Monitoring Stream Channels and Riparian Vegetation-Multiple Indicators

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INTRODUCTION

The purpose of *Monitoring Stream Channels and Riparian Vegetation—Multiple Indicators* (also referred to as "Multiple Indicator Monitoring" or the "MIM Protocol") is to provide an efficient and effective approach to monitoring streambanks, stream channels, and riparian vegetation. Monitoring within stream channels and their margins is particularly useful to the management of stream-dependent resources, including water quality and quantity, aquatic biota, and near-stream terrestrial biota. This protocol is designed to meet the recommendations in the *University of Idaho Stubble Height Study Report (University of Idaho Stubble Height Study Team 2004)* to integrate annual grazing use and long-term trend indicators. The monitoring procedures described in this document can be used to help evaluate livestock grazing management to determine whether the vegetation and stream channels are responding as anticipated. While the MIM protocol was initiated as a result of grazing management concerns, the long-term monitoring techniques described herein will provide useful data describing the general condition and trend of stream channels and riparian vegetation regardless of the kind of management activities occurring on the site.

An inevitable consequence of developing and testing a new monitoring protocol is that additions and refinements will occur. From the beginning, we have emphasized the use of existing techniques, as much as possible, to maintain consistency through time. For this reason, the techniques of the MIM protocol in this version have not been modified from previous versions. This version provides some minor clarifications, additional results of testing, and the addition of a new metric to account for the effect of riparian vegetation on terrestrial insect production. Recent research has demonstrated that terrestrial insect production is a major component of the diets for salmonid fishes and can be influenced by livestock grazing effects on riparian vegetation (Saunders and Fausch 2007). An overall description of grazing effects on stream fisheries and riparian vegetation can be found in Platts (1991).

Adaptive livestock grazing management, as described by the University of Idaho Stubble Height Study Team (2004), requires developing specific riparian and stream management objectives, a grazing management plan designed to meet those objectives, and long-term monitoring criteria used to evaluate success. Annual monitoring of livestock use helps determine if grazing management is being implemented as planned and if the plan is helping to achieve resource objectives. This includes monitoring annual indicators of grazing use, assessing the effects of this use on resource objectives, and then evaluating whether or not the grazing plan needs to be adjusted. This is consistent with the Department of Interior's recent policy to emphasize adaptive management in agency programs and procedural guidance (Sec. Order No 3270, 2007).

Trigger indicators of livestock use (e.g., residual stubble height, woody species use, streambank alteration, use compliance, changes in species preference) are monitored to determine when to move the animals to another grazing area. Endpoint indicators of livestock use (residual stubble height, woody species use, streambank alteration) are monitored after the end of the growing and grazing season to determine if the use or disturbance was within allowable levels. Endpoint monitoring data provides information necessary to evaluate the effect of grazing on long-term trends in stream and riparian habitat conditions.

Single indicators of condition or trend are usually not adequate to make good decisions (University of Idaho Stubble Height Study Team 2004). Data on the condition and trend of vegetation and stream channels (multiple indicators), combined with the knowledge of current management practices is the key to defining cause-and-effect relationships important for making well-informed decisions. Because of site complexity, it is not possible to know in advance which indicator(s) best detect management influences on stream and riparian condition. For that reason, using multiple indicators is suggested as a more complete and useful approach. Once cause-and-effect relationships have been established, it may be possible to select the specific indicator(s) that are most effective for detecting change at the site.

Appropriate vegetative cover, stream channel geometry (width and depth), substrates free of excess fine sediments, and high streambank stability are essential for achieving good water quality and aquatic habitat. Monitoring the current year's grazing impacts (short-term indicators) along with long-term indicators of riparian vegetation, streambank condition, and stream channel conditions at the same location, provides the basis for making grazing adjustments needed to achieve desired conditions. Annual indicators of grazing use (e.g., stubble height, streambank alteration, and woody species use) alone do not provide the data needed to determine condition and trend.

Previous approaches have been relatively inefficient partly due to the fact that separate protocols were required for each indicator. This protocol combines observations of up to ten indicators along the same transect, using simple refinements of the existing protocols. Since travel time to field sites represents a considerable time commitment, collecting multiple indicators at one location, using one protocol, is more efficient.

A critical component of understanding and detecting trends through time, despite natural variability in channel and riparian condition, is limiting the selection of monitoring indicators to those that are sensitive to disturbance and that can be measured objectively, precisely, and efficiently. This monitoring protocol is designed to maximize objectivity by emphasizing precision and accuracy. This is accomplished by selecting indicators that are measurable, locating observation points along the greenline according to strictly defined rules, and making class determinations using systematic procedures and classification keys.

This monitoring protocol addresses ten procedures that can be used to monitor streams and associated riparian vegetation. Seven procedures provide indicators for long-term (trend) monitoring:

1. **Modified greenline vegetation composition** (Winward 2000)**,**
2. **Modified woody species regeneration** (Winward 2000)**,**
3. **Streambank stability** (Henderson *et al.* 2004**,**
4. **Greenline-to-greenline channel width** (Burton *et al.* 2006),
5. **Maximum water depth** (Henderson *et al.* 2004)**,**
6. **Water width** (Henderson *et al.* 2004), and
7. **Substrate composition** (Bunte and 2001).

These indicators provide data to assess the current condition and trend of streambanks, channels, and vegetation. They help determine if local livestock grazing management strategies and actions are achieving the long-term goals and objectives for stream riparian vegetation and aquatic resources. Monitoring procedures for vegetation include modifications of greenline vegetation composition and woody species regeneration described by Winward (2000) and Coles-Ritchie *et al.* (2004). Streambank stability is a refinement of the PIBO method described by Henderson *et al.* (2004). The present authors developed the greenline-to-greenline width measurement. Greenline-to-greenline width is the non-vegetated width of the stream channel between the greenlines on each side of the stream. As stream channels recover from disturbance, the width between greenlines often decreases. This is because channel narrowing usually reflects increasing streambank stability and vegetative encroachment. Such narrowing is often associated with restored or enhanced fish habitat quality associated with increases in vegetative and overhanging bank cover, increased water depth, along with cleaner substrates.
Stream thalweg depth, width, and substrate parameters are measured at transects using methods similar to the PIBO protocol (Henderson *et al.* 2004).

Permanent photo points provide a long-term visual record of streambank and riparian conditions and trend. This protocol recommends a minimum number of photographs needed for an acceptable visual record. More detailed photos may be added if required to document or answer management questions.

Three indicators help determine whether current season's livestock grazing is meeting allowable use criteria. The protocol includes:

1. **Modified landscape appearance for livestock use on woody plants** (formerly the Key Forage Plant Method) (Interagency Technical Reference 1996),

2. **Modified residual vegetation (stubble height)** Interagency Technical Reference (1996) and Challis Resource Area (1999), and
3. **Streambank alteration** (Cowley 2004).

Procedures were modified to allow the use of a prescribed plot size that allows collecting data for all ten monitoring indicators in a single pass. Specific rules were developed to facilitate the use of the plot and to maintain consistency, precision, and accuracy in data collection.

In addition to documenting stream conditions and trend via field measurements, photos should also be used to document annual grazing use at the monitoring site. This helps those interpreting the data to visualize the data being analyzed, and to provide additional evidence of change through time.

The amount of residual vegetation (stubble height) left at the end of the season has a direct relationship to the long-term productivity of herbaceous riparian plants and can ultimately affect the composition of vegetation along the greenline (measured using the greenline vegetation composition procedure). Since streambank alteration by livestock can affect streambank stability, it is useful to monitor the amount of annual streambank disturbance. Shrub use, as measured by woody species use, can directly affect the long-term productivity of woody plants on the streambanks. Research has shown that heavy to extreme use by grazing animals every year is detrimental to plant health, while light to moderate use maintains overall plant health (Thorne *et al.* 2005). In addition, continued heavy to extreme use of woody species can limit the plant's ability to regenerate.

Selecting Designated Monitoring Areas (DMAs)

A designated monitoring area (DMA) is the location, or stream reach, where monitoring occurs. Essentially, there are three types of DMAs:

1. **Representative DMA**: A reach chosen to be representative of a larger area. Representative DMAs should be located within an identified riparian complex. Riparian complexes are defined by Winward (2000) as "a unit of land with a unique set of biotic and abiotic factors. Complexes are identified on the basis of their overall geomorphology, substrate characteristics, stream gradient and associated water flow features, and general vegetation patterns." Representative DMAs should be located in areas representative of grazing use (or other use) specific to the riparian area being assessed. Winward (2000) suggests that monitoring should be located at sites within the complex that "best represent influences of major activities in that complex." Generally, more than one riparian complex occurs in a management unit; therefore, the DMA should be placed in the riparian complex that is the most

sensitive to management influences. The premise is that if the DMA is placed in the most sensitive complex, and that complex is being monitored and managed to achieve desired conditions, the other less sensitive complexes will also be managed appropriately. However, it is inappropriate to place Representative DMAs in water gaps or other specific concentration zones (see critical DMA, defined below).

While the term "DMA" was initially established for grazing management applications, DMAs may be located in areas to monitor recreation impacts, the effects of roads, and other activities. Representative Designated Monitoring Areas are the most common type of DMA used by land managers.

The following criteria should be used to select Representative DMAs:

- Representative DMAs should only be selected by an interdisciplinary team of qualified personnel with a good understanding of stream functions and riparian ecology and a detailed knowledge of the area.

- Representative DMAs should occur within riparian complexes that best characterize major activities/uses in that complex (livestock grazing, recreation use, etc.).

- Where multiple riparian complexes occur in a management unit and it is not possible to establish DMAs in all complexes, select the one that is most sensitive to management influences.

- Representative DMAs should be placed in areas where it is clear that the achievement of established resource objectives can be monitored and measured. The site should have the potential to respond to and demonstrate measurable trends in condition resulting from changes in grazing management or other management activities influencing stream channels and riparian vegetation.

- Avoid placing DMAs on reaches impervious to disturbance where vegetation is not a controlling factor, such as cobble, boulder, and bedrock-armored channels.

- Avoid placing DMAs in streams over four percent gradient unless they have distinctly developed flood plains and vegetation heavily influences channel stability.

- Avoid putting representative DMAs at water gaps or locations intended for livestock concentration, or areas where riparian vegetation and streambank impacts are the result of site-specific conditions (such as along fences where livestock grazing use is not *representative* of the riparian area). These local areas of concentration may be monitored to address highly localized issues if necessary (in which case they would be described as "Critical DMAs" as defined below).

- Avoid placing DMAs in areas compounded by activities that make it difficult to establish cause-and-effect relationships. For example, an area used heavily by both recreationists and livestock would not make a good DMA to determine the effects of livestock grazing on stream conditions. In addition, avoid areas compounded by non-agency activities since the purpose is to monitor trends related to agency activities.

2. **Critical DMA:** A reach that is *not* representative of a larger area but important enough that specific information is needed at that particular site. Critical DMAs are monitored for highly localized purposes. Small critical spawning reaches when there may be concentrated livestock use is an example. Extrapolating data from a critical DMA to a larger area may not be appropriate.

3. **Reference DMA:** A reach chosen to obtain reference data useful for identifying potential condition, and for establishing initial desired condition objectives for a similar riparian complex. A common example is a grazing exclosure where livestock access to the stream is restricted.

After the DMA is selected, it is critical that the ID team document a clear and comprehensive rationale for the identification and selection of the chosen DMA location. This rationale should include a short discussion of the DMA selection process and the intent of collecting data at that site.

Selecting Appropriate Indicators

After the DMA has been located, it is important to select the appropriate objectives and indicators for the site and management strategy. Site potential or capability (vegetation and stream type); management objectives for vegetation, streambanks, and stream channel; timing, duration, and frequency of the grazing strategy; and monitoring questions must all be considered when selecting the indicators that are to be monitored (see Appendix B).

- General goals and/or broad objectives are usually established in the agency land use plans, i.e., forest resource plans, resource management plans (RMP), management framework plans (MFP), allotment management plans, ranch plans, and other management plans.

- An understanding of the basic geomorphic processes and vegetation responses is important to interpreting both the potential and the desired future condition of the stream. Streams with substrate and banks dominated by gravel, with limited fine sediment loads, are likely to be dominated by woody vegetation. In such instances, herbaceous vegetation is likely to be slow to develop, as these types require more fine soils to become established.

- Riparian Management Objectives should reflect the attainable condition. For example, incised stream channels may not likely fill with sediment under current climatic regimes. Miller *et al.* (2004) state, "The dominant process operating within the upland stream systems today is channel incision." Therefore, it is likely that incised channels will widen, develop a new floodplain, and stabilize the channel near the current elevation. In some rare instances, however, incised channels will fill with sediment and move toward a stable state at the elevation of the channel prior to incision.

Appropriate indicators may change over time. For example, if the DMA is dominated by herbaceous species with no woody species present, woody species regeneration and woody species use would not be selected as indicators. It is important to note that Winward (2000) indicates that there is a potential for willows and other woody species on most streams with a gradient of 0.05 percent or more and periodic over bank flooding with deposition. Woody species reproduction is episodic, as they require a seed source, freshly deposited soil, and moisture for a sufficient time to develop a root system adequate to support the seedling until it is established. When these conditions occur, it is appropriate to add woody species regeneration and woody species use to track the changes.

- Pastures that are in a rest period may only need validation that livestock use has not occurred. Stubble height, streambank alteration, and woody use monitoring may not be done during that year if it is not answering a specific question.

- Another situation that may be common is finding that one of the annual indicator thresholds is reached consistently before others, e.g., streambank alteration reaches threshold levels before woody species use or stubble height criteria are met. The decision may be to discontinue the stubble height and woody species use procedures and monitor only streambank alteration each year. However, caution must be exercised since the annual indicators can be affected differently based on the season of use. For example, maximum allowable willow use may be the first indicator met in a riparian zone used late in the fall (well before streambank alteration or stubble height). When the same pasture is used in the spring, it is unlikely that willow use will occur first—stubble height or streambank alteration would likely be affected first and therefore be the most appropriate indicator to monitor.

Establishing the Line Transect

After the DMA is selected, a permanently marked line transect is established on both sides of the stream. The following procedure should be followed when establishing the line transect:

- **TRANSECT or REACH:** The line transect at the DMA extends at least 110 meters (361 feet) along the stream. Longer reaches may be needed on larger streams (over 5.5 meters or 18 feet bankfull width), or those with extreme variability or site complexity.

- **REACH MARKER:** Permanently mark the lower and upper ends of the reach with *reach markers*. Place the lower marker on the left-hand side (looking upstream) and the upper marker 110 meters upstream (further if a longer reach is used). Steel t-posts are not recommended for reach markers since they attract livestock and will lead to concentrated impacts on the reach. Reach markers should be made of securely capped or bent over larger-diameter rebar or similar material. Straight, jagged, rebar stakes that are not capped or bent over present a serious hazard to horses and other animals. Pace 110 meters (361 feet) up the stream along the thalweg or greenline and place the upstream marker on the right-hand side (looking upstream). Reach markers should be placed a sufficient distance from eroding banks to reduce the risk of losing the marker.

- **REFERENCE MARKER:** A permanent *reference marker* should be used as a reference point to help relocate the DMA. Reference markers should be located well away from the Transect (at least 100 feet if a post that attracts livestock is used). Reference markers can be steel posts, a marked post in a fence line, a marked tree or unique rock, or other natural feature. Provide a geographic positioning system (GPS) location (UTM or latitude-longitude) for both the reference marker, and the reach markers. Sketch the monitoring setup to make sure future visits use the same starting point on the stream.

Skills, Training, Collection Time, and Equipment

Skills

Individuals must have a basic understanding of riparian ecology and stream function. This requires knowledge of riparian species identification, erosion, and deposition processes.

Training

Training is required to successfully apply this monitoring protocol. As a minimum, observers should receive the basic 2-day training module, including the overview, field demonstration, field data collection, and data analysis. Ideally, field practitioners should also apply the protocol for several field days in the presence of trainers to gain proficiency in the methodology. For example, bank alteration measurement variability among observers was reduced from about 30 percent variability without training to about 12 percent with training.

Collection Time

If all ten indicators are monitored in the same year, sample time is approximately 2 to 4 hours per site. Normally, a subset of the indicators is chosen in a given year which usually reduces sampling time to about 2 hours per site.

Equipment

See Appendix O.

MONITORING PROCEDURES

1. These procedures were designed to be completed at summer low flows. High water flows obscure greenlines and streambanks; attempts to collect data during these periods will result in unusable data. In addition, do not use these monitoring procedures immediately following a flood or high flow event resulting in sediment deposition and scour. Sediment deposition and scour makes it difficult, if not impossible, to determine the effects of the current season livestock use, and some vegetation may be temporarily buried.

2. Long-term (trend) monitoring data should be gathered at three to five-year intervals. This allows vegetation and streambanks time to respond to the effects of grazing management. In some cases, the period may be extended because of slower recovery rates. Ten years should be the longest interval used on any site.

3. Short-term annual indicator data may be collected in a different season than the trend data; however, short-term data should be collected when it is appropriate, typically immediately following livestock use. If the management prescription requires a certain amount of residual vegetation remaining to protect streambanks during high winter or spring flows, monitoring should be done after the growing season has ended and livestock have been removed from the area.

4. Use handheld computers to record data (see Appendix E). These devices save about one hour per transect. However, the data may be recorded on the Riparian Monitoring Data Sheet if a handheld computer is not available (see Appendix F).

Systematic Procedure

1. After the line transect markers are placed, photographs should be taken before data is collected since the monitoring process will result in some visible disturbance on the site. As a minimum, take photographs at the following locations:

    a. From the lower marker looking upstream,
    b. Across the stream from the lower marker,
    c. Downstream from the upstream marker, and
    d. Across the stream from the upstream marker.
    e. Take additional photographs as needed and describe the location of each photo in relation to the downstream marker.

2. Monitoring should begin at the lower left-hand side of the stream (looking upstream). The monitoring setup should be sketched and GPS coordinates recorded to ensure future monitoring data is collected at the same location and in the same sequence.

3. Use only the indicators appropriate for the site (see Appendix B). If the site does not have the potential for woody species with appropriate management, do not include the woody species regeneration and woody species use as part of the monitoring for the site. However, if the site objectives include woody species, but no woody species are present, woody species regeneration should be included to determine if management is making progress toward meeting the objectives. Woody species utilization data cannot be gathered until woody species begin reestablishing along the greenline.

4. Beginning at the lower transect marker on the left-hand side (looking upstream), determine a random number between 1 and 10, take that number of steps along the thalweg (deepest part of the channel) or along the streambank to the first plot location. Place the monitoring

frame (see Appendix D) down at the toe of the boot with the center bar along the greenline. Continue the procedure at predetermined intervals (usually 2, 3, or 4 steps, or short enough to obtain 40 plots on each side of the stream) until the upper transect marker is reached. If the required number of plots is obtained prior to reaching the upper marker, **continue reading plots until the marker is reached**. Once the upper marker is reached, cross the stream and repeat the procedure down the other side to the end marker. The entire length of the transect on both sides of the stream is sampled. Individuals should determine the length of their steps and adjust the interval between plots so that an adequate sample size can be obtained. Mark a distance, usually 100 feet, and count the number of steps required to cover the selected distance. Determine the average step length by pacing the distance three or four times and calculating the average. For example, if an individual takes an average of 66 steps in 100 feet, then the average step length is 18 inches. Table 1 indicates the number of steps needed to obtain at least 40 plots on a side of the stream. Measuring rods can also be used to measure the distance between plots if desired.

Table 1 – Determining the Number of Steps between Plots

Average Step length	To obtain at least 40 Plots per 110 meter (361 feet)Transect		
	Steps between plots	Spacing between plots	
		Feet	meters
15 inch	7	9	2.75
18 inch	6	9	2.75
21 inch	5	9	2.75
24 inch	4.5	9	2.75
27 inch	4	9	2.75
30 inch	3.5	9	2.75

A. Procedure: Locating the Greenline (Modified from Winward 2000)

The Greenline is “The first perennial vegetation that forms a lineal grouping of community types on or near the water’s edge. Most often occurs at or slightly below the bankfull stage” (Winward 2000). It is found only along streams with defined channels.

The greenline often forms a continuous line of vegetation adjacent to the stream, but it can also be patches of vegetation on sand bars and other areas where vegetation is colonizing or being eroded. Individual lineal groupings are considered part of the greenline when they meet the criteria described below. Review Appendices C and G for explanations and examples of many greenline locations.

Criteria and Limits

1. The Greenline is often located near the bankfull stage. For entrenched streams, the greenline may be located above the bankfull stage (Winward 2000). In these cases, the greenline may include, or be limited to non-hydric species, i.e., upland species. A guide for field identification of bankfull stage is available at the Stream Systems Technology Center: http://www.stream.fs.fed.us/publications/videos.html

2. The location of the greenline should be determined when the stream is at the summer low flow. Usually, the edge of the perennial vegetation, not the water's edge at low summer flow, is the greenline (Winward, 2000). Some perennial vegetation (e.g., spike rush, *Eleocharis* spp.) may grow in the margins of streams and in slow backwaters. When this occurs, the greenline used in this protocol is at the water's edge during summer low flow.

Vegetation

The lineal grouping of perennial vegetation must have at least 25 percent foliar cover for the entire length and width of one quadrat (50 cm or 19.6 inches by 20 cm or 6 inches). If the vegetation is not continuous within the plot, move the plot up the bank, perpendicular to the stream flow, until the cover requirement is met. A quadrat is considered to exhibit "continuous vegetation" if there are no barren patches 4 inches in diameter or greater within the quadrat.

1. Colonizer species at or near the water's edge that meet the appropriate criteria (i.e., 25 percent foliar cover, 50 cm by 20 cm) and establishing a distinct lineal grouping of perennial vegetation) are considered greenline, except as described in number 2. For example, short-awned foxtail (*Alopecurus aequalis*), spike-rush (*Eleocharis palustrus*), arroyo willow (*Salix lasiolepis*), and coyote willow (*Salix exigua*) on the streambank (above the summer low flow) should be recorded as part of the greenline (see Appendix G, Figure 10. These species have moderately deep roots and the ability to stabilize streambanks.

2. Colonizers that commonly float on or submerge in the water are NOT part of the greenline. These may include brookgrass (*Catabrosia aquatica*), watercress (*Rorippa nasturtium-aquaticum*), seep spring monkey flower (*Mimulas guttatus*), American speedwell (*Veronica americana*), and smartweed (*Polygonum amphibium*) (see Appendix G, Figures 2, 3, 4, and 5).

3. Non-vascular plants such as mosses and lichens are **NOT** considered as part of the greenline. The quadrat is moved away from the stream, perpendicular to the water flow, until the minimum vegetation, rock, and/or wood meet the criteria for greenline.

4. Under some conditions, particularly in backwaters where the current is slow, *Carex* spp., *Juncus* spp., *Eleocaris* spp., and *Scirpus* spp. may establish in the still, shallow water along the stream during the summer low-flow periods. This condition occurs most frequently during low water or in a drought period. When this occurs, the greenline is along the edge of the water (see Appendix E, Figures 1, 6, and 7).

5. The greenline runs approximately parallel to the stream channel. When the streambank or the vegetation line becomes approximately perpendicular (75 degrees or more) to the flow of the stream, the greenline ends. Then the transect moves away from the stream perpendicular to the stream flow and begins at the next lineal grouping of perennial vegetation continuing along the greenline (see Appendix C, Figures 3 and 4).

6. When there is no herbaceous understory beneath woody plants, the greenline is at the base of the first rooted plant above the water line (see Appendix C, Figures 6).

7. Woody vegetation overhanging the stream is not considered to be on the greenline.

8. When shrubs or trees have no understory (or less than 25% foliar cover), the greenline is along a line connecting the rooted base of the plants, not at the drip line of the canopy (see Appendix C, Figure 6).

9. If there is an overstory tree with a shrub understory, the greenline is at the base of the shrub. For example, if there were a narrow-leaf cottonwood tree over red osier dogwood, the greenline would be at the base of the dogwood. When shrubs such as willows are over herbaceous vegetation such as sedges, the greenline is at the edge of the sedges or the lower layer of vegetation.

10. Only canopy cover from plants rooted on the streambank on the same side of the stream is recorded. Overhanging canopy from plants on the opposite side of the stream is not recorded, even if it overhangs the plot. This condition often occurs on small streams.

Rock as Part of the Greenline

In order to be considered as greenline, rocks, boulders, talus slopes, and bedrock that are part of the streambank, must be of sufficient size to protect the streambank from erosion during high stream flows (at least 15 cm or 6 inches in diameter). The rock or boulder must be at least partially embedded/anchored in the streambank, with no evidence of movement by water. Appendix G, Figures 23 and 24 provide examples of rock along the greenline.

Anchored and Downed Wood as Part of the Greenline

Anchored wood consists of logs or root wads that are anchored in or along the streambank in such a way that high flows are not likely to move them. The anchored wood may be embedded in the streambank or wedged between rocks, trees, or other debris. Anchored wood that is part of the greenline must currently exert a hydrologic influence on the stream. There should be no evidence of active erosion that would destabilize the woody material. When logs are anchored and somewhat perpendicular to the stream, count the amount of anchored wood that joins the vegetation greenline on each side of the log.

