 2, 3
QUESTION 8:	Woody Species Establishment	____	____	N/A, 0, 2, 4, 6, 8
QUESTION 9:	Browse Utilization	____	____	N/A, 0, 1, 2, 3, 4
QUESTION 10:	Riparian Area/Flood plain Characteristics *	____	____	N/A, 0, 2, 4, 6, 8
	TOTAL	____	____	(60 total possible)

(POTENTIAL SCORE FOR MOST BEDROCK OR BOULDER STREAMS) **(36)**
(questions 1, 2, 3, 6, 7, 10)

(POTENTIAL SCORE FOR MOST LOW ENERGY "E" STREAMS) **(48)**
(questions 1 – 7, 10)

RATING: = $\frac{\text{Actual Score}}{\text{Potential Score}}$ **X 100 = % rating**

80-100% = SUSTAINABLE
50-80% = AT RISK
LESS THAN 50% = NOT SUSTAINABLE

*** Only in certain, specific situations can both of these receive an "N/A".**

Please clarify the rationale for your rating, including comments regarding potential. Can the limitations be addressed by the decision maker?

NOTES____

TREND: Does the reach appear to be improving or declining? Explain.

Appendix 1: Glossary of Commonly Used Terms

Capability – The highest stable ecologically stable state possible for a reach, but is limited by political, social and/or economic constraints.

Ephemeral stream – A stream that flows briefly and only in direct response to local precipitation, and whose channel is always above the water table.

Facultative species – A plant species that occurs about equally in wetlands and uplands. Symbol is FAC.

Facultative upland species – A plant species that occurs most of the time in uplands; its frequency of occurrence in wetlands is between 1 to 33% of the time. Symbol is FACUP.

Facultative wetland species – A plant species that occurs more often than not in wetlands; its frequency of occurrence in wetlands is between 67 and 99% of the time. Symbol is FACW.

Flood Plain – Lowlands bordering a river which are subject to recurrent flooding. Flood plains are composed of sediments carried by rivers and deposited on land during flooding.

Flood prone area – As used here, refers to the area inundated by a discharge elevation two times the average bankfull depth.

Geomorphology – refers to the scientific study of the forms of the earth surface and the processes creating them. It is based on the Greek roots, *geo* meaning earth; *hos* referring to form; and *logos* meaning discourse.

Hydrophytic vegetation – Plant life growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.

Intermittent stream – One in contact with the groundwater table that flows only at certain times of the year as when the groundwater table is high and/or when it receives water from springs or from some surface source (e.g., melting snow in mountainous areas). It ceases to flow above the stream bed when losses from evaporation or seepage exceed the available stream flow. Also, a stream that normally flows for at least thirty (30) days after the last major rain of the season and is dry a large part of the year.

Interrupted stream – A stream that contains alternating reaches that are either perennial, intermittent, or ephemeral.

Macrophyte – A member of the macroscopic plant life of an area, especially of a body of water; large aquatic plant; the term 'aquatic macrophyte' has no taxonomic significance.

Obligate wetland species – A plant species that is nearly always found in wetlands; its frequency of occurrence in wetlands is 99% or more. Symbol is OBL.

Obligate upland species – A plant species that very seldom is found in wetlands; its frequency of occurrence in wetlands is less than 99% of the time. Symbol is OBLUP.

Perennial stream - A stream that flows continuously throughout the year.

Point bar – Sediment deposited along the inside margin of bends or meanders in streams and rivers caused by the reduced velocity along the inner radius.

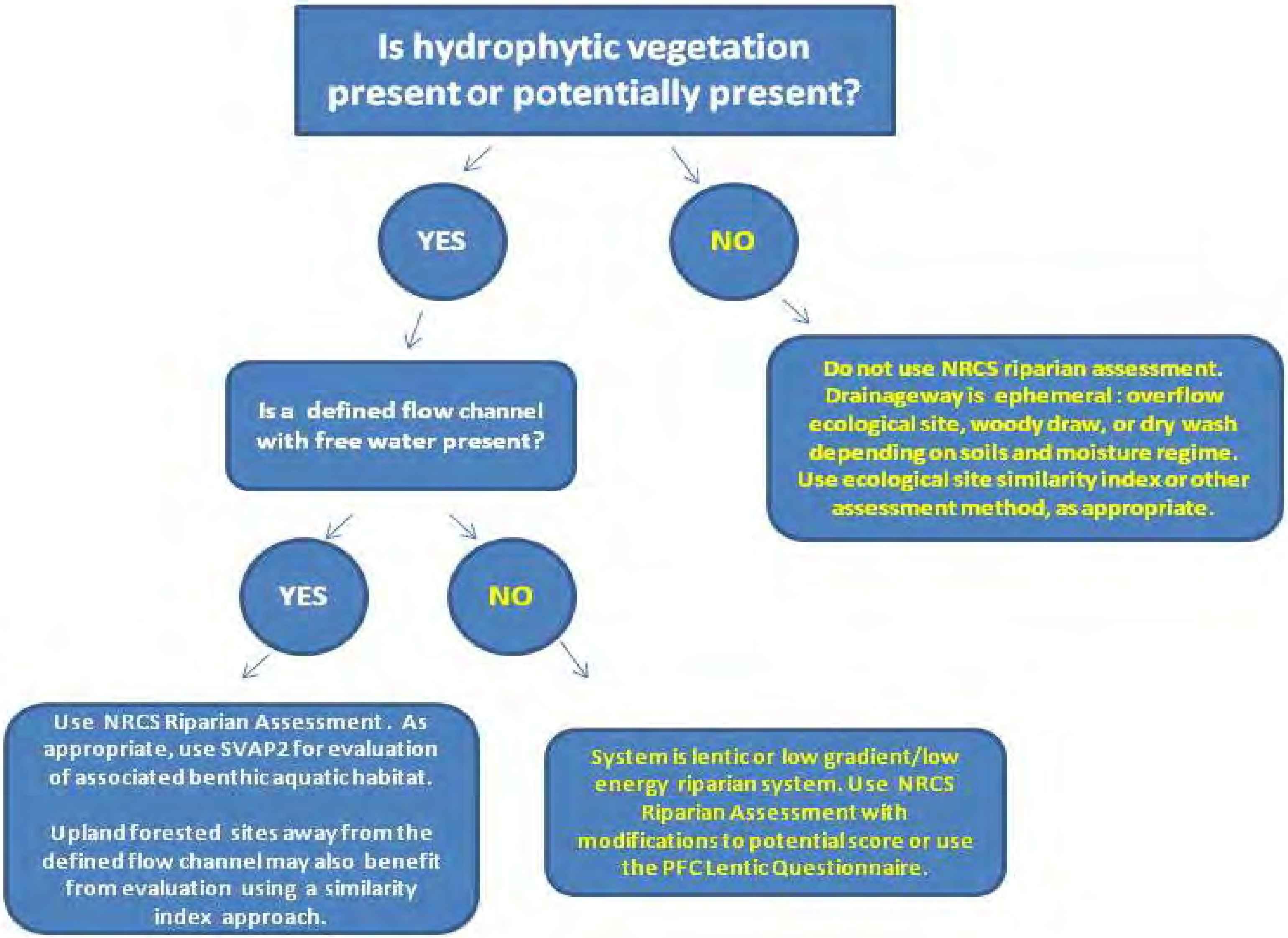
Potential - As used here, the term refers to the highest ecologically stable state possible for a stream reach, without significant human interference. Potential is influenced by the natural interactions of hydrology, soils, and climate affecting the reach.