Detached Blocks of Vegetation

Blocks of vegetation obviously detached from the streambanks are not considered as greenline. When deep-rooted hydric vegetation covers the block from the water's edge to the terrace wall, creating a new floodplain (false bank), the greenline is the edge of the vegetation along the stream (see Appendix G, Figure 16).

Islands

Islands are defined as areas surrounded by water at summer low flow or bounded by a channel that is scoured frequently enough to keep perennial vegetation from growing. The greenline follows the main banks of the stream and not islands (see Appendix C, Figure 3 and Appendix G, Figures 9 and 1).

No Greenline Present

In some instances, a greenline may not be present within proximity to the stream. In such cases, the bank may be characterized by annual vegetation, such as cheatgrass, occupying the upland. In other cases, the area in proximity to the stream may be barren.

When the criteria for greenline is lacking within 6 meters (20 feet) slope distance from the water's edge, the code "NG" (no greenline) is recorded in the vegetation column on the field form. The frame is placed on the first terrace above the waterline for measuring the other indicators (e.g. bank alteration, bank stability, etc.). If no terrace is present, place the frame at the position on the bank 6 meters from the water's edge. A terrace is a relatively flat area adjacent to a stream or lake with an abrupt steeper face adjoining the edge of the stream. The first terrace is the first relatively flat area adjacent to and above the edge of the water. It may be an active floodplain or an area too high for the water to reach under the current climate and channel conditions. The second terrace is the next elevated area above the first terrace, with a distinctly steeper slope facing the stream.

Record "NG" or no greenline present when any of these conditions exist:

- Lineal grouping of perennial vegetation is not present within 6 meters (20 feet slope distance) of the edge of the stream.

- A sharp meander bend with a narrow peninsula exists with no lineal grouping of vegetation between the stream margin and the top of the peninsula (see Appendix G, Figure 26).

Specific Instructions

1. Observers should look ahead and determine the greenline. This provides continuity for pacing in the appropriate location. The center of the monitoring frame is placed along the greenline.

2. Evaluate the vegetation within the monitoring quadrat on the floodplain side of the greenline (see Appendix C, Figure 2).

3. When there is less than 25 percent perennial foliar vegetation cover, including shrub and tree overstory, or there is one or more barren patches 4 inches in diameter or greater within the quadrat, move up the bank, perpendicular to the stream flow, until the quadrat has the appropriate amount of vegetation. The frame is adjusted along the actual edge of the greenline.

4. Record all other pertinent data at the plot location (e.g., streambank stability, woody species regeneration, streambank alteration, and woody species use, etc.).

B. Procedure: Measuring and Recording Streambank and Vegetation Indicators

1. Greenline Vegetation Composition

Prior to collecting vegetation composition on the greenline, it is critical that observers are able to identify the plant species located on the site.

Vegetation Classification

Two classification systems are commonly used to describe and record the vegetation occurring on the greenline, i.e., riparian community types and dominant plant species. Document the vegetation classification method used on the field sheet or handheld computer.

Recording Vegetation Using Dominant Plant Species

Dominant plants are the species having the largest portion of the vegetation composition by cover in the quadrat. To be considered dominant, the plant must represent at least 25 percent of the plant composition by cover within the quadrat. The exception is where a *mature* tree or *mature* shrub overstory occurs. Mature trees or shrubs with *any portion* of the canopy covering the quadrat are considered dominant. Mature trees and shrubs are defined in Tables 2 and 3 (woody regeneration). This exception applies only to mature trees and shrubs; seedlings and young plants that overhang the plot are not counted as dominant unless they are rooted within the plot and have 25% vegetation composition by cover.

When only a single species is found in or over the quadrat, it is recorded as the dominant species. When two or more species make up a majority of the composition in or over the quadrat and are of approximately equal proportions, ***each*** is recorded as dominant.

Sub-dominant plants occur when the composition of a particular plant species or group of plants, e.g., mesic forbs, ***is less*** than the dominant species. Sub-dominant plants do not have to exhibit 25 percent vegetative composition by cover within the quadrat (although it is possible). An example of this would be if the quadrat contained 75 percent water sedge (*Carex aquatilis*) and 10–25 percent Kentucky bluegrass (*Poa pratensis*). In this case, the sedge would be recorded as dominant and the bluegrass as sub-dominant. See Appendix H for a list of common dominant species in the intermountain area.

1. **How to address overstory vegetation:** Riparian vegetation structure may occur in three layers: trees, shrubs, and herbaceous. Mature plants, with any part overhanging the plot (e.g. willows) are always

recorded as dominant vegetation. Seedlings and young plants must be rooted within the plot to be counted, and are treated the same as understory vegetation. For example, when quaking aspen (*Populus tremuloides*) occurs with an understory of red-osier dogwood (*Cornus sericea*), both the taller plant layers of quaking aspen and the red-osier dogwood are recorded as dominant plants. A third dominant plant may be listed if an herbaceous understory is present and makes up at least 25 percent of the understory composition of plants in the plot (anchored rock and wood are also part of the cover). Another example: yellow willow (*Salix lutea*) occurs in the overstory with a dense mat of Nebraska sedge (*Carex nebraskensis*) in the understory within the plot. In this case, yellow willow would be recorded as dominant, and the Nebraska sedge would also be recorded as dominant.

2. **Recording sub-dominant plants with less than 25 percent composition:** Users should record important plants having less than 25 percent of the vegetative composition. Plant species that indicate potential, trend, or invaders may also be included. For example, Kentucky bluegrass (*Poa pratensis*) dominates a plot with a minor component of Nebraska sedge (*Carex nebraskensis*). The Kentucky bluegrass would be listed as the dominant plant, and even though the Nebraska sedge is only a minor portion of the vegetation composition, it is recorded as sub-dominant to track composition trends through time.

3. **Plants with equal composition:** When two or more plant species, including rock and wood, have about the same amount of plant cover in the plot, and each is over 25 percent of the composition, record each as dominant. Dominant plants are recorded on separate lines under the same plot number. These transition vegetation communities are important in describing the ecological processes occurring along the stream. When this occurs, list the most dominant species first and the second species on the next row.

4. **Rock and Wood:** Rock and/or wood making up at least 25 percent of the length of the greenline within the quadrat are considered either dominant or sub-dominant, depending on the vegetation in the remainder of the quadrat. Rock is recorded as part of the greenline when it is at least 25 percent of the length of the quadrat. If rock is at least 50 percent of the quadrat length, record “rock” as dominant. If rock is 25–49% of the plot, it is recorded as sub-dominant. Wood is recorded as part of the greenline when it is at least 25 percent of the length of the quadrat. If wood is at least 50 percent of the quadrat length, record “wood” as dominant or co-dominant. If wood is 25–49% of the plot, it is recorded as sub-dominant. For example, if anchored rock were 25 percent of the length of the quadrat and beaked sedge

were 75 percent, then beaked sedge would be the dominant and rock the sub-dominant. If rock made up 50 percent of the length and beaked sedge the remainder, rock and beaked sedge would both be dominant.

5. **Recording the data:** Record data either on a handheld computer or on the Riparian Monitoring Data Sheet (see Appendix F). Vegetation is recorded by dominant and sub-dominant species or riparian community type.

Recording Vegetation Using Riparian Community Types

Riparian Community Types may be used when riparian vegetation in the area has been classified. When riparian community types are used, record the riparian community type publication that is being used to classify the vegetation. *Riparian Community Type Classification of Utah and Southeastern Idaho* is a typical publication. When using riparian community type classification, it is very important to use the keys provided in the publication for consistency.

Rock and/or wood making up at least 25 percent of the length of the greenline within the quadrat is classified as a distinct community type. For example, suppose anchored rock is 25 percent of the length of the quadrat, and beaked sedge CT is 75 percent. Beaked sedge would be listed as the dominant and rock the sub-dominant on the data sheet. If rock made up 50 percent of the length and beaked sedge the remainder, rock and beaked sedge would both be dominant.

Record riparian community types exactly the same as those listed in the tables in Appendix I or in the tables in the handheld computer. For example, Booths willow (*Salix boothii*)–Kentucky bluegrass (*Poa pratensis*) is recorded "SABO/POPR" in the appropriate column.

2. Streambank Alteration

General Description

The procedure describes a method for estimating the percent of the linear length of streambank that has been altered by large herbivores (e.g., cattle, horses, sheep, bison, elk, and moose) walking along or crossing the stream during the current grazing season.

The part of the streambank that is measured using this protocol is a plot 50 cm long and 42 cm wide, centered on the greenline. This portion of the streambank focuses the observation where stability is affected by the erosive effects of water (see Appendix J).

Streambank Alteration Definitions

Streambank alteration occurs when large herbivores, e.g., elk, moose, deer, cattle, sheep, goats, and horses walk along streambanks or across streams. The animals' weight can cause shearing that results in a breakdown of the streambank and subsequent widening of the stream channel. It also exposes bare soil, increasing the risk of erosion of the streambank. Animals walking along the streambank may increase the amount of soil exposed to the erosive effects of water by breaking or cutting through the vegetation and exposing roots and/or soil. Excessive trampling causes soil compaction, resulting in decreased vegetative cover, less vigorous root systems, and more exposure of the soil surface to erosion.

Hoof shearing is the most obvious form of streambank alteration. It is common for the shearing action of the hoof to break off a large portion of the streambank. Include as alteration the total length of broken streambank directly associated with an occurrence of shearing, not just the width of the hoof mark (see Appendix J).

There are 5 cross-plot lines on the sampling frame used to detect and record occurrences of alteration. These lines are perpendicular to the center rib of the frame and extending on each side. As the center rib is placed on the greenline, alteration lines extend 20 cm into both the vegetated and non-vegetated side of the greenline. If more than one hoof print intercepts this line on either or both sides of the center rib, a value of 1 is recorded. Thus, observations at a single sampling point may range from 0 to 5 "hits."

The number of alteration intercepts or "hits" was limited to 5 per sample because: 1) alteration occurs primarily on the non-vegetated side of the greenline only, and double-counting the vegetated side would underestimate the frequency of disturbances along the greenline; and 2) the spacing between intercept lines approximates the diameter of a hoof print, which minimizes double-counting single hoof impressions.

Trampling impacts must be the ***obvious*** result of current season use. "*Obvious*" is defined as being able to readily observe animal hoof impacts from no closer than approximately 2 feet from the streambank. In general, these are impacts that are evident without kneeling close to or lying on the ground. The streambank is considered altered when:

- streambanks are covered with vegetation and have hoof prints that expose at least 12 mm (about ½ inch) of bare soil;

- streambanks exhibit broken vegetation cover resulting from large herbivores walking along the streambank that have a hoof print at least 12 mm (½ inch) deep—measure the total depression from the top of the displaced soil to the bottom of the hoof impression; and/or

- streambanks have compacted soil caused by large herbivores repeatedly walking over the same area even though the animals' hoofs sink into and/or displace the soil less than 12 mm (½ inch).

Large herbivores trampling and trailing on top of terraces, above the active floodplain, is not considered streambank alteration. Hoof marks within the plot with shearing on the streambank and/or terrace wall, and/or trampling at the base of the streambank or terrace wall are considered streambank alteration (see Appendix J, Figure 5).

Procedure

The procedure uses the entire 42 cm by 50 cm monitoring frame. Five lines are projected across the frame perpendicular to the center pipe (see Appendix D, Figure 1).

1. Looking down at the entire frame, determine the number of lines within the plot that intersect streambank alteration (see Appendix J). Record the number of lines (0–5) that intersect streambank alteration. Record only one occurrence of alteration, trampling, or shearing per line. This process is repeated at the predetermined interval on each side of the stream. **It is important that the observer record only the current year's streambank disturbance.**

2. When there is a vertical or near-vertical terrace wall, pace in the stream or along the greenline on top of the terrace, and place the center of the frame along the greenline at the end of the toe. Record only direct alteration occurring on the terrace wall or the streambank (see Appendix J, Figure 5).

3. Hoof prints or trampling on streambanks with fully developed, deep-rooted hydric vegetation (*e.g.*, *Carex* spp., *Juncus* spp., and *Salix* spp.) is not recorded as alteration unless plant roots or bare soil is exposed. Hoof shearing along the streambank is alteration.

4. Compacted livestock trails on or crossing the greenline that are the obvious result of the current season's impacts are counted as trampling (see Appendix J, Figures 3 and 4).

5. Roads and tributary streams are **not counted**. Continue to pace directly across the area until the greenline is reached. Separately record any samples that are on the road or water. Leave the cell blank in the handheld computer or on the form.

6. When obstructions such as trees, shrubs, or other physical impediments are encountered, sidestep at 90 degrees from the transect line and continue pacing parallel to the transect to avoid the obstruction. Project the lines from the end frame to the streambank and record the hits. Record the amount of alteration on the streambank. Most of the time it will be "0." Return to the original transect as soon as possible by sidestepping back to the transect line and continuing.

7. When there is no greenline identified within 6 meters from the waters' edge and "NG" (no greenline) is recorded, the frame is placed on the first terrace above the waterline for measuring the bank alteration (and other appropriate indicators). If no terrace is present, place the frame at the position on the bank 6 meters from the water's edge.

8. The procedure should not be used if a high flow (flood) event occurs prior to monitoring. In that situation, the water's energy and sediment will make it very difficult to determine if the effects are a result of the current grazing season or past grazing seasons.

3. Streambank Stability and Cover

General Description

Streambank stability is observed on the bank associated with the quadrat, and is recorded using one of six stability classes (see Streambank Stability Classification descriptions below and Appendix K).

Procedure

At each plot location, classify streambank stability. (see Appendix K, Streambank Stability Classification Key). The following are steps that are used to the stability class.

1. **What kind of bank?** Is the bank at the plot depositional or erosional? (See Appendix K.)

2. **Where is the bank?** The bank evaluated is equal to the length of frame (50 cm) between the scour line and the top of the first terrace. Typical scour line indicators are the elevation of the ceiling of undercut banks at or slightly above the summer low flow elevation; or, on depositional banks, the scour line is the lower limit of sod-forming or perennial vegetation (see Appendix K).

3. **Is it covered? Banks are covered** if there is at least 50% aerial cover of perennial vegetation; cobbles six inches or larger; anchored large woody debris (LWD) with a diameter of four inches or greater; or a

combination of the vegetation, rock, and/or LWD is at least 50 percent of the bank area (50 cm wide from scour line to first terrace).

4. **Is it stable? It is stable if none of the following exist:** Either a *fracture* (crack is visibly obvious on the bank); *slump* (portion of bank has obviously slipped down or has been pushed down by trampling or shearing, etc.); or *slough* (soil is breaking or crumbling and falling away and is entering the active stream channel); **or** the bank is steep (within 10 degrees of vertical), and/or bare, and eroding (including bare depositional bars).

Streambank Stability Classification

Appendix K provides definitions, key, illustrations, and photographs in regard to Streambank Stability Classification. After assessing the plot, record the data on the Riparian Monitoring Data Sheet or in the handheld computer by one of the following six streambank stability classes:

CS - Covered and stable (non-erosional). Streambanks are covered with perennial vegetation, and/or cobble (6 inches or larger), boulders, bedrock, or anchored wood (4 inches in diameter or larger) to protect them from the erosive effects of water. Streambanks do not have indications of erosion, breakdown, shearing, or trampling that exposes plant roots. Banks associated with gravel bars having perennial deep-rooted vegetation along the edge of the floodplain line are in this category (see Appendix K, illustrations and figures).

CU - Covered and unstable (vulnerable). These streambanks are covered with perennial vegetation and occur where undercutting by water may cause breakdown, slumping, nicks, bank shearing, and/or fracturing along the bank (see Appendix K, illustrations and figures).

US - Uncovered and stable (vulnerable). Streambanks having consolidated soils high in clay, particularly in the lower part of the streambank, may be uncovered and stable. These banks are vulnerable to high flows, particularly winter flows with floating ice. Uncovered and stable banks may also be compacted streambanks trampled by concentrations of ungulates, human trails, vehicle crossings, or other activities that cause compaction. Such disturbance flattens the bank so that slumping and breakdown does not occur even though vegetative cover is significantly reduced or eliminated (see Appendix K, illustrations and figures).

UU - Uncovered and unstable (erosional and depositional). These are bare, eroding streambanks and include all mostly uncovered banks that are at a steep angle to the water surface. When the bank is not present due to excessive bar deposition or to streamside trampling, the bank will be classified “uncovered/unstable.” (See Appendix K, illustrations and figures).

FB - False bank (stable). Streambanks have slumped in the past but have been stabilized by vegetation. These banks are usually at a lower level than the terrace and are covered/stable (CS). (See Appendix K, illustrations and figures).

UN - Unclassified. Side channels, tributaries, springs, road crossings, etc., cause a break in a streambank. Livestock or wildlife trails are not included in this category, but are included as uncovered/stable (see “US” above).

Streambank Cover

Streambanks are considered covered if they show **any** of the following features:

1. Perennial herbaceous and/or woody vegetation provide more than 50 percent ground cover of the vertical height of the streambank (Bauer and Burton, 1993).
2. Roots of vegetation cover more than 50 percent of the bank. (Deep rooted plants such as willows and sedges provide such cover.)
3. Cobble-size rocks (at least 6 inches in diameter), boulders, or bedrock cover more than 50 percent of the streambank surfaces.
4. Logs, at least four inches in diameter, cover more than 50 percent of the bank surfaces.
5. At least 50 percent of the bank surfaces are protected by a combination of the above.

Streambank Stability

Streambanks are considered stable if they **do not** show indications of **any** of the following features:

1. Breakdown: Obvious blocks of streambanks have broken away and are lying adjacent to the bank breakage.
2. Slumping Bank: Bank that has obviously slipped down. Cracks may or may not be obvious, but the slump feature is obvious.
3. Bank Shearing: Occurs when animals walk along the streambank or cross the stream and shear or break off portions of the streambank. Bank shearing is recognized by a shear plane with obvious hoof marks on the streambank. Include the total length of bank disturbance associated with the shearing.
4. Fracture: A crack is visibly obvious on the bank, indicating that the block of bank is about to slump or move into the stream.
5. Vertical and Eroding: The bank is mostly uncovered, and the bank angle is steeper than 80 degrees (178% slope) from the horizontal.

6. Bare Depositional Bar: A depositional bar without adequate ground cover (50%).

4. Residual Vegetation Measurement (Stubble Height)

General Description

The objective of residual vegetation (stubble height) measurement is to determine the height of key vegetation species remaining following a period of grazing. The measurement may be used in two ways: first, to determine when livestock should be moved from the riparian area, and second, at the end of the grazing season to determine whether livestock grazing management changes are needed the following year.

Procedure

Prior to recording stubble height, one or more key specie(s) must be selected. For this protocol, at least *one* of the key species selected must be a relatively abundant herbaceous forage plant that is commonly used by livestock (preferably hydric species), and able to help address some aspect of streamside conditions and grazing management. In other words, the observer must establish what the species is “key” to and why it is important to measure. It is acceptable to use more than one key species if desired to help address other important issues. For example, where hydric species are missing or lacking, species such as Kentucky bluegrass or red top can (and should in some instances) be measured if it helps answer grazing-related questions. Normally, key species are chosen to assess livestock use on the desired riparian plants; therefore, palatable hydric species are preferred. Record the measurements by species.

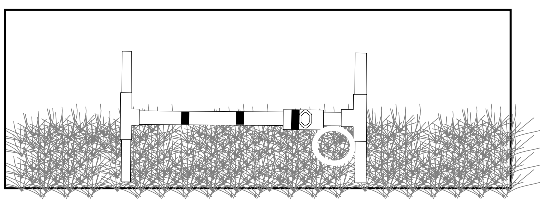

Figure 1 — Residual vegetation height is measured within a 3-inch diameter circle at the back right-hand corner of the greenline.

Most riparian key species grow tightly together, forming dense mats with little distinct separation of individual plants. As a result, the sampling method uses a 3-inch diameter circle of vegetation rather than attempting to separate the mats into individual plants. If the plants *are* distinct and not mat forming, select a 3-inch circle of vegetation nearest the handle of the frame that includes the key species (see Figure 1).

Using the frame handle with one-inch increments (or a ruler), measure within the circle to determine an "average" leaf length (rounded to the nearest ½ inch), as shown in Figure 2. Grazed and ungrazed plants are measured from the ground surface to the top of the remaining leaves. Account for very short leaves as well as tall leaves. *Do not measure seed culms*. Determining the "average" residual vegetation height will take some practice. Be sure to include all of the key species' leaves within the sample. The easiest method of doing this is to grasp the sample with the sampler's hand, stand the leaves upright, and then measure the average height (see Figure 2).

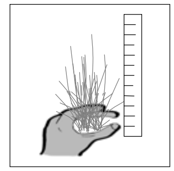

Figure 2 — Form hand into an approximate 3-inch circle, grasp the vegetation and determine the average leaf height.

When the key species does not occur in a mat near the handle of the quadrat, but as an individual plant or several individual plants, the 3-inch plot is placed over the key species plants nearest the handle (see Figure 3). Measure the leaves of all the key species rooted within the 3-inch diameter plot.

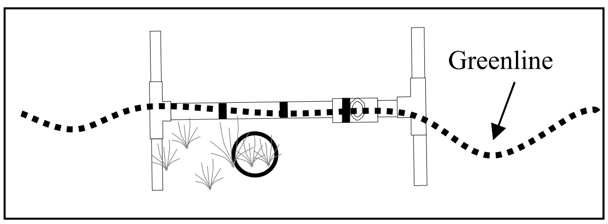

Figure 3 — When key species plants are not in the corner by the frame handle, select the key species plant(s) nearest the handle. Identify the 3-inch circle and measure the average leaf. height of all key species plants rooted within the circle.

When a key species does not occur within the quadrat, leave the cell blank and proceed to the next plot location.

Once the samples are collected, both the median and the mean (average) height are calculated and presented in the Data Analysis Module for the riparian key specie(s). The median is the single mid-point for an odd number of samples, and the average of the two co-midpoints for an even number of samples (USDI, BLM 1999). For example, if the middle two numbers for an even number of samples are 5 and 6 inches, the median is 5.5 inches.

5. Woody Species Regeneration *(Modified from Winward 2000)*

General Description

Woody species regeneration is modified from Winward (2000). The original procedure developed by Winward is a six-foot wide by 110-meter belt transect with the center of the six-foot belt being over the greenline. Woody plants are counted by species and age classed. This modification to facilitate collecting multiple indicators in a more efficient manner uses a 0.42 meter by 2 meter plot, 1 meter either side of the greenline (Figure 4), providing a sample of woody species along the transect from a definable area. This approach increases the precision of the observations.

Procedure

Identify the plant by species; count the number of plants rooted in the plot, and determine the age class (described below) of each woody plant within the plot.

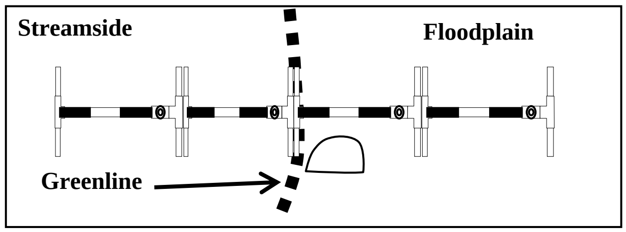

Figure 4 — Woody species regeneration plot is 0.42 meters by 2.0 meters. The plot is defined by placing the monitoring frame perpendicular to the greenline. The frame is placed end-to-end on each side of the greenline.

1. The woody species regeneration plot is .42 meter wide by 2 meters long (one meter on each side of the greenline), as shown in Figure 4.

2. Place the end of the monitoring frame on and perpendicular to the greenline, and count the number of woody plants by species ***rooted*** within the monitoring frame. If one stem at ground level is within the plot and several other stems are immediately outside the plot, determine if the stem within the plot is actually connected to those outside the plot. If it is, record the age of the entire plant to which the stem is connected. Generally, stems at ground level within 1 foot of each other are considered the same plant. If it is not connected, consider the stem as an individual plant and record the age class appropriately. Record by species and age class. (Do not count woody species canopy cover as woody species.)

3. Move the monitoring frame away from the greenline, and place it at the end of the first monitoring frame, and repeat the procedure (see Figure 4). Tables 2 and 3 provide descriptions of woody species age classes.

4. It is difficult to age class rhizomatous species such as wolf willow (*Salix wolfii*), planeleaf willow (*S. planifolia*), coyote willow (*S. exigua*), wild rose (*Rosa* spp.), and golden current (*Ribes aureum*); therefore, they are not recommended for inclusion in the woody species regeneration. When these species need to be monitored, use the greenline or a line transect.

Table 2 – Woody Species Age Classes for Multiple Stem Species
Includes clumped willow (*Salix* spp.) species and shrubby forms of mountain alder (*Alnus incana*), and water birch (*Betula occidentalis*)

Number of stems at the ground surface	Age class
1 stem	Seedling
2 to 10 stems	Young
>10 stems	Mature
0 stems alive	Dead

Modified from Winward 2000

Table 3 – Woody Species Age Class for Single Stemmed Species.
Single stemmed species: i.e., birch (*Betula* spp.), alder (*Alnus* spp.), and cottonwood or aspen (*Populus* spp.)

Age Class	Cottonwood	Other Broadleaf Species
Seedling	Stem is < 4.5 ft. tall or < 1 in. diameter breast height (dbh)	Stem is < 3 ft. tall and less than 1 in. diameter at the base
Young	Stem is ≥ 4.5 ft. tall and 1 to < 5 in. dbh, or stem is < 4.5 ft. tall and 1 to < 5 in. dbh	Stem is ≥ 3 ft. tall and < 3 in. dbh, or < 3 ft. tall and 1 to 3 in. dbh
Mature	≥ 5 in. dbh	Stem is ≥ 6 ft. tall and ≥ 3 in. dbh, or < 6 ft. tall and ≥ 3 in. dbh, or < 3 ft. tall with multiple branching (hedged) near the top of the stem
Dead	Entire canopy is dead	Entire canopy is dead

Adapted from (Thompson et al. 1998)

6. Woody Species Use (Modified Landscape Appearance Method)

General Description

This method is modified from the Qualitative Assessments—Landscape Appearance Method (also called the Key Forage Plant Method) described in *Utilization Studies and Residual Measurements*, Interagency Technical Reference (1996). Winward (2000) recommends a similar method based on estimated utilization ranges.

The technique is an ocular estimate of woody species (e.g., willow, alder, birch, dogwood, aspen, and cottonwood) use based on the general appearance of the woody species ***rooted*** within a plot along the greenline. Estimates are based on a range or class of use of the available current year's growth on the plants. Examiners must be trained to recognize the various use classes according to written class descriptions described below.

Procedure

Woody species use is observed on woody plants along a belt transect 2 meters wide (1 meter either side of the greenline), by the length of the interval between plots. For example, if the spacing between plots is two meters, observe all of the shrubs rooted within 1 meter either side of the greenline for a distance of two meters (the distance from the current plot to the next plot). Use Table 4 and record the mid-point value of each key woody species use class.

For cattle, only shrubs with at least 50 percent of the current year's leader growth below 5 feet (see Table 5) should be considered. When shrubs have over 50 percent of the active leader growth above 5 feet, the leaders are not generally available to cattle, and the plant usually has adequate leaf area for photosynthesis to maintain plant health. If no shrubs are encountered within the plot, leave the space on the field data sheet blank.

Observers examine the woody plants rooted within the belt transect (Figure 5) and classify the use based on the descriptors. The five utilization classes (Table 4) describe the relative degree of use of the available current year's leader growth for riparian shrubs and trees. Available current year's leader growth (Table 5) is that portion of shrubs or trees that are within reach of the grazing animal.

Figure 5 – Belt transect for observing woody species utilization. A two-meter measuring rod centered on the greenline is often used to locate plants within the transect. The monitoring frame contains a 1 meter long handle which may also be used to determine if individual woody plants are rooted within the belt.

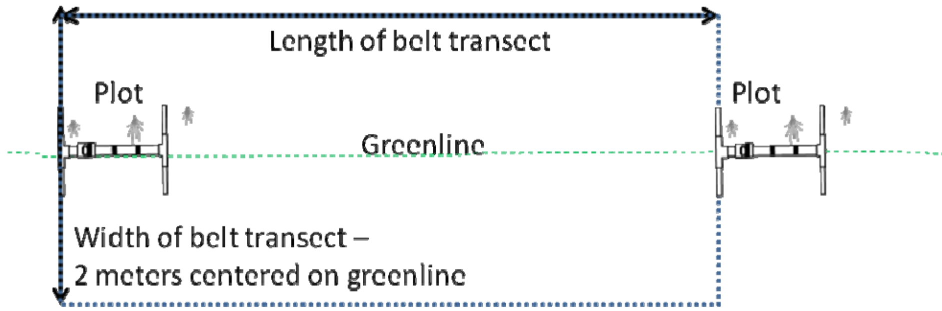

Table 4 – Woody Species Use Classes and Descriptions

Class	Percent Utilization Range	Description
None to Slight	0–10 (mid-point = 5)	Browse plants appear to have little or no use. Less than 10% of the available current year's leader growth is disturbed.
Light	11–40 (mid-point = 25)	There is obvious evidence of leader use. The available leaders appear cropped or browsed in patches and 60–89% of the available leader growth of browse plants remains intact.
Moderate	41–60 (mid-point = 50)	Browse plants appear rather uniformly used and 40–60% of available annual leader growth of the plants remains intact.
Heavy to Severe	61–90 (mid-point = 75)	The use of the browse gives the appearance of complete search by grazing animals. The preferred browse plants are hedged, and some clumps may be slightly broken. Only between 10 and 40% of the available leader growth remains intact.
Extreme	90–100 (mid-point = 95)	There are indications of repeated grazing. There is no evidence of terminal buds. Some patches of second and third years' growth may be grazed. Hedging is readily apparent, and browse plants are frequently broken. Repeated use at this level will produce a definitely hedged or armored growth form. Ten to 40% of the more accessible second and third years' growth of browse plants has been utilized. All browse plants have major portions broken.

Table 5. Available Current Year's Growth: Height of Grazing (USDI, BLM 1992.

Kind of Animal	**Height of Available Leader Growth** (feet)
Cattle	5
Sheep, antelope, big horn sheep	3.5
Horses, elk, and moose	7
Deer	4.5

Use the appropriate "Height of Available Leader Growth" for the kinds of animals that are of concern in the area. It is difficult, if not impossible, to discern between shrub use by domestic livestock and wildlife during periods of common use. In those circumstances, attempts to determine the kinds of animal that use the browse should not be made. However, wildlife use can be detected if data is collected before livestock turnout or monitoring is done immediately after livestock vacate a pasture and again at the end of the season.

C. In-Channel Indicators

The following in-channel measures have been included because they are reasonably objective, are strongly associated with livestock grazing influences to stream habitat, and have been found predictive of aquatic health.

7. Greenline-to-Greenline Channel Width (GGW)

General Description

Many stream channels are over-widened as a result of vegetative changes and physical disturbance to streambanks over time. Improper livestock grazing can alter stream habitats by channel widening and/or incision (Clary *et al.* 1996, Clary 1999, Clary and Kinney 2002, Kaufman and Krueger 1984). Under improper grazing, protective vegetation is weakened or removed, and trampling may induce a sloping streambank profile (Clary and Kinney 2002). Subsequent erosion of weakened streambanks during floods results in a wider, shallower stream channel. These changes to stream habitats can be detrimental to biota (Bohn 1986). Clary's (1999) observations at research sites indicated that the stream width of previously over-grazed streams decreases with improved grazing management of riparian zones. The average amount of narrowing was inversely associated with the level of grazing intensity. Between 1990 and 1994, width changes as a proportion of the original measurement were: No grazing—41% reduction, light grazing—34% reduction, and medium grazing—18% reduction. Stream depth, on the other hand, was variable through time and appeared to change primarily in response to climatic events. After a flood event in 1996, channel depth at the ungrazed site increased to 2.33 times the original depth. This vertical scour likely resulted from the longer-term effect of channel narrowing.

Commonly, the width of stream channels is determined by measuring channel width at the bankfull level. Detailed measurements of width and depth are accomplished by surveying channel cross-section profiles. This method is not useful at a large number of positions along the stream because it is time-consuming and expensive. Too few cross-section measurements do not adequately estimate mean channel geometry, due to site variability.

As summarized by Bauer and Ralph (2001), the major concern with use of width measurements at bankfull level is the reliability of the method. Bankfull width is determined by using field characteristics such as sediment surfaces and profile breaks to identify the elevation of the active floodplain surface. These definitions are vague, and the actual selection of bankfull level is, at best, subjective.

Other field methods have measured the "wetted width" of the stream. Although this level in the channel is easily identifiable, unfortunately, wetted width varies dramatically by stream flow. Because it is normally measured during low or intermediate streamflows, it provides little information about the overall channel characteristics of the measured stream.

Greenline-to-greenline width (GGW) is the non-vegetated distance between the greenlines on each side of the stream. As stated by Winward (2000):

> "Most often the greenline is located at or near the bankfull stage. As flows recede and the vegetation continues to develop summer growth, it may be located part way out on a gravel or sandbar. At times when banks are freshly eroding or, especially when a stream has become entrenched, the greenline may be located several feet above bankfull stage."

Though related to the bankfull stage, the greenline is easier to identify. In a recent meeting of scientists working to achieve greater consistency in riparian monitoring, it was determined that the greenline could be even more objectively determined if a set of rules or criteria could be identified. Using the greenline definition contained in this document will improve the precision greenline-to-greenline width.

To achieve an adequate sample for estimating the mean width (GGW), take measurements at each plot location. The results are a mean width of the non-vegetated stream channel. As streambanks recover, the stream channel typically narrows and the average non-vegetated GGW is reduced.

This indicator helps document stream channel recovery over time. Since the recovery process may be relatively slow, it is recommended that the procedure be repeated every three to five years. The procedure is relatively easy and does not consume a lot of time.

Procedure

1. At each plot location, measure the distance between the greenlines on each side of the stream and perpendicular to the water flow. A laser

range finder is the most expedient way of measuring the distance. It reduces the time required to do the measurements by about two-thirds. However, those instruments capable of a measuring accuracy of ±0.3 meter are about $700.00, while those accurate to ±0.03 meter are $2,400.00. Other less expensive options include measuring rods and tape measures.

2. Measure from the greenline associated with the center bar on the quadrat frame (near the toe of the boot (see Appendix C, Figure 2), to the greenline on the opposite side of the stream. The measurement is usually taken from only one side of the stream. If there are an inadequate number of samples, measurements may be taken from the opposite side of the steam. Measure to the nearest 0.25 feet or 0.1 meter.

3. When a vegetated island (at least 25% foliar cover) is encountered along the line, determine the total distance between the greenlines and deduct the length of the vegetated island to determine the non-vegetated GGW (see Appendix L, Figures 3 and 4).

4. Non-vegetated islands are included in the GGW width measurement (see Appendix L, line A in Figure 4).

8. Maximum Water Depth as Measured at the Deepest Point in the Stream (Thalweg Depth)

General Description

The bed profile, in a longitudinal direction along the stream, has been found to be an effective index of overall habitat structure and quality (Madej 1999). Increases in the variation of channel depths increase the complexity of aquatic habitat. Channel depth variations are created by in-stream and streamside elements that resist the erosion energies of the stream. Thus, as streams are subject to greater amounts of erosion-resisting streamside vegetation, habitat complexity increases. Recent research by the Pacific Northwest Research Station of the Forest Service concluded that "…measures of channel geometry, pool frequency, and pool size are viable indicator variables for effectiveness monitoring" (Woodsmith *et al.* 2005). Thalweg depth profiles allow for objective determination of pool frequency and quality. Past methods that rely upon observers to define pool boundaries have been too subjective and not reasonably repeatable. Recent research assessed the relation between fish abundance and thalweg metrics (Mossop and Bradford 2006). In that study, Chinook salmon densities varied greatly among stream reaches, and thalweg metrics explained 57% of the variation. An excellent metric, the "variation index" (calculated by the standard deviation of population residual depths along the reach), was found to be significant. It will also be possible to objectively estimate pool quality from maximum depth values and substrate sizes (described in indicator 10).

Procedure

The Thalweg profile is constructed by measuring the depth of water over the channel bed at spaced intervals along the channel's thalweg (or thread of maximum depth/velocity). Thus, at each plot location, normally while the observer(s) is measuring greenline-to-greenline width, a measurement of the maximum water depth along that transect is made. The maximum depth represents the deepest point in the cross section, and is found by probing with a depth rod until the deepest point is located. All 80+ plots should include a maximum thalweg water depth to acquire the sample size needed to objectively estimate the habitat metrics. It is important that the plot spacing be recorded in the "Header" form of the Data Analysis Module for proper calculation of the metrics.

9. Water Width

General Description

Water width is easy to measure reasonably precisely. As greenline-to-greenline width is sensitive to changes in streamside vegetation through time, water widths can also reflect vegetation changes. However, water width is influenced by streamflow and will vary according to climatic conditions and season of year. For this reason, water width alone will likely not represent a good monitoring indicator. However, in combination with maximum depth, the ratio Max Depth to Water Width is influenced more by channel cross-section profile than by streamflow. Thus, changes in channel morphology, through time, can be reflective of this parameter (Henderson *et al.* 2004).

Procedure

Measure widths between waterlines, with the tape or rod oriented perpendicular to the channel. If islands are present, subtract the width of the island from the total width of both channels. Measure only to the edge of the bank when an undercut bank exists; do not measure beneath the undercut. Measure water widths at all 80+ plot locations and in the same transect as the thalweg depth measure.

10. Substrate Composition

General Description

There is a sizeable literature that supports the contention that excess substrate fines are adverse to salmonids (Bauer and Ralph 2001, McHugh and Budy 2005). The literature also supports use of pebble counts to estimate substrate composition (Bunte and Abt 2001). With respect to riparian vegetation, the literature suggests that loss of bank stability is related to increases in substrate fines. Tests of the pebble counting technique indicate that there is operator bias against the fines fraction in the substrate (Bunte and Abt 2001). However, this bias is presumably consistent; therefore, trends through time should theoretically be detectable. Streams with complex substrate size distributions need more samples than those with simple substrates (Bundt and Abt 2001). The authors state that "…the precision of a 100-particle pebble count is usually too low to compare particle-size distributions from different sites or over time...." They suggest a minimum of 200 particles from evenly spaced collection points across the scoured channel (the non-vegetated portion of the channel). Thus, the sample size estimator used in the MIM Data Entry Module includes an estimator for this variable. The user should make sure that the 200+ sample size is adequate to confidently predict percent fines and particle size distributions. Substrate metrics include: percent finer than 6 mm (1/4 inch in diameter), D_{84} particle size, and an estimate of the Manning's roughness coefficient. The latter is used in calculations of estimated discharge, as part of the pool quality index, and as an indicator of the channel's ability to dissipate stream energy. The D_{84} particle size, or that substrate size for which 84 percent of all particles are smaller, has been used to describe substrate quality for fish habitat (McHugh and Budy 2004, Kondoff 2000).

Procedure

Beginning with the second plot in the survey, samples are collected at every other water-width/depth transect (or 20 total transects), evenly spaced along the entire length of the DMA. Collect and measure the diameter of 10 pebbles at each transect.

1. Visually estimate the number of heel-to-toe steps across the non-vegetated channel width totaling 10 (5 heel and 5 toe samples) and pace accordingly. For very small streams, cross once, then return and collect 5 samples on each crossing of the channel. Sample the entire streambed width at each transect starting with the heel of the boot at the greenline. Samples should be collected within the active channel. Never sample a particle on the streambank above the first terrace or the greenline or on slump blocks. Depositional features (e.g., point bars) are considered streambed material and should be included in the sample.

2. Alternatively, a measuring rod can be used to evenly space samples across the wetted width of the stream.

3. End the count at the greenline or first terrace, whichever is closest to the water's edge, on the opposite side of the stream.

Sample the particle at the toe (or heel) of the foot or below the extended measuring rod. Reach down with the forefinger (without looking at the sample point) and pick up the first particle touched. Measure the middle width (intermediate or "B" axis) of the particle in mm. Visualize the B axis as the smallest width of a hole that the particle could pass through. A gravelometer is an excellent tool for objectively measuring particle sizes and is highly recommended to avoid subjectivity in selecting and measuring the B axis.

A complete description of the device is available in the Stream Systems Technology Center—Stream Notes for April, 1996 (on-line at: http://stream.fs.fed.us/news/streamnt/pdf/SN_4-96.pdf). Commercial sources are available for purchasing this instrument at approximately $50.00 each.

DATA INTERPRETATION

Monitoring results must be interpreted considering precision, accuracy, and ability to detect change for each monitoring indicator. The following describes how each were evaluated in testing this protocol. See Appendix N for statistical analysis results of the variability between observers, and estimation of sample sizes needed to achieve 95% confidence in predicting the true mean.

Precision: Precision denotes agreement between repeat observations. Observations may be repeated by the same or different individuals. Precision is important for interpreting compliance and trend. If, for example, the stubble height allowable use criterion is 4 inches and the precision of the measurement is .5 inches, an observation of 3.6 inches would not exceed the criterion. With respect to trend, if the objective for bank stability is to achieve 80% stable and the precision is 8%, an 85% observation does not mean that the objective has been met. The coefficient of variation is a good statistic for estimating precision. It is a dimensionless measure calculated as follows:

CV = sq root (crew variance)⁄mean*100

Where:

CV = the coefficient of variation
Crew Variance = variance on repeat samples
Mean = the geometric mean value of the repeat samples

CV values < 20 are considered as having an acceptable level of precision (Ramsey et. al. 1992).

Accuracy: Accuracy is the degree of conformity of a measured quantity to its actual or true value. Accuracy is often associated with the "bias" in statistics. Bias is the difference between the population mean of a measured indicator and some reference value. The reference value is represented by a sub-population of samples for the indicator. Thus accuracy is strongly influenced by the size of the sample. Larger samples come closer to the true mean value for the indicator. A good statistic for accuracy is the confidence interval. The confidence interval is calculated using the sample mean and standard deviation.

$$\bar{Y} \pm \frac{z_{\alpha/2}\ \sigma}{\sqrt{N}}$$

where $\bar{Y}$ is the sample mean, $z_{\alpha/2}$ is the upper $\alpha/2$ critical value of the standard normal distribution which is found in the table of the standard normal distribution, σ is the known population standard deviation, and *N* is the sample size.

Note that as sample size increases, the confidence interval plus and minus the mean value decreases. In other words, the interval is closer to the mean.

Electronic data entry may be used to assess sample size levels while collecting field data. This protocol uses an Excel workbook, the Data Entry Module, designed for use with PDAs, and that allows computation of sample sizes for various levels of confidence (Appendix E).

Ability to detect change: The ability to detect change is critical to effective monitoring results. In natural stream and riparian systems change is a relatively frequent natural process. The ability to isolate changes due to management requires that the method be robust, precise, and accurate. A good statistic for detecting change is the Signal-to-Noise ratio. Signal-to-Noise is stream variance divided by crew variance. This ratio compares the level of a desired signal (such as music) to the level of background noise. The higher the ratio, the less obtrusive the background noise is. Thus, Signal-to-Noise compares the level of change through time or differences between streams (Signal = Stream Variance) to the differences between repeat samples (Noise = Crew Variance). Values >10 indicate reasonably high detection capability.

Discussion and Interpretation of Metrics

Seventeen metrics were created to evaluate and summarize the data. These metrics are calculated using an MS EXCEL workbook, the Data Analysis Module (See Appendix E for details). Refer to the Module for a description of each metric and how it is calculated.

1. Successional Status – Ecological Status

Successional status (Winward 2000) is weighted by the percentage of plants by successional status along the greenline (see Table 6). Dominant plants are double weighted in the spreadsheet calculations. Anchored rock and anchored wood are considered as late seral. Successional status vegetation data must be included for any new species added to the dominant or community type list for the analysis module to operate correctly. Local riparian plant association or community type classifications usually provide that type of information. The following table summarizes class ratings for ranges of ecological status as reflected by the successional status of the plant or community type, substrate, stream gradient, and presence/absence of the woody vegetation component (see Winward 2000).

Table 6 – Greenline Ecological Status (Winward 2000)

Summary Value	Descriptor Class Rating
0–15	Very Early
16–40	Early
41–60	Mid
61–85	Late
85+	PNC

Results of testing (54 tests) produced the following results:

CV = 17.1

S:N = 23.6

Average difference between observers = 9.2

Same observers = 6.9%

Different observers = 15.2%

2. Vegetation Erosion Resistance Rating (Greenline Stability Rating)

The vegetation erosion resistance rating (synonymous with "Greenline Stability Rating" Winward 2000) is based on the relative ability of a plant species (or rock and wood) to withstand the erosive forces of water. Computations result in a weighted average for the transect; dominant plants are double weighted. Generally, an average over 7 is considered adequate to protect the streambank and allow streams to function properly (see Table 7). Some early seral species such as *Eleocharis* spp. and arroyo willow (*Salix lasiolepisis*) growing together along the greenline provide a higher erosion resistance rating of 7 (see Appendices H and I).

Table 7 – Vegetation Erosion Resistance Index (referred to as the "Vegetation Stability Rating" in Winward 2000)

Summary Value	Descriptor Class Rating
0–2	Very Poor (very low)
3–4	Poor (low)
5–6	Moderate
7–8	Good (high)
9–10	Excellent (very high)

Results of testing (56 tests) produced the following results:
CV = 4.99
S:N = 16.9
Average difference between observers = .62
Same observers = .52
Different observers = .74

Ranges of variability between observers produced an average difference of 1.29. However, when samples are repeated by the same observer, the difference between repeat samples averages .75 (on a scale of 1 to 10).

3. Wetland Rating

The wetland rating (Coles-Ritchie 2005) is a weighted number (see Table 8) based on the wetland indicator status (Reed 1988 and USDI, Fish and Wildlife Service 1993). The wetland indicator status (Table 8) is the frequency that individual plant species occur in saturated (hydric) soils. For descriptive purposes only, these have been categorized according to Table 9.

Using only the values generated by the procedures described above may not give an adequate depiction of the condition of a vegetation community (including anchored rock and anchored wood). Careful review of all species described is important and should be considered in every data interpretation.

Vegetation communities in transition may be deceptive if only dominant vegetation is considered. Those interpreting the data must also consider sub-dominant species, as these species frequently provide valuable indicators of potential change. For example, if Nebraska sedge (*Carex nebraskensis*) is present on a site dominated by Kentucky bluegrass (*Poa pratensis*) and/or red top (*Agrostis stolonifera*), there is potential for deep-rooted species to dominate the site. Vigorous Nebraska sedge in the site described above is usually an indicator of an improving trend. Sometimes interpreting the data can be difficult; an example of this may be where undesirable plants such as noxious weeds occur as sub-dominant species. This may be an indicator of a trend away from the desired condition or it may be an intermediate step toward the desired condition. In these instances, it is important to carefully examine all previous data to confidently determine the direction of change. It is common for noxious weeds such as thistle (*Cirsium* spp.) to quickly manifest themselves after long periods of disturbance. Often, many of these weeds will slowly decline as the riparian vegetation recovers.

Table 8. Wetland indicator Status Rating (Coles-Ritchie 2005)

Wetland Indicator Status	Wetland Indicator Value	Wetland Indicator Status	Wetland Indicator Value
OBL	100	FAC -	42
OBL -	92	FACU +	33
FACW +	83	FACU	25
FACW	75	FACU -	17
FACW -	67	UPL +	9
FAC +	58	UPL	0
FAC	50		

Because vegetation composition monitoring is usually done over the long-term, the same people often do not repeat the initial measurements. This, along with the observer's ability or lack of ability to identify plant species, can create problems interpreting the data. Those analyzing the data must know the area, the potential plant species at the site, and understand these potential limitations in order to make a correct interpretation of the condition and trend on the site.

Table 9 – Site Wetland Rating

Wetland Indicator Value	Descriptor Class Rating
0–15	Very Poor
16–40	Poor
41–60	Fair
61–85	Good
85+	Very Good

Results of testing (54 tests) produced the following results:

CV = 5.0

S:N = 38.8

Average difference between observers = 4.1

Same observers = 3

Different observers = 5.3

4. Streambank Stability (Percent Streambanks Stable and Percent Streambanks Covered)

The streambank is that portion of the channel between the scour line and the top of the first terrace on either side of the stream. The streambank stability measurement provides an indication of the ability of streambanks, with their associated vegetation, anchored rock, anchored wood, and/or consolidated soils high in clay or compacted, to buffer the forces of water during conditions of high stream flow, floating ice, or debris. The results are expressed as a percentage of the stream in each of six classification categories, covered/stable, covered/unstable, uncovered/unstable, uncovered/stable, false banks, and unclassified.

Increased streambank stability on disturbed sites usually lags behind the recovery of herbaceous and woody vegetation. Streambank stability recovery rates will vary depending on the current stage of channel evolution. Recently incised channels will have a longer recovery rate because the channel must develop a new floodplain, which requires eroding streambanks to deposit material to create new point bars. This new deposition must then be occupied by deep-rooted vegetation species before the streambanks begin to stabilize. This process can take from a few years to decades to complete. When collecting streambank data, record false banks separately, as they are an indication of streambank recovery.

Consider streambank alteration, greenline vegetation composition, woody species regeneration, woody species use, and photographs to reach conclusions concerning the trend of streambank stability.