Riparian – Many definitions of riparian are currently in use in addition to the term's historical association with water law. NRCS uses the following science-based definition of the term: "Riparian areas are ecosystems that occur along watercourses and water bodies. They are distinctly different from the surrounding lands because of unique soil and vegetation characteristics that are strongly influenced by free or unbound water in the soil. Riparian ecosystems occupy the transitional area between the terrestrial and aquatic ecosystems. Typical examples would include flood plains, streambanks, and lakeshores".

Stream order – A number from 1 to 6 or higher, ranked from headwaters to river terminus that designates the relative position of a stream or stream segment in a drainage basin network. First-order streams have no discrete tributaries; the junction of two first-order streams produces a second-order stream; the junction of two second-order streams produces a third-order stream; etc.

Woody debris – A large piece of relatively stable woody material having a diameter greater than 30 centimeters (12 inches) and a length greater than 2 meters (6 feet) that intrudes into the stream channel. Specific types of large woody debris include floating logs, boles, deadheads, root wads, etc.

Appendix 2. Riparian Assessment Decision Matrix



APPENDIX 3. RIPARIAN ASSESSMENT EXAMPLES – ROSGEN CHANNEL CLASSIFICATIONS

G channel classification is a deeply incised, gully-like channel with no floodplain available.

B channel classification with large woody debris and boulders forming stepped, plunge pools. Gradient is 2 – 4%.

Moderately graded (<2%) C channel classification with well-vegetated point bar on right bank.

Braided D channel classification on the Madison River above Ennis Lake due to the influence of the sediment deposited on the delta.

E channel classification with wide floodplain. Wetland/riparian vegetation likely represents near potential plant community. Gradient is less than 2% and sinuosity > 1.5.

Steep (≥4% slope) A channel in headwaters showing torrent-like flow path and scour.

APPENDIX 3. RIPARIAN ASSESSMENT EXAMPLES – SCHUMM'S CHANNEL EVOLUTION MODEL

Stage I showing stable channel with good floodplain access, prior to modification. Bank height is subcritical. E channel classification.

Stage II showing incision and loss of floodplain access. Floodplain accessed only during rare flood events.

Stage 3 unstable channel as deepening and widening occurs under bank failure and sediment removal. G channel classification. Riparian vegetation establishment is difficult.

Stage 4 channel shows signs of stabilizing. Bank failure less common as vegetation begins colonizing at toe of banks. Deposition builds floodplain within wide and deep channel.

Stage 5 shows many features of stability and equilibrium with the new floodplain. C channel. Stage 1 floodplain is now an upper terrace.

Stable channel illustrates equilibrium conditions with the landscape and climate.

APPENDIX 3. RIPARIAN ASSESSMENT EXAMPLES – INDICATORS

Learn to look for and recognize riparian zone and floodplain boundaries and indicators in all sizes of waterways.

Understanding bankfull width is critical to assessing channel function and processes. Typical indictors are vegetation breaks and high water debris lines.

If possible, observe the waterway at various flow stages to better understand the relationships that drive channel and riparian function.

Look at a number of sites within the area of interest to develop an understanding of the stream's potential relative to channel dimension, floodplain elevation, and riparian structure.

APPENDIX 3. RIPARIAN ASSESSMENT EXAMPLES – PRAIRIE SYSTEMS

This ephemeral drainage does not have a water table above the channel bottom and does not support hydrophytic vegetation given the hydrology and soil. Widely scattered cottonwoods represent an interrupted system under seepage conditions created by occasional perched moisture levels. The MT NRCS Riparian Assessment does not fit this situation. Use ecological site similarity index to evaluate sustainability, as needed.

Reach with intermittent pools that reflect a water table above the channel bottom and hydrophytic vegetation (FACW or OBL species) present. Use the MT NRCS Riparian Assessment to evaluate sustainability of this system.

Lentic riparian setting on low gradient drainage is reflected in no apparent channel present and hydrophytic herbaceous vegetation. May have infrequent scour pools. MT NRCS Riparian Assessment can be used to evaluate this drainage system with modifications to vegetative potential and related scoring criteria or use PFC Lentic Assessment questionnaire.

A narrow band of hydrophytic vegetation borders this drainage channel. This system is a complex, interrupted system driven by a fluctuating water level in the alluvium as one moves downstream. Use the MT NRCS Riparian Assessment if the majority of the channel length has the potential for hydrophytic vegetation.

This portion of the channel has aggraded and does not exhibit hydrophytic vegetation. Channel response is flashy and storm driven. The MT NRCS Riparian Assessment does not fit this situation since no riparian vegetation is present and the potential does not exist under the present hydrology and soil.

An intermittent waterway with long, slow pools separated by dry riffles. Saline soil and groundwater seepage reduce the potential for woody riparian vegetation yet stability is provided by adapted FACW and OBL wetland species.

APPENDIX 3. RIPARIAN ASSESSMENT EXAMPLES – POTENTIAL AND CAPABILITY

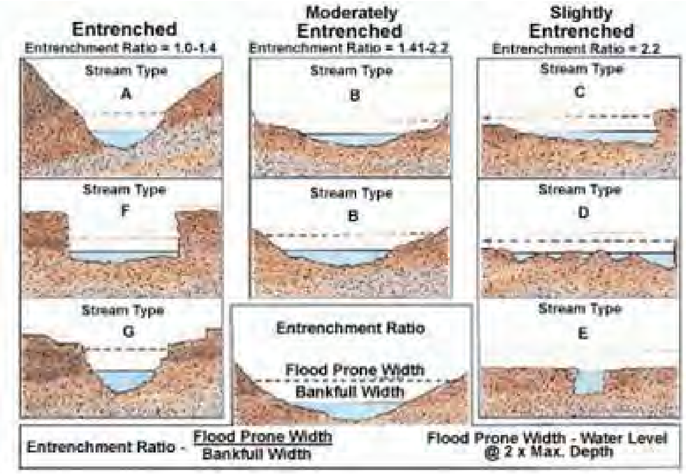
Stream near its potential for form, pattern, dimension, sediment transport, and riparian vegetation. Each stream needs to be evaluated against its own landscape, soils, climate, and hydrologic potential.

Capability of a waterway is affected by restrictions imposed by other than environmental influences such as dams, roads, irrigation withdrawals and other human sources. Capability may be difficult to change and usually impacts restoration options.

Road and railroad fill alters the capability of the channel, riparian zone and flood prone area due to changes in channel length, gradient, sediment transport, energy dissipation, and other channel forming processes and attributes. It does appear that occasionally, these restrictions are removed by the original channel forming processes.

Highway fill and channelization alters the capability of a prairie stream system. Expect to see changes in riparian vegetation, sediment transport, floodplain access, and hydrology in such cases. These changes usually influence how the system responds to major flood events.

APPENDIX 3. RIPARIAN ASSESSMENT EXAMPLES – QUESTION #1 STREAM INCISEMENT



Knowledge of channel types and cross sectional aspect help to identify the degree of entrenchment and appropriate scoring.

Visible scour of erosion resistant substrate layers may be an indication that entrenchment has occurred.

Active downcutting and initiation of widening is present, very unstable banks. Stage 3 Schumm's Model = Score 2.

Small headcut in early stage. Immediate action may prevent further degradation. Early Stage 2 Schumm's model = Score 4.

Channel is deeply incised, active downcutting. No riparian area present. Stage 2 Schumm's Model = Score 0.

Channel has begun stabilizing. Vegetation establishing at base of banks. Stage 4 Schumm's Model = Score 6.

APPENDIX 3. RIPARIAN ASSESSMENT EXAMPLES – QUESTION #2 LATERAL CUTTING

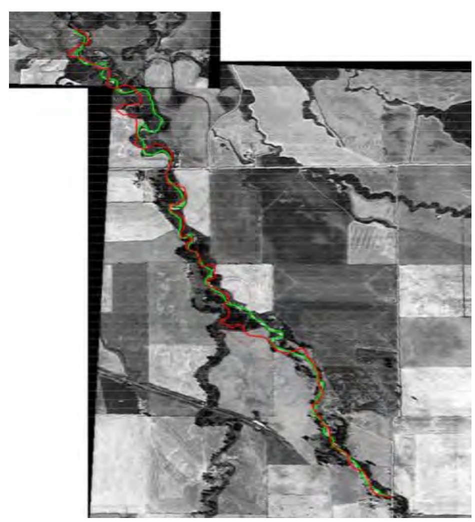
Lateral movement is in balance with the stream and its setting. Score = 8.

Bank erosion of high scarp in this case is accelerated by flooding and is not directly impacted by human practices at the site. Score in this case would be a 5.

Moderate bank erosion occuring on isolated outside bends adjacent to hay field. Score = 3.

Extensive bank erosion on inside and outside banks and along straight sections. Score = 0.

Channel migration should occur in equilibrium between inside and outside bends at meander crossovers. Vegetated point bars are one indicator that channel migration is in equilibrium.



Historic aerial imagery can be used to compare channel location over time to determine historic rate of channel migration for a particular system.

Appendix 3. Riparian Assessment Examples – Question #3 Water and Sediment Supply Balance

Poor sediment transport function results in undefined channel and sediment filled pools. Score = 0.