Results of testing (56 tests) produced the following results:
- CV = 10.6
- S:N = 36.6
- Average difference between observers = 7%
  - Same observers = 6.9 %
  - Different observers = 7.2 %

5. Streambank Alteration (Percent)

Tests of streambank alteration using the plot-with-line intercept method suggest that observer error varies according to site complexity and level of grazing use. On-site variability requires sampling enough observations along the streambank to confidently predict an accurate level of bank alteration. Our data suggest that at least 80 plots, each with 5 transect lines (or 80 x 5 = 400 observations) is needed to achieve a confidence interval of 4 to 6% of the mean. Thus if 80 plots result in a mean of 20%, the confidence interval is approximately 20%*.05 or plus and minus 1%. These observations suggest that bank alteration is measurable at a site, with reasonably narrow ranges of variability. It is true that levels of alteration can vary between sites under the same levels of grazing use. Depending upon the amount of soil moisture in the banks, the vegetation types, and the amounts of rock, logs, and other obstructions inherent to streambanks of the site, bank alteration may vary significantly. For example, a streambank dominated by deep-rooted vegetation and/or rock and logs will deform much less, when exposed to the pressure of an animal hoof, than a bank consisting of loose, moist soil covered by shallow-rooted vegetation. Thus potential bank alteration will vary according to streambank characteristics. In addition, the ability of streambanks to recover after disturbance also varies from one site to another.

Since streambank alteration is estimated from 400 individual observation along the greenline, % streambanks altered is a metric that represents the percent of hits (or lines intercepting hoof prints or shears) lineally along the greenline. Thus it is a mostly lineal proportion, or at least a very narrow areal proportion, aligned with the greenline on the streambank.

Results of testing (32 tests) produced the following results:
- CV = 19.9
- S:N = 15
- Average difference between observers = 5.6%
  - Same observers = 5.4%
  - Different observers = 7.7 %

6. Residual Vegetation (Mean and Median Stubble Height)

Residual vegetation is used as an indicator of the amount of livestock or wildlife use on dominant key vegetation species. It provides information concerning whether current grazing management is allowing adequate vegetation growth to maintain or enhance vigor and reproduction of the plants.

Interpretation of residual vegetation is not complicated. The result is the median residual height of the key herbaceous species in inches (mean or average may be used if desired). Do not interpret a measured value beyond the precision and accuracy for the method. For example, suppose 5 inches of residual vegetation height has been determined to be the amount necessary to meet riparian objectives for a site. The residual height of the key herbaceous species at the prescribed time (either during the grazing season or after plant re-growth and after livestock grazing has concluded for the season) was measured at 4.7 inches. The precision and accuracy tests, at the 95 percent confidence level, indicate a range of plus or minus one-half inch. Because the measured data (4.7 inches) was within the range of variability (± 0.5 inches), it cannot be considered below the recommended height. It does provide information suggesting that annual grazing is at or below the recommended level, and that the long-term (trend) should be carefully watched to detect any undesirable changes in the vegetation or channel conditions. These conditions and concerns must be conveyed to those involved in livestock management.

Residual vegetation should be used, along with greenline vegetation composition, to determine if livestock management is achieving resource objectives. Streambank alteration, streambank stability, photographs, and other stream/riparian indicators should also be considered prior to reaching a conclusion concerning the condition and/or trend of a riparian area.

Results of testing (32 tests) produced the following results:
CV = 11.0
S:N = 508
Average difference between observers = .81 inch
Same observers = .8 inch
Different observers = .82 inch

7. Woody Species Regeneration

The calculation in the data analysis module for woody species regeneration is based on the proportion of woody plants encountered in all plots for each of the three age classes (saplings and young, mature, dead). Woody species regeneration will likely have the largest variability of any of the protocols. This is particularly true on greenlines with few woody species present. Consequently, levels of precision and accuracy can be problematic for some sites (see test results below). Winward (2000) indicated that most streams with gradients of more than 0.5 percent have the potential for woody species. Conditions that promote the establishment of woody plants do not frequently occur on streams with less than 0.5 percent gradient. Highly disturbed streams, devoid of woody species, may require 10 to 20 years before woody species can re-colonize the streambank.

Data from the woody species regeneration and woody species use procedures, along with photographs, usually provide a good indication of changes in numbers, size, age, and abundance of the plants. Increasing numbers of seedlings and young plants may be an indication of early improvement along the greenline. Changing from a dominance of seedlings and young plants toward an abundance of mature plants is usually an indication that the shrub community is maturing. After disturbance, when stream channels are building lateral and point bars, it is common for an initial establishment of seedlings and young plants to occur. As the bar continues to grow, seedlings and young plants may become dominant along the greenline.

Results of testing (31 tests) on % seedlings/saplings produced the following results:
CV = 23.8 (slightly exceeds the desired precision level of 20)
S:N = 101.9 (high detection due to strong differences between stream reaches)

Average difference between observers = 13.1%
Same observers = 12.6 %
Different observers = 15.2 %

8. Greenline-to-Greenline Channel Width (GGW)

Greenline-to-greenline channel width is the average non-vegetated distance between the greenline on either side of the stream. It provides an indicator of the stream channel width. As disturbed, usually over-widened streams recover, the channel will narrow. Hence, narrowing greenline-to-greenline widths are indicators of stream recovery. Objectives specific to GGW should be developed from reference sites when such information is available. Data from GGW should be used with greenline vegetation composition, streambank stability, streambank alteration, and residual vegetation height.

Results of testing (54 tests) produced the following results:
CV = 6.7
S:N = 728 (a very strong detection ability)
Average difference between observers = .5 meter
Same observers = .39 meter
Different observers = .77 meter

9. Woody Species Use

Woody species use estimates are made using the value associated with classes (none to slight, light, moderate, heavy to severe, and extreme -- see Table 4). The degree of use should not be interpreted to a scale finer than a class (or range) since woody species use can only be reliably estimated at a coarse scale. For example, if the average calculated use is 59 percent, the conclusion should be that the use is moderate to heavy. If the use is 41 percent, the conclusion should be that the use is light to moderate. Woody species use indicators should be set by use class and not by specific numbers such as 35 percent.

Results of testing (34 tests) produced the following results:
CV = 38.9 (well above the desired precision level)
S:N = 561 (due to the high variability between stream reaches)
Average difference between observers = 3.1%
Same observers = 2.4 %
Different observers = 8.6 %

10. Thalweg Depth Variation Index

As used by Madej (1999), the Depth Variation Index is simply the standard deviation of thalweg depth measurements. Therefore, it is a statistical measure of the spread or variability in water depths along the length of the stream. The greater the variability, presumably the greater the habitat complexity and quality. Because streams are variable in water depth as streamflow rate changes temporally, the standard deviation is indexed to the average depth of the stream. Thus, in the Data Analysis Module, the "Thalweg Depth Variation Index" is calculated using the Coefficient of Variation, or ratio of the standard deviation to the arithmetic mean of all depth measurements. The coefficient of variation is a *dimensionless number* that allows comparison of samples through time while minimizing the effect of streamflow level on the variation of thalweg depths.

Results of testing (3 tests) produced the following results:
CV = 8.1
S:N = NA
Average difference between observers = .02 meter
Same observers = NA
Different observers = .02 meter

11. Water Width-Maximum Depth Ratio

This metric is calculated by dividing the average water width by the average thalweg depth. The W/D ratio indexes the shape of the wetted channel, whether narrow and deep, or wide and shallow. Because streams are variable in both width and depth, this dimensionless index allows comparisons of samples through time. The assumption here is that MIM samples are ALWAYS collected in late summer when streams are usually flowing within the active channel and within a relatively narrow range of discharge. In such conditions, depth changes are proportional to width changes. Thus, as channels tend towards stability, the index value decreases. As channels destabilize, the index value increases. However, if the channel is strongly entrenched (vertical banks), widths may not change with changes in depth. In this case, variability in the W/D ratio through time would reflect changes in discharge.

Results of testing (3 tests) produced the following results:
CV = 7.1
S:N = NA
Average difference between observers = 2.5
Same observers = NA
Different observers = 2.5

12. Percent Substrate Fines (<6 mm)

Surface fines represent that fraction of the pebbles sampled less than 10 mm in size. Kondoff (2000), in evaluating the biological significance of substrate for salmonid fishes, recommended using less than 10 mm (.39 inch) as the fraction that would potentially affect salmonid fry emergence. This means that pebbles fitting the 1, 2.8, 4, 5.6, and 8 mm slots in the gravelometer would be considered fine sediment. On the Wentworth Scale, particles less than 10 mm are the fine gravel and smaller substrate types. Ranges of variability between observers have not yet been evaluated for this metric.

12. D_{84} Substrate Particle Size Diameter and percent fines

This metric estimates the particle size for which 84% of the substrate is smaller, for all pebbles in the sample. As stream channels stabilize through riparian vegetation restoration and increased bank stability, the D84 size normally increases. As channels stabilize, they resist erosion, tend towards a narrower and deeper profile allowing higher levels of bed scour, and increase in sediment transport capability. These physical variables combine in determining the coarseness of the substrate. As stated in the method description, above, this metric is useful for evaluating fish habitat substrate quality.

Results of testing (3 tests) % fines produced the following results:
CV = 6.3
S:N = NA
Average difference between observers = .2%
Same observers = NA
Different observers = .2 %

13. Stage from Estimated Discharge

Discharge is the rate of water, in cubic feet per second, flowing in a stream channel. It is calculated by multiplying the cross-sectional area of the wetted stream channel by the water velocity, or Ft^2 x Ft/second, (or Ft^3/second). Discharge can be estimated using Manning's Equation, which is an empirical prediction derived from the channel velocity, flow area, and channel slope. Channel velocity is determined from the wetted perimeter (length of the wetted streambed perpendicular to the flow direction) and from Mannings ***n***, a coefficient that represents friction. Mannings ***n*** is called the "roughness coefficient" and can be estimated from substrate data. Table 1 in the Data Analysis Module – Substrate worksheet shows the ***n*** values that are applied to various median particle sizes calculated from the pebble count data. Thus, discharge is estimated from field information on water width, depth, gradient, and substrate particle size. It is used to approximate the streamflow rate at the time of the survey. Streamflow differences between sampling may be important in interpreting trends in Width-to-Depth ratio and the Thalweg Depth Variation Index. Stage is the "depth" value used in the equation to estimate discharge. Stage is an important source of calibration for assessing trends in wetted width-to-depth ratio.

14. Roughness Coefficient

Derivation of the Mannings' roughness coefficient is described above in the section on discharge. Mannings n is presented as a metric that has bearing on hydraulic friction in the channel and indexes substrate quality. If the roughness coefficient changes through time, such shifts are reflective of the channel's ability to transport water and sediment.

15. Pool Quality Index

High frequency of good quality pools is critical to sustaining salmonids in streams and rivers (Bauer and Ralph 2001). They are used at virtually every life stage, and are critical to providing space for rearing, feeding, resting, spawning, and incubation. A thalweg depth of .3 meter is considered critical as cover for salmonids. Substrate is a critical component of pool habitat for salmonids, particularly for juvenile overwinter rearing. The larger the median particle size, the greater amount of cover is available. Thus, the Pool Quality Index is calculated from a substrate score using both percent thalweg deeper than .3 meter, and the average particle size. The following table (Table 10) describes scores applied to the Pool Quality Index.

Table 10 – Water Depth and Substrate Scores Used to Calculate the Pool Quality Index

% Deeper than .3 meter	Depth Score	D50	Substrate Score
> 50%	5	> 180 mm	5
30 – 50%	4	64 – 180 mm	4
20 – 30%	3	32 – 64 mm	3
10 – 20%	2	16 – 32 mm	2
5 – 10%	1	8 – 16 mm	1
< 5%	0	< 8 mm	0

The depth score is added to the substrate score, and the total is multiplied by 10 to derive the Pool Quality Index. This index ranges from 0 to 100.

Results of testing (3 tests) produced the following results:
- CV = .01
- S:N = NA
- Average difference between observers = 1
  - Same observers = NA
  - Different observers = 1

16. Photographs

Photographs described in this protocol are designed to help validate data obtained using measured and observed protocols described in this document. They are not intended to be adequate to provide quantitative data.

17. PFC Validation

We suggest that the MIM protocols can be used to validate Riparian Proper Functioning Condition (PFC) Assessments. PFC assesses a much broader reach of stream; however, it is a qualitative method for assessing the condition of riparian-wetland areas, and is not designed to be a long-term monitoring tool. The PFC assessment uses hydrology, vegetation, and erosion/deposition (soils) attributes and processes to qualitatively assess the condition of riparian-wetland areas. Many of these same attributes can be quantitatively measured using the MIM procedure. Procedures for PFC assessment are found in the BLM Technical Reference 1737-15, *Riparian Area Management; A User Guide to Proper Functioning Condition and the Supporting Science for Lotic Areas*.

Use the Data Analysis Module to address or validate PFC checklist items and final ratings. Column N in the Data Summary Worksheet (located in the Data Analysis Module) presents quantitative values for several of the checklist items in the PFC assessment. As stated in 1737-15: "…there will be times when items from the checklist need to be quantified." Also: "These quantitative techniques are encouraged in conjunction with the PFC assessment for individual calibration, where answers are uncertain, or where experience is limited." The PFC Validation Table in the Data Analysis Module provides a listing of indicators and their quantitative values for the applicable checklist item(s), along with a note describing the indicator's relevance to the item.

18. Winward Greenline Calibration (Winward 2000)

The Data Analysis Module contains a calibration for predicting the vegetation metrics using the Winward (2000) method. This calibration is intended for those users who desire to predict trends using MIM, where previous samples were collected using the Winward (2000) method. Data for developing the calibration model were collected in 2006 from 31 samples. These samples were derived from a variety of stream/riparian types across southern and central Idaho. The calibration is based upon simple regression.

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Monitoring Streambanks and Riparian Vegetation

Appendices

SUGGESTED PROCEDURE for SELECTING THE DMA AND IDENTIFYING MONITORING INDICATORS

APPENDIX A—Selecting the DMA and Monitoring Indicators

Step 1. Define the Riparian Complex(s) within the Management Unit

In the office, obtain information on the stream within the management unit using USGS topographic maps, aerial photos, GIS maps, remote sensing imagery, and soils or landtype inventories.

1. Graph the stream profile; note average grades and breaks; classify the stream gradient type using Rosgen's criteria (Table A1).
2. Evaluate valley width, noting any abrupt changes within the pasture. Classify the valley type using Rosgen's Valley Morphology classification (Table A2).
3. Determine the dominant soil family type from the soils inventory or Landtype maps, noting key substrate characteristics—texture, potential vegetation, flooding, etc.
4. Evaluate vegetation patterns along the stream, noting key groupings of woody types and herbaceous types where possible from the imagery or photos.
5. Map the riparian complexes within the pasture based upon changes in channel type, valley type, and/or dominant soil families.

Step 2. Define the Appropriate Monitoring Indicators for the Riparian Complex

1. Use the outline in Appendix B to select the monitoring indicators appropriate to the channel type type and vegetation cover type in the riparian complex. When in doubt, apply all 10 indicators

Step 3. Locate the Designated Monitoring Area and Transect in the Field

1. Define the type of DMA to be selected (representative, critical, or reference). Consider established resource objectives and document rationale for DMA selection.
2. Walk through the Riparian Complex in the management unit to be monitored.
3. Validate the mapped Riparian Complex and adjust descriptions as necessary.
4. Evaluate grazing use or other management impacts along and adjacent to the stream. Note where the impacts occur and the types of disturbance. Use a "LIVESTOCK USE PATTERN MAP" if available and applicable.
5. Select a monitoring reach typical of the grazing use or other activities that overlaps any critical aquatic habitat—spawning and/or early rearing reaches, etc.
    a. Make sure it does not include a cattle crossing or local point of disturbance concentration.
    b. The starting point for the transect may be randomly selected by going to the downstream end of the reach, selecting a random number between 1 and 10, and then pacing off that number of steps upstream.

c. At the starting point, place a stake adjacent to the stream and well back from the edges of any cutbanks. The stake should be located above the bankfull elevation of the stream.
d. Place a stake to mark the ending point of the transect across the stream from the starting point (the transect will proceed upstream from the starting point a distance of at least 363 feet, cross the stream, and proceed from that point downstream to a stake located across the stream from the starting point).
e. Place stakes on each bank at the upstream end of the reach to define the transect extent.
f. If multiple channels are encountered, the current, most active channel should be followed. Do not sample streambanks on islands in the stream.

Table A1. Channel Type Descriptions (Rosgen 1996, p. 4–5)

Channel Type	Description	Entrenchment Ratio	W/D Ratio	Sinuosity	Slope	Landform
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels	>2.2	>12	>1.4	<.02	Broad valleys with terraces. Well-defined meandering channels.
E	Low gradient, meandering riffle/pool stream with low width/depth ratio and little deposition	>2.2	<12	>1.5	<.02	Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous. Very low width/depth ratio.
F	Entrenched meandering riffle/pool channel on low gradients with high width/depth ratio	<1.4	>12	>1.4	<.02	Entrenched in highly weathered material. Gentle gradients with high bank erosion rates.
G	Entrenched “gully” step/pool and low width/depth ratio on moderate gradients	<1.4	<12	>1.2	.02 to .039	Gullies, step/pool morphology. Narrow valleys or deeply incised in alluvial or colluvial materials. Unstable with high bank erosion rate.
B	Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools	1.4 to 2.2	>12	>1.2	.02 to .039	Moderate relief, colluvial deposition, and/or structural. Narrow, gently sloping valleys.
A	Steep, entrenched, cascading, step-pool streams. Very stable if bedrock or boulder dominated.	<1.4	<12	1.0 to 1.2	.04 to .10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches.

Table A2. Valley Morphology Types (Rosgen 1996, pages 4-12 to 4-20)

Valley Type	Shape	Channel Types Represented	Valley Slope %	Typical Substrate	Landforms
II	Broad V-shape or narrow U-shape in colluvial valleys	"B"	<4%	Cobble and boulder from alluvium and colluvium	Cryoplanated uplands with colluvial slopes – in narrow valley
III	Broad V-shape filled with alluvial fans and debris cones	"A", "B", "G", and "D"	>2%	Cobble and boulder	Colluvial and alluvial side-slope fans in the V-shaped valley
IV	V-shaped confined in entrenched canyon	"F" and "C"	<2%	Sand to cobble	Entrenched meanders (gorges) in confined alluvial valleys
V	Wide, U-shaped valley	"C", "D", and "G"	<4%	Sand to cobble	Moraines, terraces, and floodplains in wide, U-shaped valley
VI	Broad V-shape or narrow U-shape	"B"	<4%	Sand to cobble	Fault-line valley with steeper slopes on one side of the valley
VIII	Wide, flat valley shape	"C" and "E"	<2%	Sand to cobble	Alluvial terraces and floodplains in broad valley
IX	Wide, flat	"C" and "D"	<2%	Sand to gravel	Glacial outwash plain
X	Very wide, flat plain	"C", "E", and "DA" with "G" and "F"	<2%	Sand to gravel	Broad lacustrine and alluvial flats
XI	Broad, flat to lobate shapes	"DA", "D", "C", and "E"	<2%	Sand to gravel	River deltas, tidal flats

APPENDIX B—Guide to the Selection of Monitoring Indicators

The following guide can be used to prescribe streamside monitoring indicators appropriate for various channel types (Rosgen, 1996) and for existing and potential vegetative conditions along the greenline.

I. "C" channel type, herbaceous vegetation dominant, potential vegetation: herbaceous or mixed herbaceous and shrubs.


- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Stubble height on key riparian species, or species groups on the greenline
  - Use compliance (livestock numbers and time in pasture)
  - Bank disturbance or alteration
- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stabilizers:**
  - Stubble height on key riparian species, or species groups on the greenline
  - Bank disturbance or alteration
- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives:**
  - Streambank stability
  - Greenline composition maintained or trend toward hydric stabilizers
- **STREAM CHANNEL: Long-term indicators of stream channel condition to assess attainment of the Riparian Management Objectives:**
  - Greenline-greenline width
  - Thalweg water depth with water width
  - Pebble count (substrate composition)

II. "C" channel type, mixed shrub-herbaceous vegetation dominant, potential vegetation: mixed herbaceous and shrubs, or shrubs.


- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Stubble height on key riparian species or species groups on the greenline
  - Use compliance (livestock numbers and time in pasture)
  - Bank disturbance or alteration
  - Change in preference to woody species seedlings and young
- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stabilizers:**
  - Stubble height on key riparian species or species groups on the greenline
  - Bank disturbance or alteration
  - Woody species use on seedlings and young (less than 5 feet above ground)
- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives:**
  - Streambank stability
  - Greenline composition maintained or trend toward hydric stabilizers
  - Woody species regeneration—15–20% seedlings and young, 60–70% mature, and 15–20% dead
- **STREAM CHANNEL: Long-term indicators of stream channel condition to assess attainment of the Riparian Management Objectives:**
  - Greenline-greenline width
  - Thalweg water depth with water width
  - Pebble count (substrate composition)

APPENDIX B—Guide to the Selection of Monitoring Indicators

III. "C" channel type, woody dominant, potential vegetation: shrubs and trees.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Use compliance (livestock numbers and time in pasture)
  - Bank disturbance or alteration
  - Change in preference to woody species seedlings and young
- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stabilizers:**
  - Bank disturbance or alteration
  - Woody species use on seedlings and young (less than 5 feet above ground)
- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives:**
  - Streambank stability
  - Woody species regeneration—15–20% seedlings and young, 60–70% mature, and 15–20% dead
- **STREAM CHANNEL: Long-term indicators of stream channel condition to assess attainment of the Riparian Management Objectives:**
  - Thalweg water depth with water width
  - Pebble count (substrate composition)

IV. "E" channel type, herbaceous vegetation dominant, potential vegetation: herbaceous or mixed herbaceous and shrubs.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
    - Stubble height on key riparian species, or species groups on the greenline
    - Use compliance (livestock numbers and time in pasture)
    - Bank disturbance or alteration
- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stabilizers:**
    - Stubble height on key riparian species, or species groups on the greenline
    - Bank disturbance or alteration
- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
    - Streambank stability
    - Greenline composition maintained or trend toward hydric stabilizers
- **STREAM CHANNEL: Long-term indicators of stream channel condition to assess attainment of the Riparian Management Objectives:**
    - Greenline-greenline width
    - Thalweg water depth with water width
    - Pebble count (substrate composition)

V. "F" channel type (entrenched floodplain), herbaceous vegetation dominant, potential vegetation: herbaceous or mixed herbaceous and shrubs.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Stubble height on key riparian species, or species groups on the greenline
  - Use compliance (livestock numbers and time in pasture)
  - Bank disturbance or alteration
- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stabilizers:**
  - Stubble height on key riparian species, or species groups on the greenline
  - Bank disturbance or alteration
- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives:**
  - Streambank stability
  - Greenline composition maintained or trend toward hydric stabilizers
- **STREAM CHANNEL: Long-term indicators of stream channel condition to assess attainment of the Riparian Management Objectives:**
  - Greenline-greenline width
  - Thalweg water depth with water width
  - Pebble count (substrate composition)

VI. "G" channel type (entrenched—no floodplain), herbaceous vegetation or bare banks dominant. Potential vegetation: herbaceous.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Use compliance (livestock numbers and time in pasture)
  - Bank disturbance or alteration
- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stabilizers:**
  - Bank disturbance or alteration
- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives:**
  - Streambank stability
  - Greenline composition maintained or trend toward hydric stabilizers
- **STREAM CHANNEL: Long-term indicators of stream channel condition to assess attainment of the Riparian Management Objectives:**
  - Greenline-greenline width
  - Thalweg water depth with water width
  - Pebble count (substrate composition)

APPENDIX B—Guide to the Selection of Monitoring Indicators

VII. "B" channel type, mixed shrub-herbaceous vegetation dominant, potential vegetation: mixed herbaceous and shrubs, or shrubs.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Stubble height on key riparian species, or species groups on the greenline
  - Use compliance (livestock numbers and time in pasture)
  - Bank disturbance or alteration
  - Change in preference to woody species seedlings and young
- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stabilizers:**
  - Stubble height on key riparian species, or species groups on the greenline
  - Bank disturbance or alteration
  - Woody species use on seedlings and young (less than 5 feet above ground)
- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives:**
  - Streambank stability
  - Greenline composition maintained or trend toward hydric stabilizers
  - Woody species regeneration—15–20% seedlings and young, 60–70% mature, and 15–20% dead
- **STREAM CHANNEL: Long-term indicators of stream channel condition to assess attainment of the Riparian Management Objectives:**
  - Greenline-greenline width
  - Thalweg water depth with water width
  - Pebble count (substrate composition)

VIII. "B" channel type, woody dominant, potential vegetation: Shrubs and trees.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
    - Use compliance (livestock numbers and time in pasture)
    - Bank disturbance or alteration
- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stabilizers:**
    - Bank disturbance or alteration
    - Woody species use on seedlings and young (less than 5 feet above ground)
- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
    - Streambank stability
    - Woody species regeneration—15–20% seedlings and young, 60–70% mature, and 15–20% dead
- **STREAM CHANNEL: Long-term indicators of stream channel condition to assess attainment of the Riparian Management Objectives:**
    - Greenline-greenline width
    - Thalweg water depth with water width
    - Pebble count (substrate composition)

IX. "A" channel. Mixed shrubs and herbaceous, or shrubs dominant. Potential vegetation: mixed shrubs and herbaceous, or shrubs. Substrate large.

TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:
- o Use compliance (livestock numbers and time in pasture)
- o Bank disturbance or alteration
- o Change in preference to woody species seedlings and young

- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stabilizers:**
  - o Bank disturbance or alteration
  - o Woody vegetation use on seedlings and young (less than 5 feet above ground)
- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
  - o Streambank stability
  - o Woody species regeneration—15–20% seedlings and young, 60–70% mature, and 15–20% dead
- **STREAM CHANNEL: Long-term indicators of stream channel condition to assess attainment of the Riparian Management Objectives:**
  - o Greenline-greenline width
  - o Thalweg water depth with water width
  - o Pebble count (substrate composition)

Herbaceous vegetation does not normally contribute significantly to the stability of A channels. The rare exception would likely be associated with A5 and A6 channel types. A5's are steep channels incised in sandy materials and occur on highly weathered granites or sedimentary rocks. Such channels often experience natural bank erosion through fluvial and earth flow processes. A6's are steep, entrenched channels in weathered shales and lacustrine soils that are very cohesive.

APPENDIX C—Greenline Location

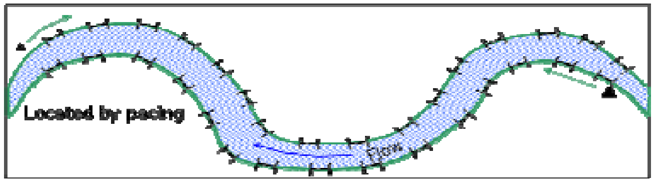

Figure 1—placement of the monitoring frame along the greenline. Note that frame placement is not necessarily perpendicular to the placement on the opposite bank due to differences in greenline length.

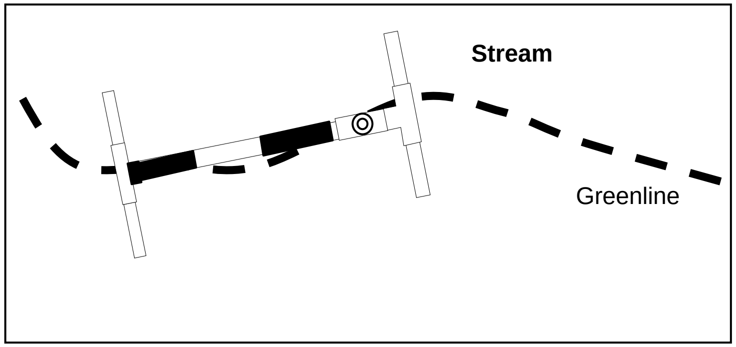

Figure 2—place the monitoring frame with the center of the frame along the greenline.

APPENDIX C—Greenline Location

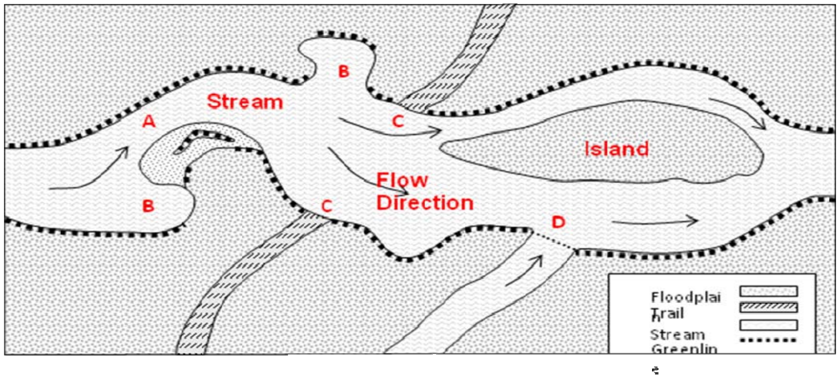

Figure 3—the point bar (A) shows an interrupted greenline with vegetation growing the bar not connected to the vegetation along the stream. The greenline runs more-or-less parallel to the flow of the stream. The areas shown by the letter “B” constitute an interrupted greenline as the vegetation exceeds 75 degrees toward perpendicular to the stream flow. The greenline continues when the line of vegetation begins to parallel the stream. Roads, trails (C), and tributary streams (D) are not considered part of the greenline. They may be recorded as information, but not included in greenline calculations. These include livestock and wildlife trail.

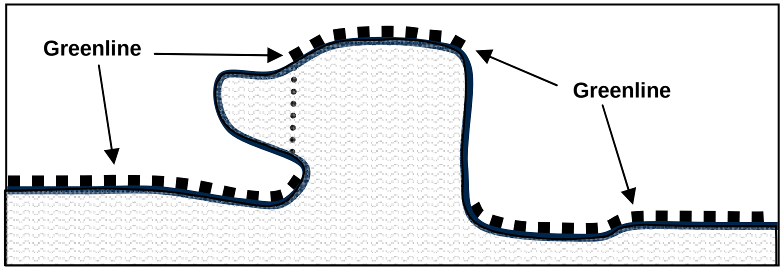

Figure 4—the greenline is on the streambank approximately parallel to the water flow. Streambanks perpendicular (over 75-degree angle) to the stream flow are not considered greenline.

APPENDIX C—Greenline Location

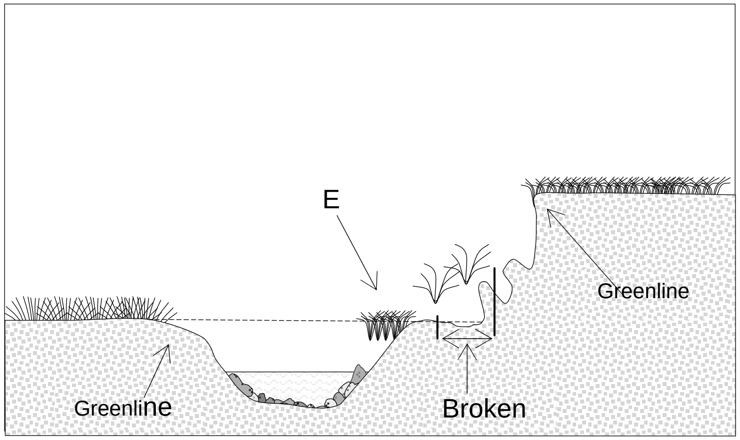

Figure 5—the diagram shows the location of the greenline in a situation with a broken bank. The field horsetail (E) is shown on an area that is an island during above bankfull flows, and therefore the greenline is on the edge of the higher bank (terrace). The greenline on the left-hand bank is typical of vegetation at or slightly above the bankfull flow line.

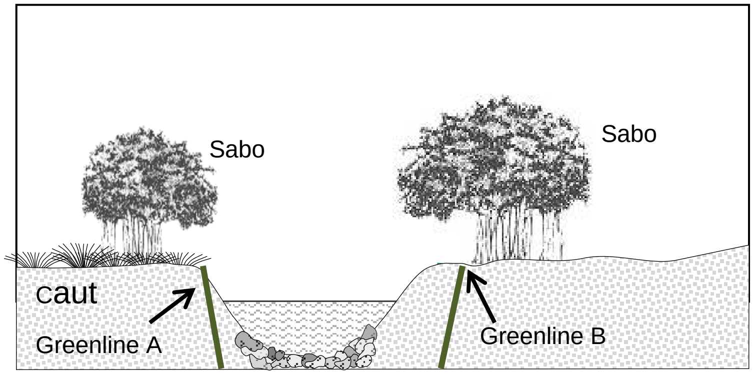

Figure 6—greenline A is an example of a Booth's willow (Sabo) overstory with beaked sedge (Caut) as an understory. The type name would be Sabo/Caut. Greenline B is an example of the location of the greenline when there is a shrub overstory and no vegetation understory; the greenline is at the base of the shrub or tree.

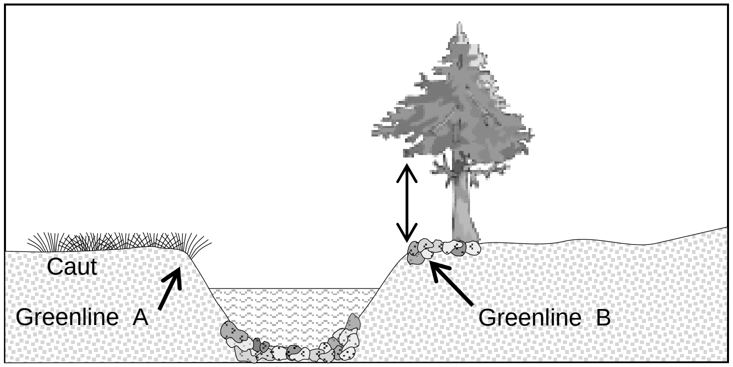

Figure 7—greenline A is an example of a single species, beaked sedge (Caut). Greenline B is an example of the location of the greenline when there is a conifer tree overstory with anchored rock in the streambank. Conifer and anchored rock are both recorded as dominant.

APPENDIX D—Modified Daubenmire Monitoring Frame

Monitoring frames may be constructed of ½-inch schedule 40 PVC pipe or metal. Schedule 40 PVC is rigid and does not warp as much as the lighter PVC pipe. PVC material is inexpensive, light, and easy to use. Carefully measure each of the pieces before they are glued together since fittings may not be uniform between manufacturers. If handles or other components are constructed with slip fittings, they should be glued together. Threaded fittings glued onto the pieces work well if the frame needs to be disassembled for transport. Electrical tape wrapped around the pipe is a good material for marking the frame and handle segments. Tape is more durable than paint.

Metal frequency plot frames (typically 40 by 40 cm) may also be used by extending the tines to 50 cm in length and marking the four incremental segments with lines or alternating colors.

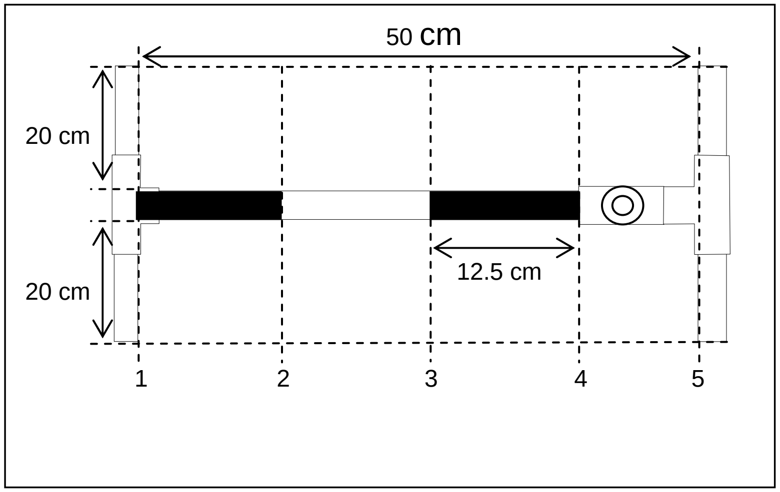

Figure 1—standard multiple indicator monitoring quadrat frame. Based on field experience, this is the preferred quadrat configuration. It is light, easy to carry, and easy to manipulate in shrub-type vegetation. Observers must be careful to extend the lines to complete the quadrat. Mark one-inch increments on the handle to with electrical tape to facilitate stubble height measurements.

APPENDIX D—Modified Daubenmire Monitoring Frame

Figure 1—Material list for standard quadrat frame.

Item	Number	Length	
		Inches	Centimeters
½-inch Tee	3	-	-
PVC pipe	4	7.75	19.7
PVC pipe	1	16.9	43
PVC pipe	1	1.25	3.2
PVC pipe (handle)	1	39	100

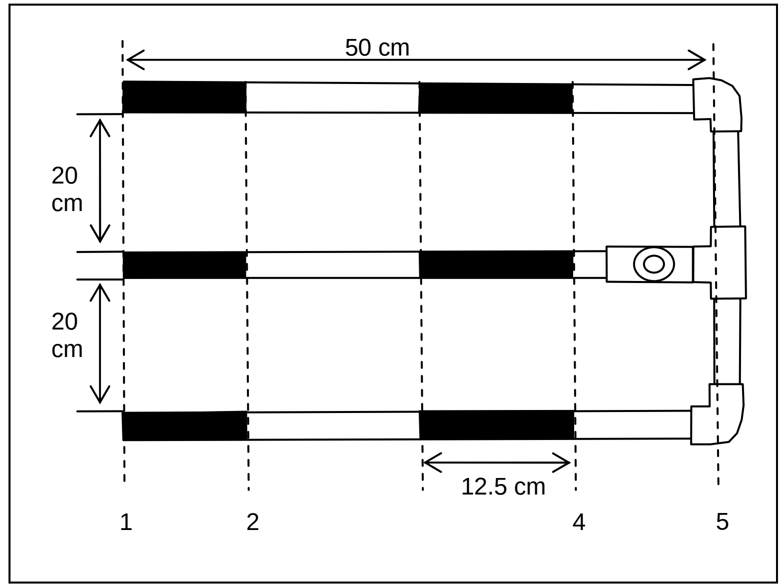

Figure 2—alternate design for multiple indicator monitoring quadrat frame. This configuration more succinctly defines each of the two plots and can be easily used on streams lacking shrubs. The frame consists of two 20-cm by 50-cm Daubenmire monitoring quadrats set side-by-side.

APPENDIX D—Modified Daubenmire Monitoring Frame

Figure 2—Material list for alternate design quadrat frame.

Item	Number	Length	
		Inches	Centimeters
½-inch tee	2	-	-
½-inch elbow	2	-	-
PVC pipe	3	19.6	49.7
PVC pipe	2	7.6	19.4
PVC pipe	1	1.5	3.8
PVC pipe (handle)	1	39	100

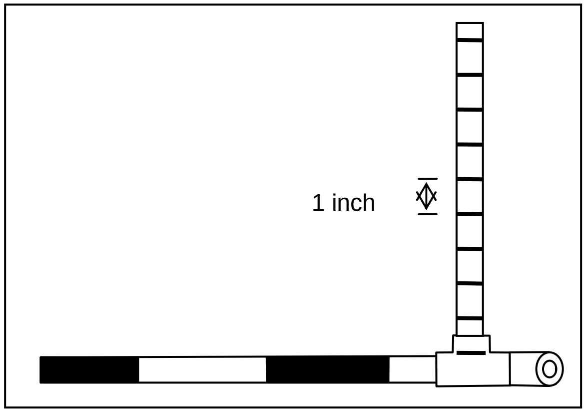

Figure 3—for either frame design, mark the handle in one-inch increments to facilitate measuring stubble height.

APPENDIX E—Data Entry and Analysis

A data entry form has been prepared for use with PDAs using the Excel spreadsheet format. The form can be downloaded into Excel on the user's PC, and then converted to Pocket Excel in the PDA through synchronization. This file includes user instructions. Calculations and analyses are limited in this form to avoid time delays caused by the much-reduced processing speed of handheld computers (see Appendix M).

Using Pocket Excel for PDAs & the Data Entry Module

Use Pocket Excel to enter data in the field and determine sample size needed.

The Data Entry Module is designed to be used with Pocket Excel.

Enter data for one pasture in an allotment, on one file. Save the file as the pasture or DMA name.

Entering data

Header

The "Header" worksheet records descriptive info and is required.

You can generate a random number in the "Header" worksheet entering the formula "=RAND()*10," followed by enter.

You should also indicate how many steps you take in a pace, and the length of your step in meters.

Gradient is stream gradient in %. You should also enter the substrate class using the codes in the "Codes" spreadsheet.

The questions concerning woody plants must be answered to obtain a seral status rating.

DMA

Use plant codes from the Codes worksheet

Data entry cells are non-colored.

Codes

This worksheet describes the bank stability and woody regeneration age classes.

Vegetation

Worksheets contain vegetation codes for grasses (including grass-likes), shrubs, trees, and forbs.

Key species are listed in a column on the right side of the DMA spreadsheet.

Substrate

This worksheet allows entering stream substrate data using the Pebble Count method as explained in the bulletin and in the field cards. Data are entered for all 20 cross sections, 10 per section for a total of 200. If more pebbles are desired, for example to meet sample size needs, add them to the rows indicated. Measure pebble counts across the stream channel at every other plot until the desired sample size is achieved.

Comments

Comments may be general or by plot.

Statistics

The "Stats" worksheet describes statistics used to calculate sample size.

Using the Data Analysis Module

The “Data_Analysis_Module 2008 V5” is a file that will import all of the raw data from the “Data_Entry_Module 2008 V5,” and calculate metrics useful for data interpretation. This analysis module will also format the data for export to the MIM database, and the IIT IM Database, which are both in ACCESS format. Data may also be copied directly into this module. Thus, when users record data on hard copy sheets, the data are transferred directly to this file rather than the Data Entry Module, which is used for field entry only.

MACROS: The Macros in this analysis module open your Data Entry file and extract data for analysis, and examine and correct common mistakes in coding plants in the DMA worksheet. There is also a macro for entering new plant codes into the system.

Macros must be enabled to function. Enable Macros in "Tools," "Macro," "Security."

-

The "Data Summary" worksheet can then be opened to examine results.

Analyzing Data collected using Data Entry Module

In the Data_Analysis_Module, run the macro Ctrl "m" by holding down the control key and select the letter "m" to import and analyze the data. Data are brought into the module from the Header, DMA, and Substrate worksheets of the Data Entry Module. Follow the prompts as described above for data prior to 2007.

Correcting plant codes in the DMA worksheet

Use Ctrl "r" for execution. This macro searches for commonly made mistakes in the coding of plants and corrects them. Not all mistakes are likely to be found, so users MUST check the data to assure that all plant codes are correct. The drop-down menus in the plant code fields of the DMA worksheet provide a quick and efficient means of checking the plant code list. When unsure of the code for a particular plant, refer to the "Codes" worksheet for a complete list with their scientific and common names.

Correcting numeric data

Use Ctrl "c" to let the system analyze the numeric values entered by the user. This quality control measure checks to see if decimals are in the right place.

Adding plant codes not currently in the DMA worksheet

Use Ctrl "p" for execution. If a plant is encountered in the field and is not included in the list of plants provided in the "DMA" or the "Codes" worksheets, this macro will insert it. You must first select a plant code from the plant list that you did not use. You will be prompted for that code name. You will then be prompted for the code name you intend to use for the new plant encountered. The system will then replace the unused plant code with the new plant code, which will now be counted in the metric calculations.

Each iteration of data import into the Data Analysis Module provides an opportunity to save the raw data and data summary.

> A good convention is to save the file as follows: "allotment_DMAname" (e.g. for the Dry Creek Allotment, Long Creek DMA: "drycreek_longcreek").

Once the file has been saved, close it, then reopen the Data Analysis Module to import and analyze additional DMA data.

Always keep the master copy of the Data Analysis Module in a separate folder.

Make copies of the Module and place them in each data file folder.

APPENDIX E—Data Entry and Analysis
Use these copies to run the Macros and analyze the data—never use the master copy.

Your field-entered vegetation codes must match those in the "Codes" worksheet. If they don't, you will need to replace the field-entered codes with those in this worksheet to run the analysis.

Additional instructions for use of the Module are contained in the "Instructions" worksheet. This includes instructions for using the Export worksheet. Also, there are instructions in the MIM database for transferring data from the Data_Analysis_Module 2008 V5 directly into the database table and for up-loading images.

Worksheets in the Data Analysis Module are protected to prevent inadvertent modification of equations used to calculate the metrics. If the user desires to modify a component, first make a copy to assure that the original is not lost in case of errors; second, select "Tools," "Protection," "Unprotect Sheet," and and press enter. Users are cautioned not to make substantial changes without making sure that such changes affect the outcomes of metric calculation. For example, if a plant code is changed in the "Codes" worksheet, it must also be changed at all locations of occurrence in the "DMA" and "Summary" worksheets for the metrics to be correctly calculated. If there is any doubt, contact the developer first: Tim Burton at: tburton@blm.gov.

APPENDIX F—Riparian Monitoring Data Sheet

Plot No.—Enter the plot number manually for each plot. This allows multiple rows to be used for additional species encountered for the vegetation entries.

Riparian Vegetation

Dominant—Enter the species code for the dominant vegetation. If any part of the quadrat contains a woody species overstory, enter that plant code in the first line of the plot. If there is a co-dominant species, enter it on the next line without a plot number. The first species code of riparian community type may be entered into this column. The second species code in the riparian plant community designation may be entered into the Subdominant Vegetation column.

Subdominant—Enter the species code of the species into this column. If there are two subdominant plant species, enter the code on the next line without a plot number.

Streambank

Altered—Record the number of lines (0 to 5) that intersect streambank disturbance caused by the hooves of livestock and/or wildlife. If more than one animal track is intersected along one of the five lines, only one is recorded.

Stability Class—Record the streambank stability class (cs-covered/stable, cu-covered/unstable, uu-uncovered/unstable, us-uncovered stable, fs-false bank, or un-unclassified).

Stubble Height

Key Species—Enter the code of the key species.

Average Height—Record the average height of the leaves of the key riparian species nearest the handle and within the plot. When there are no key species in the quadrat, leave the cell blank.

Woody Species Regeneration

Species—Enter the code for the woody species encountered within the plot. Leave the cell blank if no plants are encountered.

Seedlings—Record the number of individual woody plants classified as seedlings.

Young—Record the number of individual woody plants classified as young.

APPENDIX F—Riparian Monitoring Data Sheet

Mature—Record the number of individual woody plants classified as mature.

Decadent—Record the number of individual woody plants classified as decadent (over 50 percent of the plant is dead).

Dead—Record the number of individual woody plants classified as dead (no part of the plant is alive).

Unclassified—Use this column for recording the number of woody species stems within the plot that are not classified by age. It may be used for rhizomatous species such as coyote willow (*Salix exigua*).

Greenline-to-Greenline Width (GGW)

Record the non-vegetated distance (meter or English) at each plot location. The measurement is from the greenline at the back of the quadrat across the stream, perpendicular to the water flow direction, to the greenline. When a vegetated island is encountered, subtract the distance of the vegetated island from the total greenline-to-greenline distance.

Woody Use

Species—Record the code of the woody species on which use will be determined.

Percent Use—Enter the midpoint number (none to slight = 5; slight to moderate = 25; moderate = 50; heavy to severe = 75; and extreme = 95) of the use class for each transect.

In-Stream Variables

Thalweg depth—Record the maximum water depth under the greenline-greenline width transect in meters.

Water width—Measure and record the width of water (excludes islands/peninsulas) in meters.

Substrate sizes—Record substrate sizes in mm for each transect on the substrate form.

APPENDIX G—Example Greenlines

Figure 1—vegetation growing within the stream channel is not part of the greenline. Photo - PIBO, U.S. Forest Service

Figure 2—the greenline follows the (*Carex* sp.) on each side of the stream. Water speedwell (*Veronica anagallis-aquatica*) growing in the stream is not part of the greenline. Photo - PIBO, U.S. Forest Service

APPENDIX G—Example Greenlines

Figure 3—monkey flower (*Mimulus guttatus*) is an annual or short-lived rhizomatous perennial colonizing species. It is not included as a greenline species. Photo - PIBO, U.S. Forest Service

Figure 4—watercress (*Rorippa nasturtium-aquaticum)* is not considered part of the greenline. It should be noted in the remarks section**.**

APPENDIX G—Example Greenlines

Figure 5— brookgrass (*Catabrosia aquatica*) is a short-lived perennial grass that occasionally grows on the streambank. It grows mostly in the margin of a stream. It is not considered part of the greenline.

Figure 6—greenline follows the continuous vegetation along the edge of the water at summer low flow and not vegetation growing in the water or channel. There is a distinct line between the vegetation on the streambank and the vegetation in the channel. Photo - PIBO, U.S. Forest Service

APPENDIX G—Example Greenlines

Figure 7—when willows grow in the channel, the greenline follows the water's edge or streambanks at summer low flow.

Figure 8—greenline follows the relatively continuous line of vegetation and not the scatter vegetation on the sand/gravel bar. Photo - PIBO, U.S. Forest Service

APPENDIX G—Example Greenlines

Figure 9—the greenline follows the outer streambank at bankfull. It does not cross a channel to the island. A small channel runs along the island on the left. Photo - PIBO, U.S. Forest Service

Figure 10—colonizing species short-awned fox tail (*Alopecurus aequalis*) forming a lineal grouping of vegetation with at least 25% foliar cover; it is at least 6 inches (15 cm) wide and 19.6 inches (50 cm) long.

APPENDIX G—Example Greenlines

Figure 11—in the case of a peninsula, or back-water channel, the greenline jumps across the backwater channel to the inner bank of the peninsula.

APPENDIX G—Example Greenlines

Figure 12—the island, even with vegetation, is not part of the greenline.

Figure 13—greenline on the left side of the photo is in two segments, the lower segment near the water's edge and the upper segment along the edge of the terrace with upland vegetation. The greenline on the right side of the stream is continuous along the perennial vegetation.

APPENDIX G—Example Greenlines

Figure 14—for steep, bare banks, the greenline is at the top. Vegetation does not have to be "hydric" to be included as part of the greenline.