Width to depth ration exceeds what is expected for the stream type. Extensive bar formation is evident. Score = 2.

Stream is somewhat wider than expected due to bank erosion and other stressors. Bar formation present. Pools present but are shallower. Score = 4.

This prairie stream is wider than expected for the stream type and geomorphic setting. Sediment supply is naturally high, however, mid-channels bars indicate some imbalance. Score 4.

This stream is in balance with the water and sediment supply. Width/depth is appropriate and no evidence of excessive deposition. Pools are common and deep. Score = 6.

Sediment transport function is regulated by channel dimension, gradient, and discharge. Channel modifications that don't recognize these relationships are doomed to fail. Walla Walla River 1964 (OSU Archives).

APPENDIX 3. RIPARIAN ASSESSMENT EXAMPLES – QUESTION #4 VEGETATION (KIND) WITH A DEEP, BINDING ROOTMASS

Example of a riparian plant community with more than 4 species of plants with a deep, binding root mass. Several willow and sedge species provide bank stability. Score = 6.

Three, deep-rooted species are present in this section with some signs of instability as a result. One willow species, boxelder maple, and one sedge species present. Score = 4.

Two species of plants with a deep, binding root mass are present at this location; one species of willow and reed canarygrass. Score = 2.

One or less specie of deep-rooted plant is present at this location. Only shallow-rooted plants present. Score = 0.

When available, grazing exclosures help to determine the riparian species' potential.

Dense and deep, binding root mass of herbaceous plants help to give stability to streambanks, particularly when vertical.

Appendix 3. Riparian Assessment Examples – Question #5 Vegetation (Amount) With A Deep, Binding Rootmass

Stream with over 85% canopy cover of species with a deep, binding root mass. Score = 6.

75 to 85% of the riparian/wetland canopy has a stability rating ≥ 6. Score = 4.

Riparian/deep-rooted wetland vegetation is between 65 and 75% canopy cover. Score = 2.

Less than 65% of the riparian/wetland canopy cover has a stability rating 6. Primarily shallow-rooted, introduced grasses are present. Score = 0.

Although the riparian/wetland canopy here consists of only a few species, the willow and sedge species are both deep-rooted and constitute 100% of the cover. Score = 6.

While some grass species may dominate a moist site, such as this Garrison creeping meadow foxtail, they do not have a stability rating greater than 6. Rarely would the score be higher than 2.

APPENDIX 3. RIPARIAN ASSESSMENT EXAMPLES – QUESTION #6 NOXIOUS WEEDS IN THE RIPARIAN AREA

Extensive and frequent occurrence of salt cedar (tamarix) results in a score = 0. Note that Russian olive is not currently a noxious weed in MT and therefore is not considered under question #6, but it is included in scoring under question #7, undesirable/exotic species.

Frequent distribution of perennial pepperweed and leafy spurge in this reach results in a score = 1 as 10 to 15% of the area is occupied by noxious weeds.

Canada thistle and common tansy are widespread and frequent throughout the riparian area. Score = 0.

Occasional noxious weed such as this St. Johnswort results in a score of 3 as < 5% of the area is occupied.

Spotted knapweed is a frequent invader on gravel bars and coarse sediment deposits in and along stream systems in western Montana.

APPENDIX 3. RIPARIAN ASSESSMENT EXAMPLES – QUESTION #7 UNDESIRABLE/EXOTIC PLANTS IN RIPARIAN AREA

The fine roots of quackgrass and smooth brome may be deep as seen here in this unconsolidated gravel and cobble material, but they don't have the mass and strength to provide the necessary bank stability.

These fine roots have a depth of about 18 inches but can't adequately bind the soil.

The dense, deep, and tough roots of wiregrass (Juncus balticus) provide good resistance to accelerated bank erosion as opposed to the other plants featured on this page.

Garrison creeping meadow foxtail, an introduced species, has fine, relatively shallow roots that equate to a stability rating of 5, not sufficient to provide channel bank stability. Garrison also tends to dominate the sites where it is adapted. Overall score is based on its occurrence throughout the riparian area of the reach being evaluated.

Appendix 3. Riparian Assessment Examples – Question #8 Woody Species Establishment

Skip question #8 if hydrology or soil (salinity in this case) prohibits the potential for woody species in the riparian community.

Woody species are not part of the potential in this mountain meadow, herbaceous (sedge) dominated plant community.

A riparian community with all age classes of the expected woody species present bodes well for sustainability. Score = 8.

This riparian community has good density of cover but has one age class missing. Score = 6.

Disturbance induced site where primarily upland herbaceous species dominate. Woody species present consist of decadent and dying individuals. Score = 2.

Very few adapted woody species are present and Russian olive ≥ 5% canopy cover in riparian zone causes score to = 0.

APPENDIX 3. RIPARIAN ASSESSMENT EXAMPLES – QUESTION #9

Degree of browse appears to be minimal at this location. 0 to 5% of available second year and older stems are browsed. Score = 4.

Somewhat shaped appearance of shrubs indicates that browsing use has influenced shrub architecture. Primarily annual growth used. 5 to 25% of second year and older stems are browsed lightly. Score = 3.

Moderate (25 to 50%) browse use score = 2.

High degree of browse use and physical damage results in umbrella shape to willows. Pugging or hummocks created by livestock use is also indicative of heavy use when wet. Score = 1.

Use of nearly 100% of annual and older stems on this willow plant. Score = 0.

Noticeable use of unpalatable or normally unused woody riparian species, silver buffaloberry, in this case. Score = 0.

Extensive, large woody debris provides sufficient roughness to adequately dissipate energy on the floodplain. Score = 8.

Woody debris and floodplain roughness is below that needed to dissipate energy. Some evidence of erosion or disturbance but not enough to affect channel development. Score = 6.

Floodplain has vegetation and woody debris present but is generally insufficient to fully dissipate energy. Slight erosion present where flow returns to main channel. Score = 4.

Inadequate riparian vegetation (herbaceous and woody) or woody debris to dissipate energy and capture sediment. Streambank alteration and some erosion is present. Score = 2.

Floodplain is very limited or not present and inadequate to dissipate energy. Streambank shows common evidence of erosion or human alteration. Score = 0.

Visible evidence of limited woody debris or adequate riparian vegetation along with human disturbance in the floodplain. Score = 0.

Appendix 4. Rosgen Stream Classifications

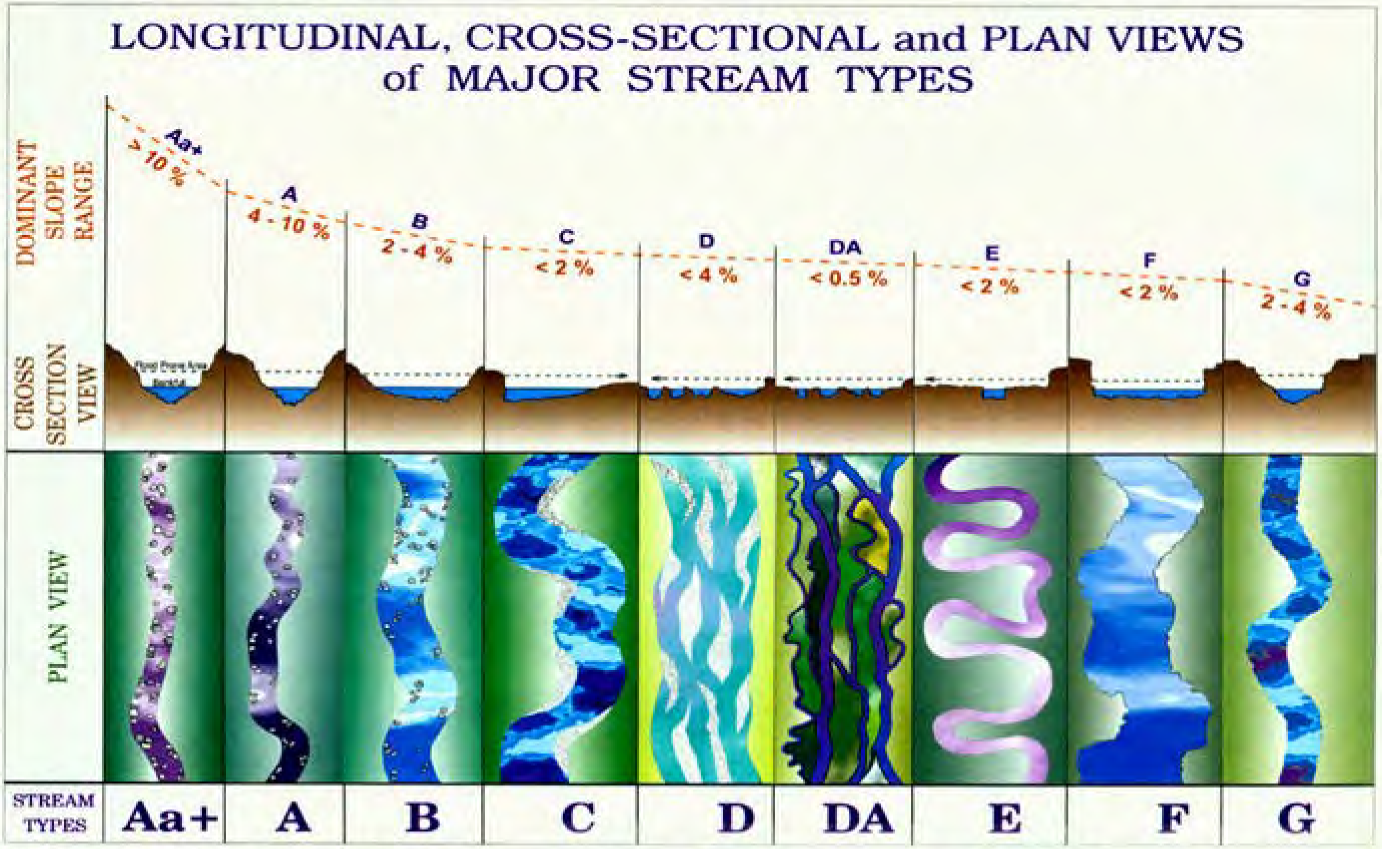


FIGURE 2. Broad level stream classification delineation showing longitudinal, cross-sectional and plan views of major stream types. (from Rosgen, 1994)

FIELD GUIDE FOR STREAM CLASSIFICATION by ROSGEN (1998) DR©

Appendix 5
Plant Stability Rating Table

Grass/Grasslike dominated communities [1/]

Plant Name	Stability Rating [1/]
Grasslikes	
Baltic rush	9
Beaked sedge	9
Buxbaum sedge	8
Creeping spikerush	6
Douglas sedge	4
Few flowered spikerush	5
Holm Rocky Mt. sedge	9
Lentil fruit sedge	4
Mud sedge	8
Nebraska sedge	9
Rock sedge	8
Short beaked sedge	8
Small fruited bulrush	9
Small winged sedge	4
Swordleaf rush	7
Three square bulrush	9
Water sedge	9
Woolly fruit sedge	8
Woolly sedge	9
Grasses	
Bluejoint reedgrass	8
Brookgrass	3
Common reedgrass	9
Creeping bentgrass	3
Garrison creeping foxtail	4
Kentucky bluegrass	3
Mannagrass	8
Mat muhly	3
Meadow barley	3
Nevada bluegrass	3
Orchardgrass	2
Quackgrass	3
Prairie Cordgrass	8
Redtop	2
Reed canarygrass	9
Shortawn foxtail	3
Slimstem reedgrass	7
Smooth brome	3
Timber oatgrass	3
Timothy	2
Tufted hairgrass	4
Water foxtail	3