Figure 15—the greenline follows the relatively continuous line of vegetation. The vegetation near "A" does not meet the greenline criteria of being at least 50 cm long. Photo - PIBO, U.S. Forest Service

APPENDIX G—Example Greenlines

Figure 16—slump blocks "A" are detached and not considered part of the greenline. The dashed line shows greenline. Photo - PIBO, U.S. Forest Service

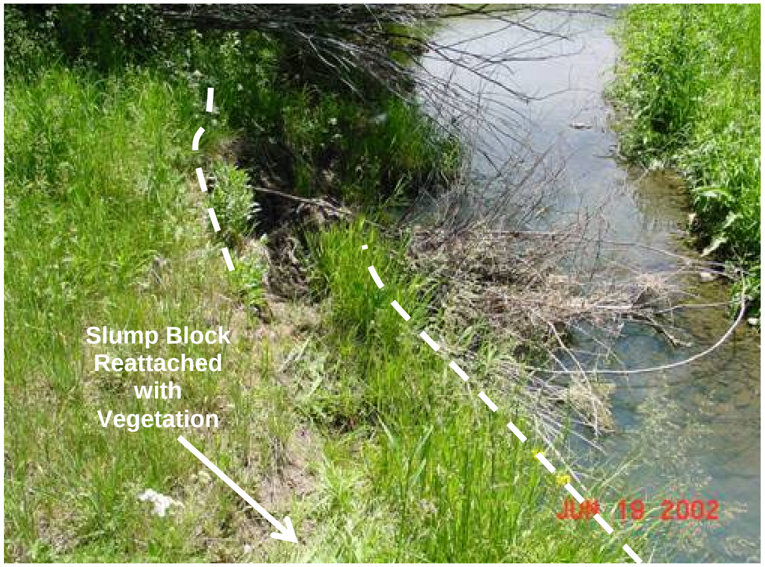

Figure 17—slump block re-attached to the bank with vegetation.

APPENDIX G—Example Greenlines

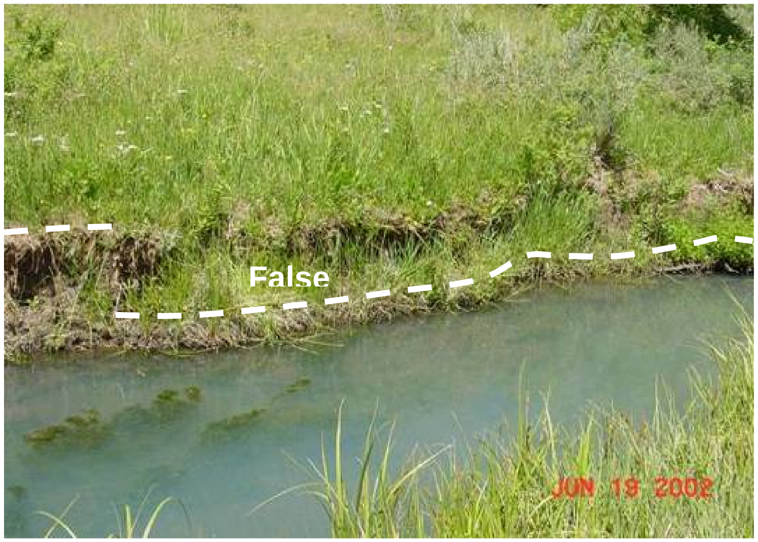

Figure 18—false bank is an old slump block with vegetative cover. The slump feature is reattached to the streambank. The greenline follows edge of the false bank.

Figure 19—vegetation is not well established between the slump block and the terrace; thus, the greenline follows the bank behind it.

APPENDIX G—Example Greenlines

Figure 20—when a log jam that crosses the stream is encountered, the greenline continues over the log jam and is recorded as anchored wood. Photo - PIBO, U.S. Forest Service

Figure 21—the patch of vegetation that the quadrant is on does not meet the 15 cm (6 in) by 50 cm (19.6 in) rule.

APPENDIX G—Example Greenlines

Figure 22—the rock “A” is anchored and part of the greenline. Active erosion exists on the streambank side of rock “B” and is not considered part of the greenline.

Figure 23— greenline follows the line of relatively continuous with lineal groupings of perennial vegetation with 25 percent foliar cover.

APPENDIX G—Example Greenlines

Figure 24—large anchored boulders and bedrock are recorded as rock. Note the color change on the rocks, indicating the bankfull stage. Photo - PIBO, U.S. Forest Service

Figure 25—the greenline along talus slope is considered as rock and is at about the bankfull stream level. Record the data as rock. Photo - PIBO, U.S. Forest Service

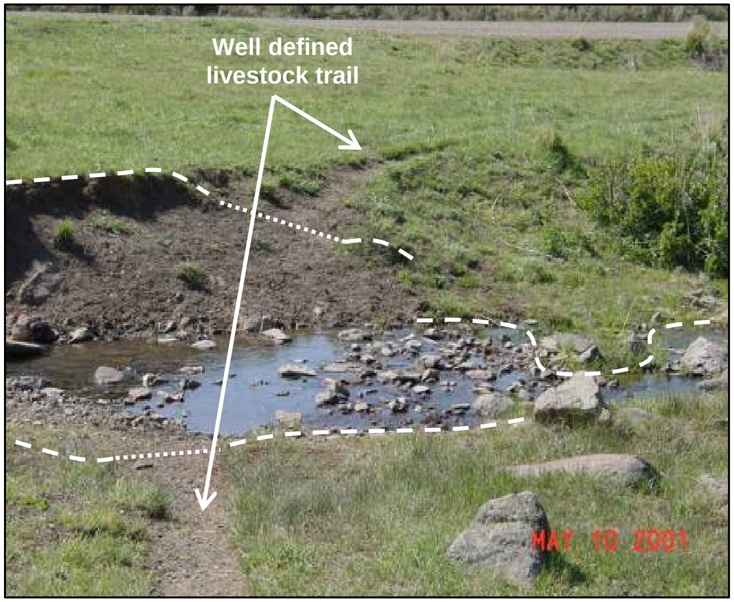

Figure 26—water, tributary streams, roads, and livestock trails are not considered part of the greenline. Livestock trails must be well defined by use over years of use, such as the trail shown above. Heavy use during a single season usually does not create a well-defined trail. Should the quadrat fall on a trail, it is recorded as “NG” (no greenline).

APPENDIX G—Example Greenlines

Figure 27—a narrow peninsula on a tight meander bend has no greenline vegetation. Place the frame with the center bar along the top of the ridge and record “NG” (no greenline vegetation). Record the non-vegetative indicators.

APPENDIX H—Greenline Dominance Plant Types

This is a partial list of plants, and should be supplemented with species that are important in a particular area.

CODES	GREENLINE DOMINANCE SPECIES	COMMON NAME	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
ABLA	ABIES LASIOCARPA	Subalpine fir	9	L	FACU
ACGR	ACER GRANDIDENTATUM	Big tooth maple	7	L	FAC
ACNE	ACER NEGUNDO	Boxelder	7	L	FACW
ACER	ACER SPP.	Boxelder	7	L	FAC
AGSM	AGROPYRON SMITHII	Western Wheatgrass	6	L	FACU
AGSC	AGROSTIS SCABRA	Rough Bentgrass	2	E	FAC
AGST	AGROSTOS STOLINIFERA	Red Top	3	E	FW
ALIN	ALNUS INCANA	Mountain Alder	6	E	FACW
ALRH	ALNUS RHOBIFOLIA	White Alder	9	L	FACW
ALSI	ALNUS SINUATA	Sitka alder	7	M	FACW
ALAQ	ALOPECURUS AEQUALIS	Short-awned foxtail	3	E	OBL
ALGE	ALOPECURUS GENICULATUS	Water foxtail	3	E	FACW
ALOP	ALOPECURUS SPP.	Foxtail	2	E	FW
AMAL	AMELANCHIER ALNIFOLIA	Serviceberry	9	L	FAC
ROCK	ANCHORED ROCK	Rock	10	L	
WOOD	ANCHORED WOOD	Wood	10	L	
ANKI	ANGELICA KINGII	King' angelica	5	E	FACW
ARCA	ARTEMISIA CANA	Silver Sagebrush	4	E	FAC

APPENDIX H—Greenline Dominance Plant Types

CODES	GREENLINE DOMINANCE SPECIES	COMMON NAME	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
ARLU	ARTEMISIA LUDOVICIANA	White sagebrush	4	E	UPL
ARTR	ARTEMISIA TRIDENTATA TRIDENTATA	Basin big sagebrush	2	L	UPL
ARTRV	ARTEMISIA TRIDENTATA VACEYANA	Mountain big sagebrush	2	L	UPL
ARTRW	ARTEMISIA TRIDENTATA WYOMINGENSIS	Wyoming big sagebrush	2	L	UPL
ASCH	ASTER CHILENSIS	Western aster	4	E	FAC
ASIN	ASTER INTEGRIFOLIUS	Thick-stem aster	3	E	FACW
BARREN	BARREN	Barren	1	E	
BEER	BERULA ERECTA	Cut-leaf water parsnip	3	L	OBL
BEOC	BETULA OCCIDENTALIS	Western water birch	7	L	FACW
BRCA	BROMUS CARINATUS OR MARGINATUS	Mountain brome	7	M	FAC+
BRIN	BROMUS INERMIS	Smooth brome	5	M	FAC+
BRTE	BROMUS TECHORUM	Cheatgrass	1	E	UPL
CACA	CALAMAGROSTIS CANADENSIS	Blue-joint reedgrass	9	L	FACW+
CANE2	CALAMAGROSTIS NEGLECTA (C.STRICTA)	Slim-stem reedgrass	9	L	FACW+
CALE	CALTHA LEPTOSEPALA	White marsh marigold	6	M	FACW
CARDA	CARDAMINE SPECIES	Bittercress	8	E	FACW
CAAQ	CAREX AQUATILUS	Water sedge	6	E	FACW
CABU	CAREX BUXBAUMII	Buxbaum sedge	8	L	OBL
CADO	CAREX DOUGLASII	Douglas' sedge	4	E	FAC-
CALA2	CAREX LANUGINOSA	Wooly sedge	9	L	OBL
CALA1	CAREX LASIOCARPA	Wooly-fruit sedge	8	L	OBL
CALE	CAREX LENTICULARIS	Tufted sedge	4	E	FACW+
CALI	CAREX LIMOSA	Mud sedge	8	L	OBL

APPENDIX H—Greenline Dominance Plant Types

CODES	GREENLINE DOMINANCE SPECIES	COMMON NAME	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
CAMI	CAREX MICROPTERA	Small-winged sedge	5	M	FAC
CANE	CAREX NEBRASCENSIS	Nebraska sedge	9	L	OBL
CAPR	CAREX PRAEGRACILLIS	Cluster field sedge	8	M	FACW
CASA	CAREX SAXATILIS	Rocky Mountain sedge	8	L	FACW+
CASC	CAREX SCOPULORUM	Mountain sedge	9	L	FACW
CASH	CAREX SHELDONII	Sheldon's sedge	9	L	OBL
CASI	CAREX SIMULATA	Short-beaked sedge	8	E	OBL
CAREX	CAREX SPP	Sedge	6	M	FACW
CAUT	CAREX UTRICULATA	Beaked sedge	9	L	OBL
CAVU	CAREX VULPINOIDEA	Fox sedge	5	M	OBL
CAAQ2	CATABROSIA AQUATICA	Brookgrass	3	E	OBL
CIAR	CIRSIUM ARVENSE	Canada thistle	5	E	FACU+
CONIF	CONIFER OVERSTORY	Conifer	9	L	FAC
COSE	CORNUS SERICEA (STOLONIFERA)	Red osier dogwood	9	L	FACW
CRDO	CRAETAGEOUS DOUGLASII	Black hawthorn	8	L	FAC
DACA	DANTHONIA CALIFORNICA	California oatgrass	5	L	FACU-
DAIN	DANTHONIA INTERMEDIA	Timber oatgrass	2	E	FACU+
DECE	DESCHAMPSIA CESPITOSA	Tufted hairgrass	5	L	FACW
DISP	DISTICHLIS SPICATA	Inland saltgrass	5	L	FACW
DOJE	DODECATHEON JEFFREYI	Sierra shooting star	4	E	FACW
DG	DRY GRAMINOID	Upland grass	3	E-L	UPL
DS	DRY SHRUB	Upland shrub	3	E-L	UPL
ELAN	ELAEGNUS ANGUSTIFOLIA	Russian olive	7	E	FAC

APPENDIX H—Greenline Dominance Plant Types

CODES	GREENLINE DOMINANCE SPECIES	COMMON NAME	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
ELPA1	ELEOCHARIS PALUSTRIS	Common spikerush	6	E	OBL
ELPA2	ELEOCHARIS PAUCIFLORA	Few-flowered spikerush	5	E	OBL
ELRO	ELEOCHARIS ROSTELLA	Beaked spikerush	6	M	OBL
ELGL	ELYMUS GLAUCUS	Blue wildrye	3	M	FACU-
EQAR	EQUISETUM ARVENSE	Field horsetail	5	E	FAC
EQUIS	EQUISETUM SPECIES	Horsetail	8	L	FAC
GLGR	GLYCERIA GRANDIS	American mannagrass	8	L	OBL
GLYCE	GLYCERIA SPECIES	Mannagrass	6	E	OBL
GLST	GLYCERIA STRIATA	Fowl mannagrass	8	L	OBL
HOBR	HORDEUM BRACHYANTHERUM	Meadow barley	3	E	FACW
HOJU	HORDEUM JUBATUM	Foxtail barley	2	E	FAC+
IRMI	IRIS MISSOURIENSIS	Rocky Mountain iris	6	E	FACW+
JUSC	JINIPERUS SCOPULORUM	Rocky Mountain juniper	6	L	FAC
JUBA	JUNCUS BALTICUS	Baltic rush	8	L	OBL
JUEN	JUNCUS ENSIFOLIUS	Swordleaf rush	8	L	FACW
JUOC	JUNIPERUS OCCIDENTALIS	Western juniper	6	M	UPL
JUOS	JUNIPERUS OSTEOSPERMA	Utah juniper	6	M	UPL
LONI	LONICERA SPP.	Honeysuckle	6	M	FAC
LS	LOW SALIX	Low willow	7	L	FAC-
LS/MF	LOW SALIX/MESIC FORB	Low willow/mesic forb	7	L	FAC-
LUPO	LUPINUS POLYPHYLLUS	Large-leafed lupine	5	E	FACW
MEAR	MENTHA ARVENSIS	Field mint	5	E	FAC
MECI	MERTENSIA CILIATA	Streamside bluebells	7	L	FACW+

APPENDIX H—Greenline Dominance Plant Types

CODES	GREENLINE DOMINANCE SPECIES	COMMON NAME	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
MF	MESIC FORB	Mesic forb	4	E	FACW
MFE	MESIC FORB EARLY	Mesic forb early	3	E	FAC
MFL	MESIC FORB LATE	Mesic forb late	7	L	FACW
MFM	MESIC FORB MEADOW	Mesic forb meadow	6	M	FACW-
MG	MESIC GRASS	Mesic grass	7	M	FACW
MIGU	MIMULUS GUTTATUS	Common monkey flower	3	E	OBL
MUAN	MUHLENBERGIA ANDINA	Foxtail muhly	3	E	FAC+
MURI	MUHLENBERGIA RICHARDSONIS	Mat muhly	3	E	FACW
NAOF	NASTURTIUM OFFICINALE	True water-cress	6	E	OBL
NG	NO GREENLINE		1	E	
PHAR	PHALARIS ARUNDINACEAE	Reed canarygrass	7	M	FACW
PHLE	PHILADELPHUS LEWISII	Lewis' mock orange	6	M	FACU
PHPR	PHLEUM PRETENSE	Timothy	5	M	FACU
PHCO	PHRAGMITES COMUNIS (P.AUSTRALIS)	Common reedgrass	7	M	FACW+
PICEA	PICEA SPP.	Spruce	9	L	FAC
PICO	PINUS CONTORTA	Lodgepole pine	7	M	FAC-
PIFL	PINUS FLEXIS	Limber pine	7	M	UPL
PIPO	PINUS PONDEROSA	Ponderosa pine	6	L	FACU-
PONE	POA NEVADENSIS	Nevada bluegrass	3	E	FACU-
POPA	POA PALUSTRIS	Fowl bluegrass	3	E	FAC
POPR	POA PRATENSIS	Kentucky bluegrass	3	E	FACU+
POAM	POLYGONUM AMPHIBIUM	Water knotweed	5	E	OBL
POAN	POPULUS ANGUSTIFOLIA	Narrow-leaf cottonwood	5	E	FACW-

APPENDIX H—Greenline Dominance Plant Types

CODES	GREENLINE DOMINANCE SPECIES	COMMON NAME	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
POTR	POPULUS TREMULOIDES	Quaking aspen	7	L	FACW
POTR15	POPULUS TRICOCARPA	Black cottonwood	6	E	FACW
POFR	POTENTILLA FRUTICOSA	Shrubby cinquefoil	6	M	FAC
POPUL	POPULUS SPP.	Cottonwood	5	E	FACW-
PREM	PRUNUS EMARGINATA	Bitter cherry	6	M	FACU
PRVI	PRUNUS VIRGINIA	Chokecherry	6	E	FACU
PSME	PSEUDOTSUGA MENZIESII	Douglas fir	8	L	FAC+
RAAQ	RANUNCULUS AQUATILIS	Whitewater crowfoot	6	E	OBL
RHAL	RHAMNUS ALNIFOLIA	Alderleaf buckthorn	8	E	FACU
RHAR	RHUS AROMATICA	Skunkbush sumac	6	E	FAC
RHTR	RHUS TRILOBATA SHRUBLAND	Skunkbush sumac/Shrubland	6	M	FAC
RIAU	RIBES AUREUM	Goldern Currant	6	E	FAC
RIBIES	RIBIES SPP	Currant	8	M	FAC
ROWO	ROSA WOODSII	Woods' rose	6	E	FACU
SAAM	SALIX AMYGDALOIDES	Peachleaf willow	7	M	FACW
SABE	SALIX BEBBIANA	Bebb willow	8	L	FACW
SABO	SALIX BOOTHII	Booth's willow	9	L	OBL
SADR	SALIX DRUMMONDIANA	Drummond's willow	8	L	FACW
SAEA	SALIX EASTWOODII	Mountain willow	9	L	FACW
SAEX	SALIX EXIGUA	Coyote willow; Narrow-leaf willow	6	E	OBL
SAGE	SALIX GEYERIANA	Geyer's willow	7	L	FACW
SALA1	SALIX LASIANDRA	Whiplash willow	9	L	FACW

APPENDIX H—Greenline Dominance Plant Types

CODES	GREENLINE DOMINANCE SPECIES	COMMON NAME	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
SALA2	SALIX LASIOLEPIS	Arroyo willow	5	E	FACW
SALE	SALIX LEMMONII	Lemon's willow	10	L	FACW-
SALU	SALIX LUTEA	Yellow willow	8	L	OBL
SAOR	SALIX ORESTERA	Sierra willow	7	E	FACW
SAPL	SALIX PLANIFOLIA	Planeleaf willow; Diamond leaf willow	9	L	OBL
SASC	SALIX SCOULERIANA	Scouler's willow	8	L	FAC
SALIX	SALIX SPP.	Willow	6	E	FACW-
SAWO	SALIX WOOLFII	Wolf's willow	9	L	FACW+
SAVE	SARCOBATUS VERMICULATUS	Greasewood	5	L	FACU+
SCAC	SCIRPUS ACUTUS	Hardstem bulrush	7	L	OBL
SCAM	SCIRPUS AMERICANUS	Chairmaker's bulrush	7	L	OBL
SCMI	SCIRPUS MICROCARPUS	Panicled bulrush	7	L	OBL
SCPA	SCIRPUS PALLIDUS	Cosmopolitan bulrush	7	L	OBL
SCPU	SCIRPUS PUNGENS	Chairmaker's bulrush	7	L	OBL
SMST	SMILACINA STELLATA	Starry false lily of the valley	7	M	FAC
SPBE	SPIREA BETULIFOLIA	White spirea	9	M	FACW
SPAI	SPOROBOLUS AIROIDES	Alkali sacaton	4	E	FACU
SYOC	SYMPHORICARPOS OCCIDENTALIS	Mountain snowberry	5	M	FAC
TF	TALL FORB	Tall forb	6	M	FAC
TAPA	TAMARIX PARVAFLORA	Small flowered tamarisk	6	E	FACW
THPL	THUJA PLICATA	Western red cedar	8	L	FAC
TORY	TOXICODENDRON RYDBERGII	Western poison ivy	6	M	FACW-
TYLA	TYPHA LATIFOLIA	Broadleaf Cattail	9	L	OBL

APPENDIX H—Greenline Dominance Plant Types

CODES	GREENLINE DOMINANCE SPECIES	COMMON NAME	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
URDI	URTICA DIOICA	Stinging nettle	6	E	FAC+
VACCI	VACCINIUM SPP.	Blueberry	8	L	FAC+
VECA	VERATRUM CALIFORNICUM	California false hellebore	6	E	OBL
VEAM	VERONICA AMERICANA	American speedwell	4	E	OBL
WATER	WATER				
XANTH	XANTHIUM SPP.	Cockleburr	2	E	FAC

This list of greenline dominance types and community types is a compilation of types from Winward 2000, Boise National Forest, Hansen and Hall 2002, and Jankovsky-Jones et al. 2001.

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
ABLA	ABIES LASIOCARPA	9	L	FACU
ABLA/ATFI	ABIES LASIOCARPA/ATHYRIUM FILIX-FEMINA	8	L	FACW+
ABLA/CACA	ABIES LASIOCARPA/CALAMAGROSTIS CANADENSIS	9	L	FACW+
ABLA/STAM	ABIES LASIOCARPA/STREPTOPUS AMPLEXIFLIUS	9	L	FAC-
ACER	ACER SPP.	7	L	FAC
ACER/TF	ACER SPP./TALL FORB	7	E	FAC+
ACGR	ACER GRANDIDENTATUM	7	L	FAC
ACNE	ACER NEGUNDO	7	L	FACW
ACNE/COSE	ACER NEGUNDO/CORNUS SERICEA	8	L	FACW
ACNE/EQAR	ACER NEGUNDO/EQUISETUM ARVENSIS	8	L	FAC+
AGROP/MF	AGROPYRON SPP/MESIC FORB	4	E	FAC+
AGSC	AGROSTIS SCABRA	2	E	FAC
AGSM	AGROPYRON SMITHII	6	L	FACU
AGST2	AGROSTOS STOLINIFERA	3	E	FACW
AGTR/MF	AGROPYRON TRACHYCAULUM/ MESIC FORB	5	E	FAC+
ALAQ	ALOPECURUS AEQUALIS	3	E	OBL
ALGE	ALOPECURUS GENICULATUS	3	E	FACW
ALIN	ALNUS INCANA	6	E	FACW
ALIN/BENCH	ALNUS INCANA/BENCH	6	E	FACW
ALIN/CAAQ	ALNUS INCANA/CAREX AQUATILUS	8	L	FACW+
ALIN/CAUT	ALNUS INCANA/CAREX UTRICULATA	10	L	FACW+
ALIN/COSE	ALNUS INCANA/CORNUS SERICEA	9	L	FACW+
ALIN/EQAR	ALNUS INCANA/EQUISETUM ARVENSE	7	E	FACW-
ALIN/MF	ALNUS INCANA/MESIC FORB	9	L	FACW
ALIN/MG	ALNUS INCANA/MESIC GRAMINOID	9	L	FACW
ALIN/RIHU	ALNUS INCANA/RIBES HUDSONIUM	9	L	OBL
ALIN/RIBIES	ALNUS INCANCA/RIBIES	8	M	FAC
ALIN/SPBE	ALNUS INCANA/SPIREA BETULIFOLIA	9	L	FACW
ALOP	ALOPECURUS SPP.	2	E	FACW
ALRH	ALNUS RHOBIFOLIA	9	L	FACW

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
ALRH/PHLE	ALNUS RHOBIFOLIA/PHILADELPHUS LEWISII	9	L	FACW
ALSI	ALNUS SINUATA	7	M	FACW
AMAL	AMELANCHIER ALNIFOLIA	9	L	FAC
AMAL/MF	AMELANCHIER ALNIFOLIA/MESIC FORB	9	L	FAC
AMAL/SMILE	AMELANCHIER ALNIFOLIA/SMILACINA SPP.	9	L	FAC-
ANKI	ANGELICA KINGII	5	E	FACW
ARCA	ARTEMISIA CANA	4	E	FAC
ARCA/AGSM	ARTEMISIA CANA/AGROPYRON SMITHII	5	L	FAC
ARCA/DECE	ARTEMISIA CANA/DESCHAMPSIA CESPITOSA	4	E	FACW-
ARCA/DG	ARTEMISIA CANA/DRY GRAMINOID	4	E	FAC
ARCA/FEID	ARTEMISIA CANA/FESTUCA IDAHOENSIS	4	E	FAC-
ARCA/FEOV	ARTEMISIA CANA/FESTUCA OVINA	4	E	FAC-
ARCA/POPR	ARTEMISIA CANA/POA PRATENSIS	4	E	FAC-
ARLU	ARTEMISIA LUDOVICIANA	4	E	UPL
ARTR	ARTEMISIA TRIDENTATA	4	E	UPL
ARTR/ROWO	ARTEMISIA TRIDENTATA TRIDENTATA/ROSA WOODSII	4	E	UPL-
ASCH	ASTER CHILENSIS	4	E	FAC
ASIN	ASTER INTEGRIFOLIUS	3	E	FACW
ASIN\DAIN	ASTER INTEGRIFOLIUS\DANTHONIA INTERMEDIA	3	E	FACW+
ASIN\DECE	ASTER INTEGRIFOLIUS\DESCHAMPSIA CESPITOSA	3	E	FACW
ASIN\FEID	ASTER INTEGRIFOLIUS\FESTUCA IDAHOENSIS	3	E	FACU
BEER	BETULA ERECTA	3	L	OBL
BEOC	BETULA OCCIDENTALIS	7	L	FACW
BEOC/BENCH	BETULA OCCIDENTALIS/BENCH	6	E	FACW-
BEOC/CAUT	BETULA OCCIDENTALIS/CAREX UTRICULATA	9	L	FACW+
BEOC/COSE	BETULA OCCIDENTALIS/CORNUS SERICEA	9	L	FACW
BEOC/EQUIS SPP.	BETULA OCCIDENTALIS/EQUISETUM SPECIES	7	M	FACW
BEOC/MF	BETULA OCCIDENTALIS/MESIC FORB	9	L	FACW
BEOC/MG	BETULA OCCIDENTALIS/MESIC GRAMINOID	7	L	FACW
BEOC/PHLE	BETULA OCCIDENTALIS/PHILADELPHUS LEWISII	8	M	FAC-