Tall Willow dominated communities

Plant Name	Stability Rating
Bebb willow/mesic graminoid	7-10
Booth willow/water sedge	10
Booth willow/bluejoint reedgrass	10
Booth willow/Nebraska sedge	10
Booth willow/beaked sedge	10
Booth willow/horsetail	7
Booth willow/mesic forb	7-8
Booth willow/mesic graminoid	7-10
Booth willow/fowl bluegrass	7
Booth willow/Kentucky bluegrass	7
Booth willow/false Solomon seal	7
Drummond's willow communities	7
Coyote willow/barren community	6
Coyote willow/horsetail	7
Coyote willow/mesic forb	7-8
Coyote willow/mesic graminoid	7-10
Coyote willow/Kentucky bluegrass	6
Coyote willow/woods rose	8
Geyer's willow/water sedge	10
Geyer's willow/bluejoint reedgrass	9
Geyer's willow/beaked sedge	10
Geyer's willow/tufted hairgrass	7
Geyer's willow/mesic forb	7-8
Geyer's willow/mesic graminoid	7-10
Geyer's willow/fowl bluegrass	6
Geyer's willow/Kentucky bluegrass	6
Pacific willow/mesic forb	7-8
Lemmon willow/Holm Rocky Mt. sedge	10
Lemmon willow/water sedge	10
Lemmon willow/mesic forb	7-8
Lemmon willow/mesic graminoid	7-10
Lemmon willow/tall forb community	7
Yellow willow community	6
Yellow willow/mesic forb	6-10
Yellow willow/mesic graminoid	6-10
Yellow willow/Kentucky bluegrass	6
willow/rose	8
willow/beaked sedge	10
willow/mesic forb	6-8
willow/mesic graminoid	6-10
willow/Kentucky bluegrass	6
willow/tall forb community	7

[1/] 1 = least and 10 = greatest

Appendix 5
Plant Stability Rating Table -- Continued

Short willow dominated communities

Plant Name	Stability Rating [1/]
low willow/mesic forb	6-8
Eastwood willow community	7
Eastwood willow/Holm Rocky Mountain sedge	9
Planeleaf willow community	7
Planeleaf willow/water sedge	9
Planeleaf willow/bluejoint reedgrass	9
Planeleaf willow/Holm Rocky Mountain sedge	9
Planeleaf willow/tufted hairgrass communities	7
Wolf's willow/water sedge	9
Wolf's willow/beaked sedge	9
Wolf's willow/Holm Rocky Mountain sedge	9
Wolf's willow/tufted hairgrass	7
Wolf's willow/mesic forb	6-8

Tall deciduous tree dominated communities

Plant Name	Stability Rating
Box elder/red osier dogwood	9
Box elder/horsetail	8
cottonwood or aspen/water birch	8
cottonwood or aspen/red osier dogwood	8
cottonwood or aspen/Kentucky bluegrass	6
cottonwood or aspen/rose	6-7
cottonwood/bar	6
cottonwood or aspen/willow	8
cottonwood or aspen/dry graminoid	6

Short deciduous tree dominated communities

alder or water birch/red osier dogwood	8
alder or water birch/horsetail	7
alder or water birch/mesic forb	6-8
alder or water birch/mesic graminoid	6-8

Coniferous tree dominated communities

conifer/monkshood	6
conifer/baneberry	6
conifer/water birch	8
conifer/bluejoint reedgrass	8
conifer/redosier dogwood	8
conifer/tufted hairgrass	5
conifer/blue wildrye	6
conifer/horsetail	7
conifer/mesic forb	6
conifer/shrubby cinquefoil	6
conifer/Kentucky bluegrass	5
conifer/woods rose	7
conifer/tall forb	6
spruce/bluejoint reedgrass	8
spruce/redosier dogwood	8
spruce/bog birch	9
spruce/horsetail	7
spruce/bedstraw	6
lodgepole pine/Holm Rocky Mt sedge	8

Forb dominated communities

aster/bunchgrass communities	3
marshmarigold communities	6
bittercress communities	4
Canada thistle communities	6
Jeffrey shootingstar communities	3
horsetail communities	5-7
Rocky Mt. iris/dry graminoid	6
Rocky Mt. iris/mesic graminoid	6-8
lupine/groundsel	5
field mint communities	5
mountain bluebells communities	7
mesic forb meadow communities	4-6
monkeyflower communities	3
watercress communities	6
water buttercup communities	6
cattail communities	9
stinging nettle communities	7
American speedwell communities	3
California falsehellebore	6

[1/] 1 = least and 10 = greatest

Appendix 5
Plant Stability Rating Table

Non-willow shrub dominated communities

Plant Name	Stability Rating [1/]	Plant Name	Stability Rating
Silver sagebrush/tufted hairgrass	4	Silver sagebrush/dry graminoid	4
Silver sagebrush/K. bluegrass	4	Silver sagebrush/Idaho or sheep fescue	4
Silver sagebrush/mesic graminoid	4-6	Woods rose communities	6
Big sagebrush/woods rose	5	Redosier dogwood communities	7
Redosier dogwood/willow	8	Redosier dogwood/bedstraw	7
Redosier dogwood/cowparsnip	7	Shrubby cinquefoil/tufted hairgrass	5
Shrubby cinquefoil/Idaho fescue	5	Shrubby cinquefoil/ligusticum	5
Shrubby cinquefoil/Kentucky bluegrass	5	chokecherry/woods rose	6
		buckthorn communities	8

Non-Vegetated Types

Barren	1
Anchored rock	10
Anchored log	10

[1/] 1 = least and 10 = greatest

Appendix 6
Estimating Percent Composition

Questions four, five, six, and seven require estimation of the percentage of an area impacted by each criterion. Several methods may be used to determine the relative percentage of area. For estimation of a rectangular area such as a stream reach, riparian zone, or flood-prone area, Table 4 below may be used to visualize relative compositions of various sized stream reaches. Pacing or estimation of distance is sufficient for the level of detail required in this assessment method.

Table 4. Estimating Proportional Areas

Riparian Area Size	Proportional Size (feet)	Proportion (%)
¼ mile L x 150 feet W each side 396,000 sq. ft or 9.9 acres	20 x 20	0.1
	45 x 45	0.5
	140 x 140	5
	200 x 200	10
	244 x 244	15
¼ mile L x 50 feet W each side 132,000 sq. ft. or 3 acres	11 x 11	0.1
	26 x 26	0.5
	81 x 81	5
	115 x 115	10
	141 x 141	15

Example: Using Table II-1, an area infested with noxious weeds estimated to be 45 x 45 feet in size within a riparian corridor that is ¼ mile long and 150 feet wide on each side of the stream would have a proportional area of 0.5 percent.

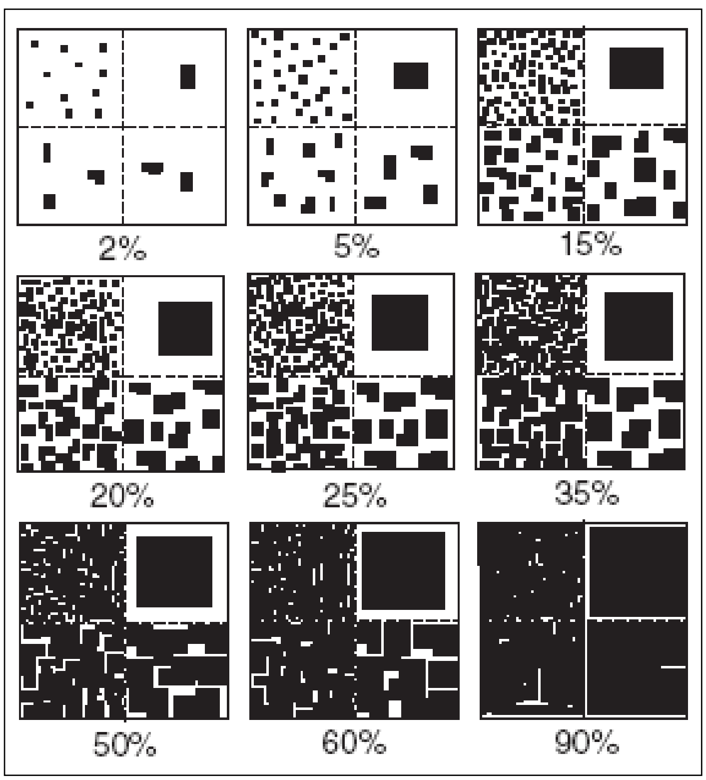
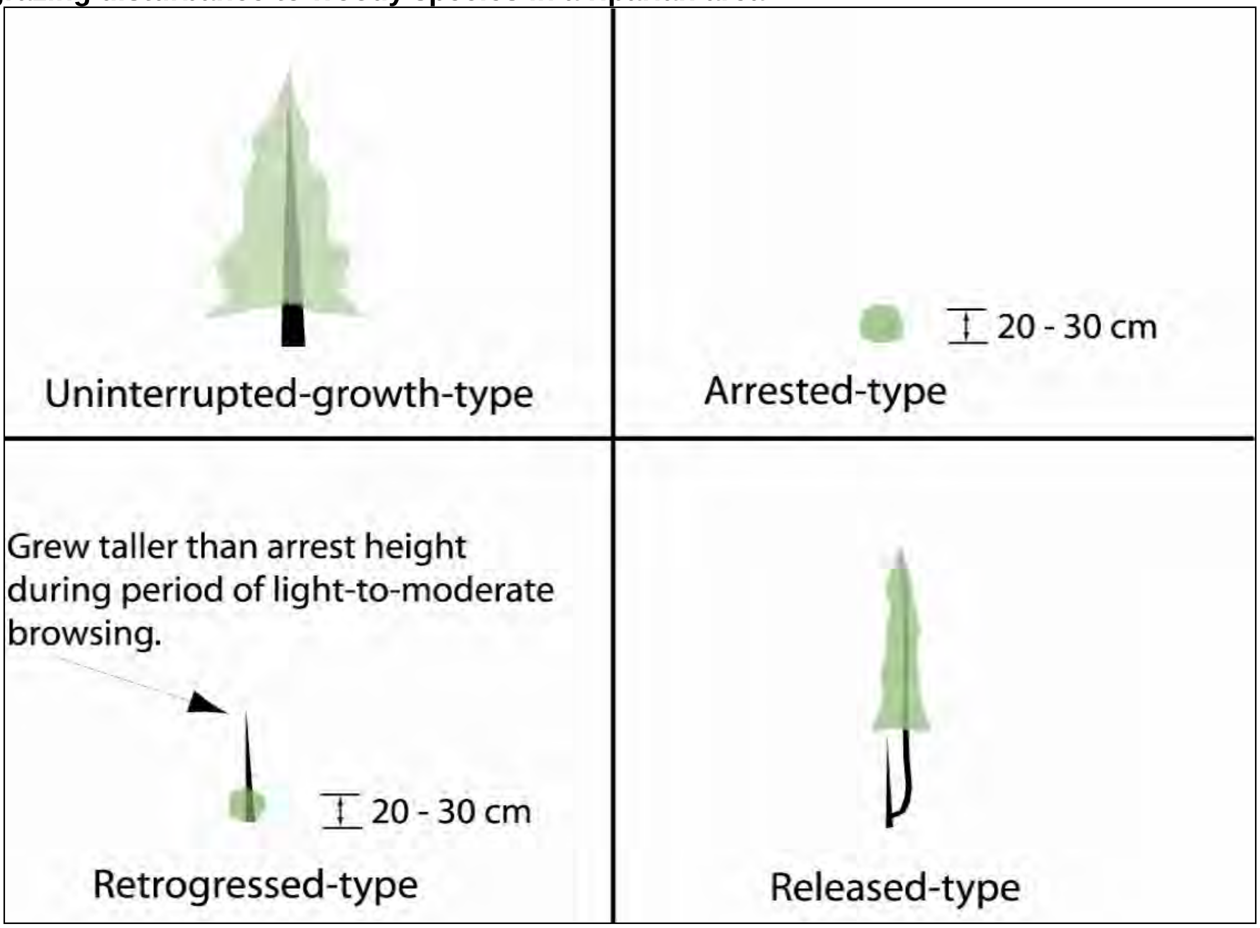