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
BEOC/POPR	BETULA OCCICENTALIS/POA PRATENSIS	6	E	FACW-
BEOC/RIBIES	BETULA OCCIDENTALIS/RIBIES SPP	8	L	FACW-
BEPU	BETULA PUMULA	7	L	FACW
BRCA	BROMUS CARINATUS OR MARGINATUS	7	M	FAC+
BRIN	BROMUS INERMIS	5	M	FAC+
CAAQ	CAREX AQUATILUS	9	L	OBL
CAAQ/CACA	CAREX AQUATILUS/CALIMIGROSTIS CANADENSIS	9	L	OBL-
CAAQ/CAMI	CAREX AQUATILUS/ CAREX MICROPTERA	8	L	OBL
CAAQ/DECE	CAREX AQUATILUS/DESCHAMMPSIA CESPETOSA	9	L	OBL
CAAQ/JUBA	CAREX AQUATILUS/JUNCUS BALTICUS	6	M	OBL-
CAAQ/LUPIN	CAREX AQUATILUS/LUPINUS SPP.	9	L	OBL
CAAQ/MF	CAREX AQUATILUS/MESIC FORB	6	M	OBL-
CAAQ/MG	CAREX AQUATILUS/MESIC GRAMINOID	6	M	OBL
CAAQ/PHAR	CAREX AQUATILUS/PHALARIS ARUNDINACEAE	8	L	OBL-
CAAQ/PHAR	CALAMAGROSTIS CANADENSIS	8	M	OBL-
CAAQ2	CATABROSIA AQUATICA	3	E	OBL
CABU	CAREX BUXBAUMII	8	L	OBL
CACA	CALAMAGROSTIS CANADENSIS/JUNCUS BALTICUS	9	L	FACW+
CACA/JUBA	CALAMAGROSTIS NEGLECTA (C.STRICTA)	9	L	FACW+
CACA/LUPIN	CALAMAGROSTIS CANADENSIS/MESIC FORB	7	M	FACW-
CADO	CAREX DOUGLASII	4	E	FAC-
CAPE	CAREX PELLITA (LANUGINOSA)	9	L	OBL
CALA2	CAREX LASIOCARPA	8	L	OBL
CALE	CAREX LENTICULARIS	4	E	FACW+
CALE1	CALTHA LEPTOSEPALA	6	M	FACW
CALI	CAREX LIMOSA	8	L	OBL
CAMI	CAREX MICROPTERA	5	M	FAC
CAMI/CAAQ	CAREX MICROPTERA/CAREX AQUATILUS	7	L	FACW
CAMI/DECE	CAREX MICROPTERA/DESCHAMPSIA CESPETOSA	6	M	FACW
CAMI/MOSS	CAREX MICROPTERA/MOSS	6	M	FAC+

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
CAMIMF	CAREX MICROPTERA/MESIC FORB	6	M	FAC+
CANE	CAREX NEBRASCENSIS	9	L	OBL
CANE2	CALAMAGROSTIS CANADENSIS/LUPINUS SPP.	7	L	FACW
CAPR	CAREX PRAEGRACILLIS	8	M	FACW
CARDA	CARDAMINE SPECIES	8	E	FACW
CAREX	CAREX SPP	6	M	FACW
CAREXRH	CAREX SPP RHIZOMATOUS	9	L	OBL
CAREXTU	CAREX SPP TUFTED	5	M	FAC
CASA	CAREX SAXATILIS	8	L	FACW+
CASC	CAREX SCOPULORUM	9	L	FACW
CASH	CAREX SHELDONII	9	L	OBL
CASI	CAREX SIMULATA	8	E	OBL
CAUT	CAREX UTRICULATA	9	L	OBL
CAUT/CACA	CAREX UTRICULATA/CALAMAGROSTIS CANADENSIS	8	L	OBL
CAUT/JUBA	CAREX UTRICULATA/JUNCUS BALTICUS	9	L	OBL
CAUT/MOSS	CAREX UTRICULATA/ MOSS	8	L	OBL
CAVU	CAREX VULPINOIDEA	5	M	OBL
CIAR	CIRSIUM ARVENSE	5	E	FACU+
CONIF	CONIFER OVERSTORY (NOT LISTED)	9	L	FAC
CONIF/ACCO	CONIFER/ACONITUM COLUMBIANUM	6	E	FACW
CONIF/ACRU	CONIFER/ACTAEA RUBRA	6	E	FACW-
CONIF/BEOC	CONIFER/BETULA OCCIDENTALIS	7	L	FACW
CONIF/CACA	CONIFER/CALAMAGROSTIS CANADENSIS	8	L	FACW+
CONIF/COSE	CONIFER/CORNUS SERICEA	8	L	FACW
CONIF/DECE	CONIFER/DESCHAMPSIA CESPITOSA	5	E	FACW-
CONIF/ELGL	CONIFER/ELYMUS GLAUCUS	6	E	FACU-
CONIF/EQAR	CONIFER/EQUISETUM ARVENSE	7	L	FAC
CONIF/MF	CONIFER/MESIC FORB	8	L	FAC+
CONIF/MG	CONIFER/MESIC GRAMINOID	7	M	FAC+
CONIF/POFR	CONIFER/POTENTILLA FRUTICOSA	6	E	FAC+

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
CONIF/POPR	CONIFER/POA PRATENSIS	4	E	FAC
CONIF/ROWO	CONIFER/ROSA WOODSII	6	E	FAC
CONIF/TF	CONIFER/TALL FORB	7	M	FAC
CONIF/VACCI	CONIFER/VACCINIUM SPP.	7	M	FAC
COSE	CORNUS SERICEA (STOLONIFERA)	9	L	FACW
COSE/GATR	CORNUS SERICEA/GALIUM TRIFOLIUM	7	L	FACW-
COSE/HELA	CORNUS SERICEA/HERACLEUM LANATUM	7	L	FAC+
COSE/MF	CORNUS SERICEA/MESIC FORB	8	L	FACW
COSE/SALIX SPP.	CORNUS SERICEA/SALIX SPECIES	9	L	FACW
COSE/SPBE	CORNUS SERICEA/SPOROBULUS sp.	8	L	FACW
CRDO	CRAETAGEOUS DOUGLASII	8	L	FAC
CRDO/ROWO	CRAETAGEOUS DOUGLASII/ROSA WOODSII	7	M	FAC+
DACA	DANTHONIA CALIFORNICA	5	L	FACU-
DAIN	DANTHONIA INTERMEDIA	2	E	FACU+
DECE	DESCHAMPSIA CESPITOSA	5	L	FACW
DECE/CANE	DESCHAMPSIA CESPITOSA/CAREX NEBRASCENSIS	7	L	FACW+
DECE/MF	DESCHAMPSIA CESPITOSA/MESIC FORB	5	E	FACW
DECE/POPR	DESCHAMPSIA CESPITOSA/POA PRATENSIS	2	E	FACW-
DISP	DISTICHLIS SPICATA	5	L	FACW
DG	DRY GRAMINOID	3	E-L	UPL
DS	DRY SHRUB	3	E-L	UPL
ELAN	ELAEGNUS ANGUSTIFOLIA	7	E	FAC
ELAN/PHAR	ELAEGNUS ANGUSTIFOLIA/PHALARIS ARUNDINACEA	7	E	FAC+
ELPA1	ELEOCHARIS PALUSTRIS	6	E	OBL
ELPA2	ELEOCHARIS PAUCIFLORA	5	E	OBL
ELRO	ELEOCHARIS ROSTELLA	6	M	OBL
EQAR	EQUISETUM ARVENSE	5	E	FAC
EQUIS	EQUISETUM SPECIES	8	L	FAC
EQUIS/CACA	EQUISETUM/CALAMIGROSTIS CANADENSIS	7	M	FACW
ELSP	ELEOCHARIS SPECIES	6	E	OBL

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
GLGR	GLYCERIA GRANDIS	8	L	OBL
GLST	GLYCERIA STRIATA	8	L	OBL
GLYCE	GLYCERIA SPECIES	6	E	OBL
HOBR	HORDEUM BRACHYANTHERUM	3	E	FACW
HOJU	HORDEUM JUBATUM	2	E	FAC+
IRMI	IRIS MISSOURIENSIS	6	E	FACW+
IRMI/DG	IRIS MISSOURIENSIS/DRY GRAMINOID	6	E	FACW-
IRMI/MG	IRIS MISSOURIENSIS/MESIC GRAMINOID	7	E	FACW+
JUBA	JUNCUS BALTICUS	8	L	OBL
JUEN	JUNCUS ENSIFOLIUS	8	L	FACW
JUOC	JUNIPERUS OCCIDENTALIS	6	M	UPL
JUOS	JUNIPERUS OSTEOSPERMA	6	M	UPL
JUOS/COSE	JUNIPERUS OSTEOSPERMA/CORNUS SERICA (STOLONIFERA)	8	L	FAC+
JUSC	JINIPERUS SCOPULORUM	6	L	FAC
JUSC/COSE	JUNIPERUS SCOPULORUM/CORNUS SERICA (STOLONIFERA)	8	L	FACW-
JUSC/ELGL	JUNIPERUS SCOPULORUM/ELYMUS GLAUCUS	7	M	FAC
JUSP	JUNCUS SPECIES	8	L	OBL
LONI	LONICERA SPP.	6	M	FAC
LONI/CAAQ	LONICERA/CAREX AQUALITILUS	8	L	OBL
LONI/CACA	LONICERA/CALAMIGROSTIS CANADENSIS	8	L	FACW+
LONI/JUBA	LONICERA/JUNCUS BALTICUS	8	L	OBL
LOW SALIX/MF	LOW SALIX/MESIC FORB	7	L	FAC-
LUPO/SETR	LUPINUS POLYPHYLLUS/SENECIO TRIANGULARIS	5	E	FACW
MEAR	MENTHA ARVENSIS	5	E	FAC
MECI	MERTENSIA CILIATA	7	L	FACW+
MF	MESIC FORB	4	E	FAC
MFE	MESIC FORB EARLY	3	E	FAC
MFL	MESIC FORB LATE	7	L	FACW
MSHRUB	MESIC SHRUB	8	M	FAC
MFM	MESIC FORB MEADOW	6	M	FACW-

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
MG	MESIC GRASS	4	E	FACW
MIGU	MIMULUS GUTTATUS	3	E	OBL
MUAN	MUHLENBERGIA ANDINA	3	E	FAC+
MURI	MUHLENBERGIA RICHARDSONIS	3	E	FACW
NAOF	NASTURTIUM OFFICINALE	6	E	OBL
PHAR	PHALARIS ARUNDINACEAE	7	M	FACW
PHCO	PHRAGMITES COMUNIS (P.AUSTRALIS)	7	M	FACW+
PHLE	PHILADELPHUS LEWISII	6	M	FACU
PHPR	PHLEUM PRETENSE	5	M	FACU
PICEA	PICEA SPP.	9	L	FAC
PICEA/BEGL	PICEA/BETULA GLANDULOSA	10	L	FACW
PICEA/BEOC	PICEA/BETULA OCCIDENTALIS	9	L	FACW
PICEA/CAAQ	PICEA/CAREX AQUATILUS	8	L	FACW
PICEA/CACA	PICEA/CALAMAGROSTIS CANADENSIS	8	L	FACW
PICEA/COST	PICEA/CORNUS STOLINEFERA	8	L	FACW
PICEA/EQAR	PICEA/EQUISETUM ARVENSE	7	L	FAC+
PICEA/GATR	PICEA/GALIUM TRIFLORUM	9	L	FACU
PICEA/LYAM	PICEA/LYSICHITON AMERICANUM	6	E	FAC
PICEA/MF	PICEA/MESIC FORB	8	L	FAC+
PICEA/RIBIES	PICEA/RIBIES SPP.	8	L	FAC+
PICEA/SABO	PICEA/SALIX BOOTHII	9	L	OBL-
PICEA/TF	PICEA/TALL FORB	8	M	FACW
PICO	PINUS CONTORTA	7	M	FAC-
PICO/CAAQ	PINUS CONTORTA/CAREX AQUATILUS	7	L	FACW
PICO/CASC	PINUS CONTORTA/CAREX SCOPULORUM	6	E	FACW
PICO/DECE	PINUS CONTORTA/DESCHAMPSIA CESPETOSA	8	M	FACW-
PICO/MF	PINUS CONTORTA/MESIC FORB	6	E	FACW-
PICO/MG	PINUS CONTORTA/MESICGRAMINOID	8	L	FACW-
PICO/SAWO	PINUS CONTORTA/SALIX WOOLFII	8	L	FACW+
PIFL	PINUS FLEXIS	7	M	UPL

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
PIPO	PINUS PONDEROSA	6	L	FACU-
PIPO/COST	PINUS PONDEROSA/CORNUS STONONIFERA	8	L	FACW
PIPO/CRDO	PINUS PONDEROSA/CRAETAGEUS DOUGLASII	7	L	FAC
PIPO/MG	PINUS PONDEROSA/MESIC GRAMINOID	6	E	FAC+
POAN	POPULUS ANGUSTIFOLIA	5	E	FACW-
POAN/BAR	POPULUS ANGUSTIFOLIA/BAR	5	E	FACW-
POAN/RBAR	POPULUS ANGUSTIFOLIA/RECENT ALLUVIAL BAR	6	E	FACW-
POAN/BEOC	POPULUS ANGUSTIFOLIA/BETULA OCCIDENTALIS	7	L	FACW
POAN/CIST	POPULUS ANGUSTIFOLIA/CORNUS STOLINIFERA	8	L	FACW
POAN/COSE	POPULUS ANGUSTIFOLIA/CORNUS SERICEA	8	L	FACW
POAN/HERB	POPULUS ANGUSTIFOLIA/HERBACEOUS COMMUNITY	6	E	FACW
POAN/POPR	POPULUS ANGUSTIFOLIA/POA PRATENSIS	5	E	FACW-
POAN/RHAR	POPULUS ANGUSTIFOLIA/RHUS AROMATICS	6	E	FACW-
POAN/ROWO	POPULUS ANGUSTIFOLIA/ROSA WOODSII	6	E	FACW-
POAN/SYOC	POPULUS ANGUSTIFOLIA/SYMPHORICARPOS OCCIDENTALIS	7	M	FACW-
POFR	POTENTILLA FRUTICOSA	6	M	FAC
POFR/CAAQ	POTENTILLA FRUTICOSA/CAREX AQUATILIS	7	M	FACW
POFR/CACA	POTENTILLA FRUTICOSA/CALMAGROSTIS CANADENSIS	6	M	FACW
POFR/DECE	POTENTILLA FRUTICOSA/DESCHAMPSIA CESPITOSA	6	E	FACW
POFR/FEID	POTENTILLA FRUTICOSA/FESTUCA IDAHOENSIS	5	E	FACW
POFR/JUBA	POTENTILLA FRUTICOSA/JUNCUS BALTICUS	7	M	FACW
POFR/LIGR	POTENTILLA FRUTICOSA/LIGUSTICUM GRAYII	5	E	FACW
POFR/MG	POTENTILLA FRUTICOSA/MESIC GRAMONOID	5	M	FACW-
POFR/ROWI	POTENTILLA FRUTICOSA/ROSA WOODSII	5	M	FACW-
POFR/TF	POTENTILLA FRUTICOSA/TALL FORB	6	M	FAC
PONE	POA NEVADENSIS	3	E	FACU-
POPA	POA PALUSTRIS	3	E	FAC
POPR	POA PRATENSIS	3	E	FACU+
POPR/DECE	POA PRATENSIS/DESCHAMPSIA CESPETOSA	3	E	FACW-
POPUL	POPULUS SPP.	5	E	FACW-

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
POPUL/BAR	POPULUS/BAR	5	E	FACW-
POPUL/BEOC	POPULUS/BETULA OCCIDENTALIS	7	L	FACW
POPUL/COSE	POPULUS/CORNUS SERICEA	8	L	FACW
POPUL/RHAR	POPULUS/RHUS AROMITICS	6	E	FACW-
POPUL/ROWO	POPULUS/ROSA WOODSII	6	E	FACW
POPUL/SALIX	POPULUS/SALIX	8	L	FACW+
POTR	POPULUS TREMULOIDES	7	L	FACW
POTR/BEOC	POPULUS TREMULOIDES/BETULA OCCIDENTALIS	7	L	FACW
POTR/COSE	POPULUS TREMULOIDES/CORNUS SERICEA	8	L	FACW
POTR/DG	POPULUS TREMULOIDES/DRY GRAMINOID	6	E	FAC
POTR/MF	POPULUS TREMULOIDES/MESIC FORB	9	L	FACW-
POTR/ROWO	POPULUS TREMULOIDES/ROSA WOODSII	8	L	FACW-
POTR/SALIX	POPULUS TREMULOIDES/SALIX SPECIES	8	L	FACW
POTR/TALL SHRUB	POPULUS TREMULOIDES/TALL SHRUB	7	M	FACW-
POTR15	POPULUS TRICOCARPA	6	E	FACW
POTR15/ACGL	POPULUS TRICOCARPA/ACER GLABRUM	8	L	FACW-
POTR15/BARREN	POPULUS TRICOCARPA/BARREN	6	E	FACW
POTR15/COST	POPULUS TRICOCARPA/CORNUS STOLONIFERA	7	L	FACW
POTR15/CRDO	POPULUS TRICOCARPA/CRATAEGUS DOUGLASII	7	L	FACW-
POTR15/POPR	POPULUS TRICOCARPA/POA PRATENSISI	6	E	FACW
POTR15/ROWO	POPULUS TRICOCARPA/ROSA WOODSII	6	E	FACW
POTR15/SALA	POPULUS TRICOCARPA/SALIX LASIANDRA	8	L	FACW+
POTR15/SALU	POPULUS TRICOCARPA/SALIX LUTEA	8	L	FACW+
POTR15/SYAL	POPULUS TRICOCARPA/SYMPHORORICARPUS ALBA	7	L	FACW-
POTR15/SYOC	POPULUS TRICOCARPA/SYMPHORORICARPUS OCCIDENTALIS	7	L	FACW
PREM	PRUNUS EMARGINATA	6	M	FACU
PRVI	PRUNUS VIRGINIA	6	E	FACU
PRVI/ELGL	PRUNUS VIRGINIA/ELYMUS GLAUCUS	6	M	FACU
PRVI/ROWO	PRUNUS VIRGINIA/ROSA WOODSII	6	E	FAC
PSME	PSEUDOTSUGA MENZIESII	8	L	FAC+

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
PSME/ACGL	PSEUDOTSUGA MENZIESII/ACER GLABRUM-PHMA FLOODPLAIN	8	L	FAC+
PSME/COSE	PSEUDOTSUGA MENZIESII/CORNUS SERICEA	8	L	FACW
RAAQ	RANUNCULUS AQUATILIS	6	E	OBL
RHAL	RHAMNUS ALNIFOLIA	8	E	FACU
RHAR	RHUS AROMATICA	6	E	FAC
RHTR	RHUS TRILOBATA SHRUBLAND	6	M	FAC
RIAU	RIBES AUREUM	6	E	FAC
RIBIES	RIBIES SPP	8	M	FAC
RIBIES/CACA	RIBIES SPECIES/CALAMIGROSTIS CANADENSIS	7	M	FACW
RIBIES/MF	RIBIES SPECIES/MESIC FORB	7	M	FAC+
RIBIES/MG	RIBIES SPECIES/MESIC GRASS	7	M	FAC+
RIBIES/TF	RIBIES SPECIES/TALL FORB	7	M	FAC+
ROWO	ROSA WOODSII	6	E	FACU
SAAM	SALIX AMYGDALOIDES	7	M	FACW
SABE	SALIX BEBBIANA	8	L	FACW
SABE/MG	SALIX BEBBIANA/MESIC GRAMINOID	8	L	FACW
SABO	SALIX BOOTHII	9	L	OBL
SABO/CAAQ	SALIX BOOTHII/CAREX AQUATILUS	9	L	OBL
SABO/CACA	SALIX BOOTHII/CALAMAGROSTIS CANADENSIS	9	L	OBL
SABO/CAMI	SALIX BOOTHII/CAREX MICROPTERA	8	L	OBL
SABO/CANE	SALIX BOOTHII/CAREX NEBRASKENSIS	8	L	OBL
SABO/CAUT	SALIX BOOTHII/CAREX UTRICULATA	8	L	OBL
SABO/EQAR	SALIX BOOTHII/EQUISETUM ARVENSE	7	E	OBL-
SABO/JUBA	SALIX BOOTHII/JUNCUS BALTICUS	8	L	OBL-
SABO/LUPIN	SALIX BOOTHII/LUPINE	6	E	OBL-
SABO/MF	SALIX BOOTHII/MESIC FORB	9	L	0BL-
SABO/MG	SALIX BOOTHII/MESIC GRAMINOID	9	L	OBL-
SABO/POPA	SALIX BOOTHII/POA PALUSTRIS	6	E	FACW
SABO/POPR	SALIX BOOTHII/POA PRATENSIS	6	E	FACW
SABO/ROWO	SALIX BOOTHII/ROSA WOODSII	7	M	OBL-

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
SABO/SADR	SALIX BOOTHII/SALIX DRUMMONDIANA	9	L	OBL
SABO/SCMI	SALIX BOOTHII/SCIRPUS MICROCARPUS	9	L	OBL
SABO/SMST	SALIX BOOTHII/SMILACINA STELLATA	7	L	OBL
SADR	SALIX DRUMMONDIANA	8	L	FACW
SADR/CAAQ	SALIX DRUMMONDIANA/CAREX AQUATILUS	9	L	OBL
SADR/CACA	SALIX DRUMMONDIANA/CALAMAGROSTIS CANADENSIS	9	L	FACW
SADR/CAMI	SALIX DRUMMONDIANA/CAREX MICROPTERA	8	L	FACW
SADR/CANE	SALIX DRUMMONDIANA/CAREX NEBRASKENSIS	10	L	OBL
SADR/CAUT	SALIX DRUMMONDIANA/CAREX UTRICULATA	9	L	OBL
SADR/DECE	SALIX DRUMMONDIANA/DESCHAMPSIA CESPETOSA	7	M	OBL-
SADR/LONI	SALIX DRUMMONDIANA/LONICERA	8	L	FACW
SADR/LUPIN	SALIX DRUMMONDIANA/LUPINUS SPP.	8	L	FACW
SADR/MF	SALIX DRUMMONDIANA/MESIC FORB	8	L	FACW
SADR/MG	SALIX DRUMMONDIANA/MESIC GRAMINOID	9	L	FACW
SADR/POFR	SALIX DRUMMONDIANA/POTENTILLA FRUTICOSA	8	L	FACW
SADR/POPR	SALIX DRUMMONDIANA/POA PRATENSIS	5	M	FACW
SADR/RIBIES	SALIX DRUMMONDIANA/ RIBIES SPP.	6	M	FACW
SADR/SCMI	SALIX DRUMMONDIANA/SCIRPUS MICROCARPUS	8	L	OBL-
SADR/SPBE	SALIX DRUMMONDIANA/SPIREA BETULIFOLIA	8	L	FACW
SAEA	SALIX EASTWOODII	9	L	FACW
SAEA/CACA	SALIX EASTWOODII/CALAMAGROSTIS CANADENSIS	8	L	FACW
SAEA/CASC	SALIX EASTWOODII/CAREX SCOPULORUM	9	L	FACW
SAEA/CAUT	SALIX EASTWOODII/CAREX UTRICULATA	8	L	FACW
SAEO/CAMI	SALIX EASTWOODII/CAREX MICROPTERA	7	M	FACW
SAEX	SALIX EXIGUA	6	E	OBL
SAEX/BARREN	SALIX EXIGUA/BARREN	6	E	FACW
SAEX/BENCH	SALIX EXIGUA/BENCH	5	E	FACW
SAEX/BEOC	SALIX EXIGUA/BETULA OCCIDENTALIS	9	L	OBL
SAEX/CAUT	SALIX EXIGUA/CAREX UTRICULATA	9	L	OBL
SAEX/EQAR	SALIX EXIGUA/EQUISETUM ARVENSE	9	M	FACW