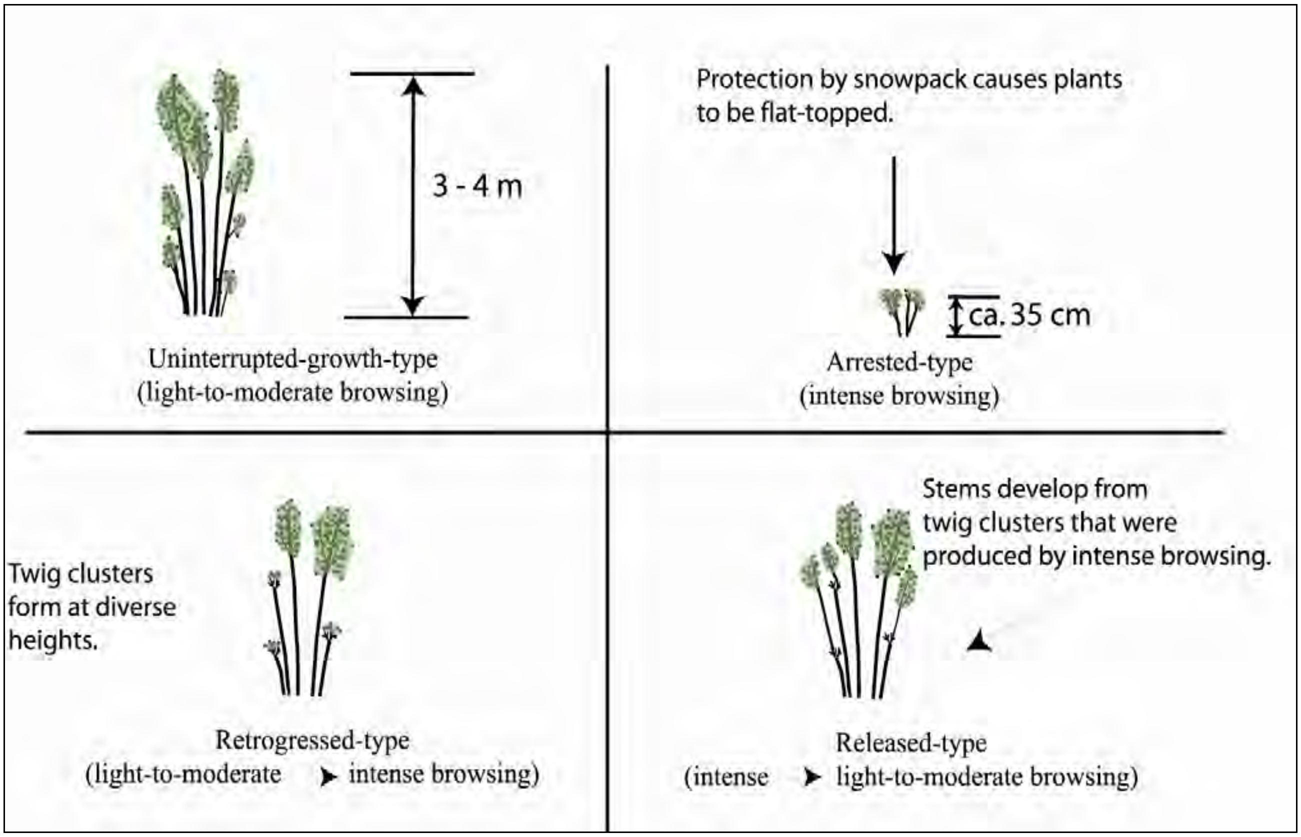
Figure 4. Dot matrix illustrations for estimating frequency of occurrence or percent composition. Source: Field Book for Describing and Sampling Soils (NSSC, 2002).

Appendix 7. Depiction of tree architectural form can be a very useful tool in visualizing the grazing disturbance to woody species in a riparian area.



Source: Keigley and Frisina 1998.

Appendix 8. Woody Shrub architecture relative to grazing history and impact



Source: Keigley and Frisina 1998.