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
SAEX/MF	SALIX EXIGUA/MESIC FORB	7	E	OBL
SAEX/MG	SALIX EXIGUA/MESIC GRAMINOID	7	E	OBL
SAEX/POPR	SALIX EXIGUA/POA PRATENSIS	4	E	FACW
SAEX/ROWA	SALIX EXIGUA/ROSA WOODSII	7	E	FACW
SAGE	SALIX GEYERIANA	7	L	FACW
SAGE/CAAQ	SALIX GEYERIANA/CAREX AQUATILUS	9	L	OBL
SAGE/CACA	SALIX GEYERIANA/CALAMAGROSTIS CANADENSIS	9	L	FACW
SAGE/CAUT	SALIX GEYERIANA/CAREX UTRICULATA (ROSTRATA)	8	L	OBL
SAGE/DECE	SALIX GEYERIANA/DESCHAMPSIA CESPITOSA	5	E	FACW
SAGE/JUEN	SALIX GEYERIANA/JUNCUS ENSIFOLIUS	9	L	FACW
SAGE/LONI	SALIX GEYERIANA/LONICERA	8	L	FACW
SAGE/MF	SALIX GEYERIANA/MESIC FORB	9	L	FACW
SAGE/MG	SALIX GEYERIANA/MESIC GRAMINOID	9	L	FACW
SAGE/POPA	SALIX GEYERIANA/POA PALUSTRIS	6	E	FAC
SAGE/POPR	SALIX GEYERIANA/POA PRATENSIS	6	E	FACW
SAGE/ROWO	SALIX GEYERIANA/ROSA WOODSII	7	M	FACW
SAGE/SCMI	SALIX GEYERIANA/SCIRPUS MICROCARPUS	7	L	OBL
SALA1	SALIX LASIANDRA	9	L	FACW
SALA1/ALIN	SALIX LASIANDRA/ALNUS INCANNA	9	L	FACW
SALA1/BENCH	SALIX LASIANDRA/BENCH	8	M	FACW
SALA1/CAAQ	SALIX LASIANDRA/CAREX AQUALITILUS	9	L	OBL
SALA1/CACA	SALIX LASIANDRA/CALAMAGROSTIS CANADENSIS	9	L	FACW+
SALA1/CAMI	SALIX LASIANDRA/CAREX MICROPTERA	9	L	OBL-
SALA1/CAUT	SALIX LASIANDRA/CAREX UTRICULATA	9	L	OBL
SALA1/COSE	SALIX LASIANDRA/CORNUS SERICEA	9	M	FACW
SALA1/JUEN	SALIX LASIANDRA/JUNCUS ENSIFOLIUS	9	L	FACW
SALA1/MF	SALIX LASIANDRA/MESIC FORB	9	L	FACW
SALA1/RIBIES	SALIX LASIANDRA/RIBIES SPP.	9	L	FACW
SALA1/SCMI	SALIX LASIANDRA/SCIRPUS MICROCARPUS	9	L	OBL
SALA2	SALIX LASIOLEPIS	7	E	FACW

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
SALA2/BARREN	SALIX LASIOLEPIS/BARREN	7	E	FACW-
SALA2/BENCH	SALIX LASIOLEPIS/BENCH	7	E	FACW-
SALA2/ELPA	SALIX LASIOLEPIS/ELEOCARIS PALUSTRIS	7	E	FACW-
SALA2/ROWO	SALIX LASIOLEPIS/ROSA WOODSII	7	E	FACW
SALE	SALIX LEMMONII	10	L	FACW-
SALE/BENCH	SALIX LEMMONII/BENCH	6	E	FACW-
SALE/CAAQ	SALIX LEMMONII/CAREX AQUATILUS	10	L	OBL
SALE/CASC	SALIX LEMMONII/CAREX SCOPULORUM	10	L	OBL
SALE/MF	SALIX LEMMONII/MESIC FORB	7	E	FACW
SALE/MG	SALIX LEMMONII/MESIC GRAMINOID	8	E	FACW
SALE/SEEO	SALIX LEMMONII/SEEP	7	L	FACW
SALE/TF	SALIX LEMMONII/TALL FORB	7	E	FACW
SALIX	SALIX SPP.	6	E	FACW-
SALIXRH	SALIX SPP RHIZOMATOUS	6	E	OBL
SALIXCL	SALIX SPP CLUMPED	8	L	FACW
SALIX/CAUT	SALIX/CAREX UTRICULATA	10	L	OBL
SALIX/MF	SALIX/MESIC FORB	7	E	FACW
SALIX/MG	SALIX/MESIC GRAMINOID	8	E	FACW
SALIX/POPR	SALIX/POA PRATENSIS	6	E	FACW-
SALIX/ROWO	SALIX/ROSA WOODSII	7	E	FACW
SALIX/TF	SALIX/TALL FORB	7	E	FACW
SALU	SALIX LUTEA	8	L	OBL
SALU/BARREN	SALIX LUTEA/BARREN	7	M	OBL-
SALU/BENCH	SALIX LUTEA/BENCH	7	M	OBL-
SALU/CACA	SALIX LUTEA/CALAMAGROSTIS CANADENSIS	8	L	OBL
SALU/CAUT	SALIX LUTEA/CAREX UTRICULATA	8	L	OBL
SALU/MF	SALIX LUTEA/MESIC FORB	6	M	OBL
SALU/MG	SALIX LUTEA/MESIC GRAMINOID	7	M	OBL
SALU/POPR	SALIX LUTEA/POA PRATENSIS	6	E	OBL-
SALU/ROWO	SALIX LUTEA/ROSA WOODSII	7	M	OBL-

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
SAOR	SALIX ORESTERA	7	E	FACW
SAOR/DECE	SALIX ORESTERA/DESCHAMPSIA CESPETOSA	7	E	FACW
SAOR/TF	SALIX ORESTERA/TALL FORB	7	E	FACW
SAPL	SALIX PLANIFOLIA	9	L	OBL
SAPL/CAAQ	SALIX PLANIFOLIA/CAREX AQUATILIS	9	L	OBL
SAPL/CACA	SALIX PLANIFOLIA/CALAMIGROSTIS CANADENSIS	8	L	OBL
SAPL/CAMI	SALIX PLANIFOLIA/CAREX MICROPTERA	8	L	OBL
SAPL/CASC	SALIX PLANIFOLIA/CAREX SCOPULORUM	9	L	OBL
SAPL/CAUT	SALIX PLANIFOLIA/CAREX UTRICULATA	9	L	OBL
SAPL/DECE	SALIX PLANIFOLIA/DESCHAMPSIA CESPITOSA	7	E	OBL-
SAPL/MF	SALIX PLANIFOLIA/MESIC FORB	8	M	OBL
SAPL/MG	SALIX PLANIFOLIA/MESIC GRAMINOID	8	L	OBL
SAPL/VACCI	SALIX PLANIFOLIA/VACCINIUM SPP.	7	L	OBL
SASC	SALIX SCOULERIANA	7	L	FAC
SASC/CAAQ	SALIX SCOULERIANA/CAREX AQUATILUS	8	L	OBL
SASC/CACA	SALIX SCOULERIANA/CALIMIGROSTIS CANADENSIS	8	L	FACW
SAVE	SARCOBATUS VERMICULATUS	5	L	FACU+
SAVE/DOSP	SARCOBATUS VERMICULATUS/DISTICHLIS SPICATA	6	L	FACW
SAVE/ELCI	SARCOBATUS VERMICULATUS/ELYMUS CINEREUS	7	L	FACU
SAVE/POSE	SARCOBATUS VERMICULATUS/POA SECUNDA	5	E	FACU
SAVE/POSE	SARCOBATUS VERMICULATUS/POA SECUNDA	5	E	FACU
SAWO	SALIX WOOLFII	9	L	FACW+
SAWO/CAAQ	SALIX WOOLFII/CAREX AQUATILUS	9	L	OBL
SAWO/CACA	SALIX WOOLFII/CALAMIGROSTIS CANADENSIS	9	L	OBL
SAWO/CAMI	SALIX WOOLFII/CAREX MICROPTERA	7	L	OBL
SAWO/CASC	SALIX WOOLFII/CAREX SCOPULORUM	9	L	OBL
SAWO/CAUT	SALIX WOOLFII/CAREX UTRICULATA	9	L	OBL
SAWO/DAIN	SALIX WOOLFII/DANTHONIA INTERMEDIA	4	E	OBL-
SAWO/DECE	SALIX WOOLFII/DESCHAMPSIA CESPETOSA	5	E	OBL-
SAWO/JUBA	SALIX WOOLFII/JUNCUS BALTICUS	9	L	OBL

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
SAWO/LONI	SALIX WOOLFII/LONICERA SPP.	8	L	OBL-
SAWO/MF	SALIX WOOLFII/MESIC FORB	5	M	OBL-
SAWO/MG	SALIX WOOLFII/MESIC GRAMINOID	6	E	OBL-
SAWO/POFR	SALIX WOOLFII/POTENTILLA FRUTICOSA	7	L	OBL-
SAWO/POPR	SALIX WOOLFII/POA PRATENSIS	4	E	OBL-
SAWO/SWPE	SALIX WOOLFII/SWERTIA PERENNIS	9	L	FACW
SCAC	SCIRPUS ACUTUS	7	L	OBL
SCAM	SCIRPUS AMERICANUS	7	L	OBL
SCMI	SCIRPUS MICROCARPUS	7	L	OBL
SCSP	SCIRPUS PALLIDUS	7	L	OBL
SCPU	SCIRPUS PUNGENS	7	L	OBL
SMST	SMILACINA STELLATA	7	M	FAC
SMST/MG	SMILACINA STELLATA/MESIC GRAMINOID	8	M	FAC
SPBE	SPIREA BETULIFOLIA	9	M	FACW
SPBE/CAAQ	SPIREA BETULIFOLIA/CAREX AQUATILUS	8	L	FACW+
SPBE/CACA	SPIREA BETULIFOLIA/CALIMIGROSTIS CANADENSIS	7	L	FACW+
SPBE/CAUT	SPIREA BETULIFOLIA/CAREX UTRICULATA	8	L	FACW+
SPBE/MF	SPIREA BETULIFOLIA/MESIC FORB	9	L	FACW
SPBE/MG	SPIREA BETULIFOLIA/MESIC GRAMINOID	9	L	FACW
SPBE/SALA1	SPIREA BETULIFOLIA/SALIX LASIANDRA	8	L	FACW
SPBE/SCMI	SPIREA BETULIFOLIA/SCIRPUS MICROCARPUS	9	L	FACW+
SYOC	SYMPHORICARPOS OCCIDENTALIS	5	M	FAC
TAPA	TAMARIX PARVAFLORA	6	E	FACW
TF	TALL FORB	6	M	FAC
THPL	THUJA PLICATA	8	L	FAC
THPL/ATFI	THUJA PLICATA/ATHYRIUM FILIX-FEMINA	8	L	FAC
THPL/GYDR	THUJA PLICATA/GYNMOCARPIUM DRYOPTERIS	8	L	FAC
THPL/OPHO	THUJA PLICATA/OPLOPANAX HORRIDUM	9	L	FAC
TORY	TOXICODENDRON RYDBERGII	6	M	FACW-
TYLA	TYPHA LATIFOLIA	9	L	OBL

APPENDIX I—Riparian Vegetation Community Types of the Intermountain Area

CODES	GREENLINE COMMUNITY TYPES	VEGETATION STABILITY CLASS	SUCCESSIONAL STAUS	WETLAND RATING
URDI	URTICA DIOICA	6	E	FAC+
VACCI	VACCINIUM SPP.	8	L	FAC+
VACCI/CAAQ	VACCINIUM SPP./CAREX AQUATILIS	8	L	OBL
VACCI/CACA	VACCINIUM SPP./CALAMIGROSTIS CANADENSIS	8	L	OBL
VACCI/JUBA	VACCINIUM SPP./JUNCUS BALTICUS	7	L	OBL
VACCI/SAPL	VACCINIUM SPP./SALIX PLANIFOLIA	8	L	OBL
VACCI/TF	VACCINIUM SPP./TALL FORB	7	M	FACW
VEAM	VERONICA AMERICANA	4	E	OBL
VECA	VERATRUM CALIFORNICUM	6	E	OBL
XANTH	XANTHIUM SPP.	2	E	FAC
XAST	XANTHIUM STRUMARIUM	2	E	FAC
RK	ROCK	10	L	
BN	BARREN	1	E	
WD	WOOD	10	L	

1. Boise National Forest modified from Integrated Riparian Evaluation Guide, R-4, 3/1992, based on 1100 samples, 1994-95.

2. Modified based on riparian community types by Ervin Cowley, 2004.

APPENDIX J—Streambank Alteration

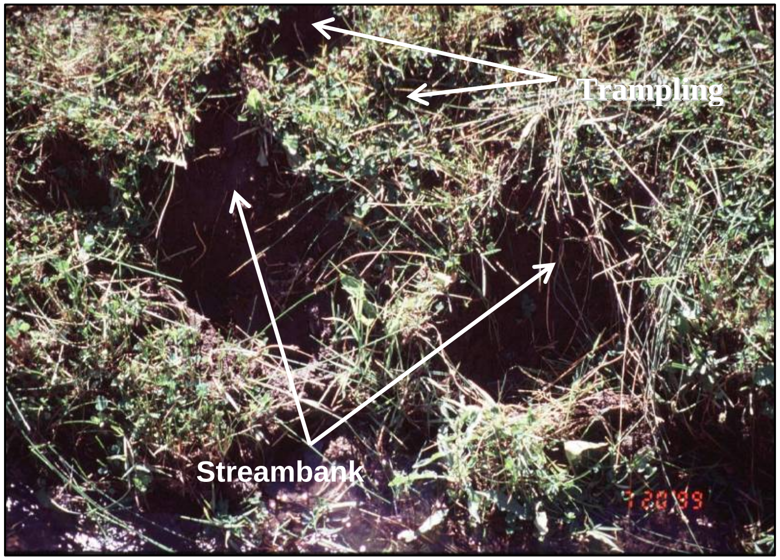

Figure 1—disturbance is considered trampling when a track caused by a large herbivore exposes at least ½ inch of bare soil. Streambank shearing is the physical displacement of part of the streambank downward toward the stream channel.

Figure 2—the monitoring frame is centered on the greenline and the number of lines (0 to 5) that intersect streambank alteration (trampling or shearing) is counted and recorded. Lines 1, 2, 4, and 5 intersect streambank alteration. Four is recorded.

APPENDIX J—Streambank Alteration

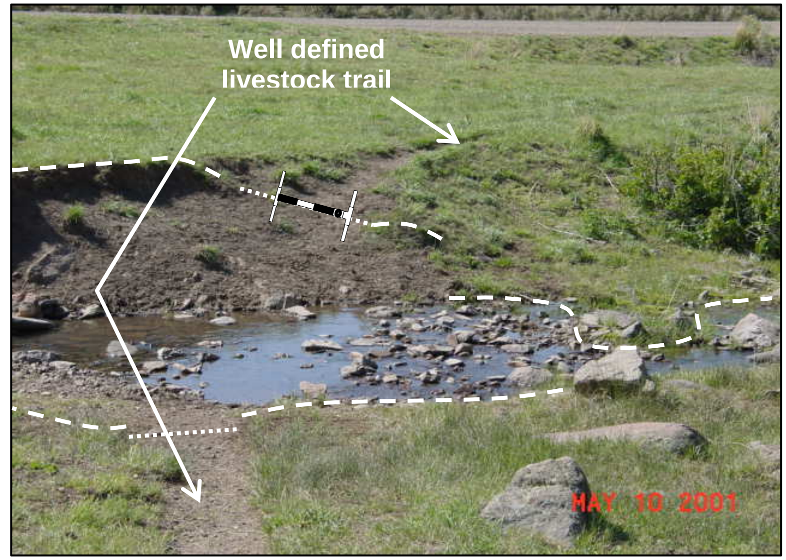

Figure 3—while livestock trails are not considered part of the greenline, they are considered for streambank alteration. The frame is placed on a line that joins the greenline on either side of the trail. The example above shows the frame on a livestock trail that has been used during the current grazing season since all five lines intersect streambank alteration, five is recorded.

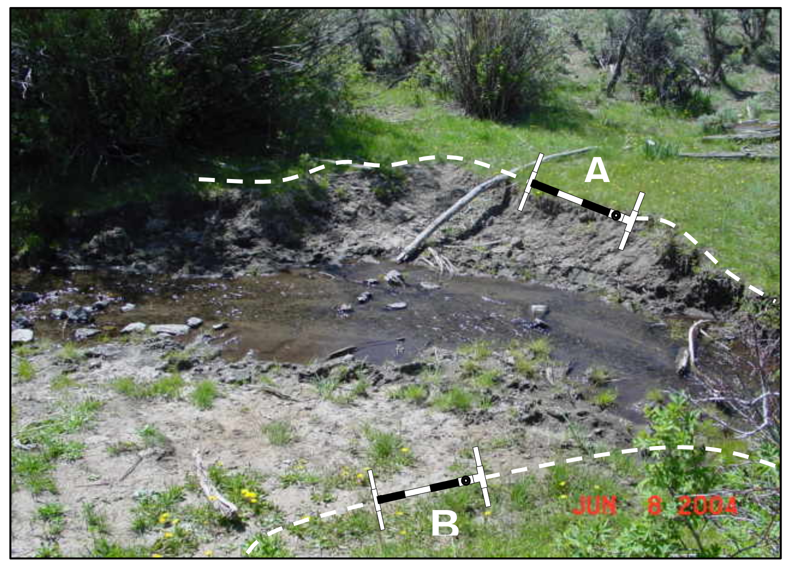

Figure 4—example A is heavily trampled and all five lines intersect streambank alteration. B shows no evidence of current year's trampling that displaces soil at least ½ inch deep. Five is recorded for A and zero for B.

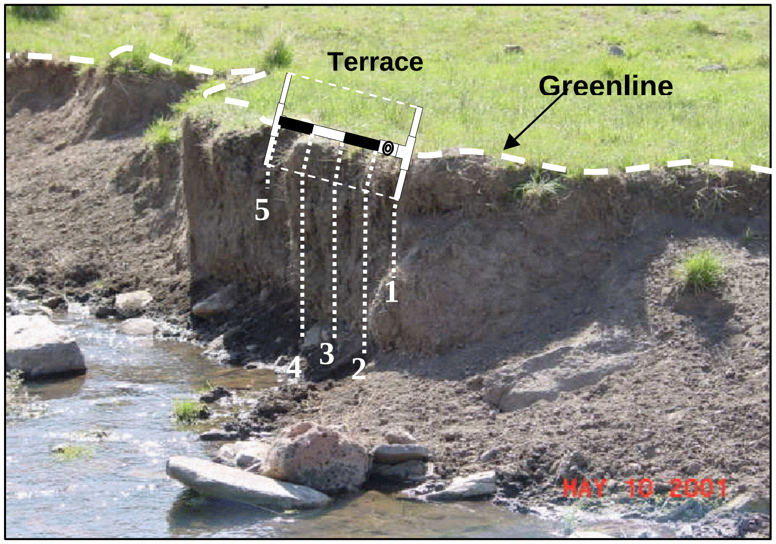

Figure 5—trampling on the terrace is not recorded as streambank alteration. Alteration is only recorded if it occurs on the steep face of the bank. The lines are projected for the greenline down the bank, within the quadrat, to the water line. In the example above, line 1, nearest the handle, does not intersect alteration. Lines 2 through 5 intercept shears. A total of 4 is recorded.

APPENDIX J—Streambank Alteration

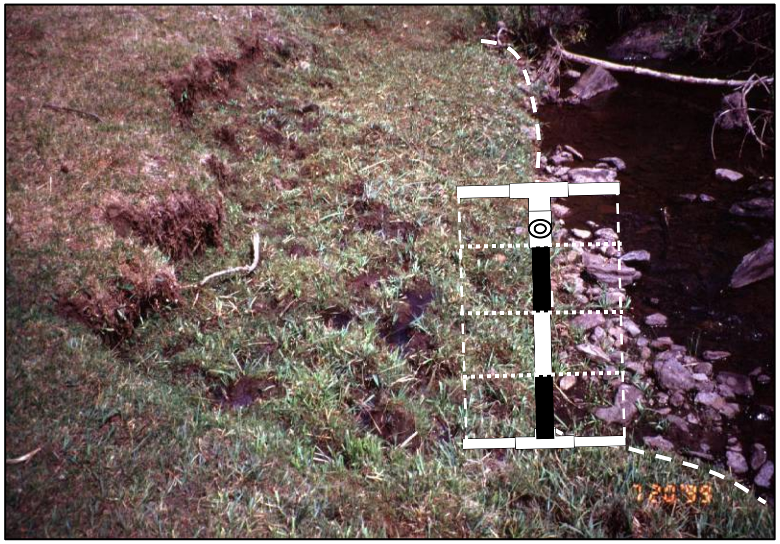

Figure 6—no evident streambank alteration intersects any of the lines within the plot. Zero is recorded.

Figure 7—lines 2 and 4 intersect streambank alteration caused by livestock. Two is recorded.

APPENDIX J—Streambank Alteration

Figure 8—current streambank alteration can be difficult to distinguish from previous season's use. Streambank alteration measurements should be made while livestock are still in the pasture or within two weeks of use. Streambank alteration should not be conducted on a site such as this where the current season's impacts are difficult to distinguish from previous seasons.

APPENDIX K—Streambank Stability

Definitions

Base Flow: The typical low flow water level in a stream late in the season is usually in the late summer and fall after the spring snowmelt.

Covered Streambank: Perennial or sod-forming vegetation covers at least 50 percent of the height streambank (the vegetation line is usually at least 20 cm (6 in.) wide and 50 cm (20 in.), cobbles, six inches or larger, anchored large woody debris (LWD) with a diameter of four inches or greater, or a combination of the vegetation, rock, and/or LWD is at least 50 percent).

Crack: A visible fracture that has not separated two portions of a streambank. Cracks indicate a high risk of breakdown.

Depositional Bank: A streambank associated with sand, silt, clay, or gravel deposited by the stream.

False Bank: Streambanks have slumped in the past but have been stabilized by relatively shallow-rooted vegetation. These banks are usually lower than the terrace. False banks vegetated with deep-rooted riparian vegetation may be considered stable and should be counted separately and added to the stable category.

Floodplain Line: The upper limit of the streambank. The floodplain line is the level at which water first spills onto the lowest terrace or floodplain.

Fracture: A crack is visibly obvious on the bank indicating that the block of bank is about to slump or move into the stream.

Scour Bank: That part of the streambank subject to the erosive energy of the stream. Depositional features are absent.

Scour Line: The lower elevational limit of a streambank. The scour line is the elevation of the ceiling of undercut banks along streambanks. On depositional banks, the scour line is the lower limit of sod-forming or perennial vegetation. On small streams, it is generally the base flow.

Slough (Sluff): Soil breaking or crumbling or falling away from a bank (see Illustrations 1 and 2).

Slumping Bank: A streambank that has obviously slipped down. Cracks may or may not be obvious, but the slump feature is obvious.

Streambank: Morphological features of the stream channel created by the erosion and deposition forces of stream flow which control the lateral movement of water (Platts *et al* 1987). Streambanks are that part of a channel between the edge of the 1st terrace and the scour line. Streambanks are the steeper-sloped sides of the stream channel and are most susceptible to erosion during high-flow events (Platts *et al.* 1987). Streambanks form above the streambed where vegetation, roots, rocks, and other obstructions cause resistance to the flow energy (Rosgen 1996). Streambanks are subject to instability primarily from the edge of the 1st terrace/floodplain down to the scour line because bankfull discharges occur almost every year (Leopold 1994). Streambanks are the area between the edge of the 1st terrace/floodplain and the scour line.

Terrace: A relatively flat area adjacent to a stream or lake with an abrupt steeper face adjoining the edge of the stream.

> **1st Terrace:** The first relatively flat area adjacent to and above the scour line or at the edge of the water. It may be an active floodplain or an area too high for the water to reach under the current climate and channel conditions (see Figures 1 and 2).
>
> **2nd Terrace:** The next elevated relatively flat area above the 1st terrace, with a distinctly steeper slope facing the stream (see Figure 2).

STREAMBANK STABILITY CLASSIFICATION KEY

I. Streambank Absent (side channel, tributary, slew, road, etc.)........................ UN
II. Streambank present or should be present
  A. Streambank depositional
    1. Streambank not present due to excessive deposition ....US
    2. Streambank is present (deposition not excessive)
      a. Bank Covered..CS
      b. Bank NOT Covered (Bar) .... UU
  B. Streambank erosional or a scour bank
    1. Streambank not fractured or the streambank is fractured with the slump block no longer attached to the streambank, and is either lying adjacent to the breakage or is no longer present
      a. No crack is visible from the scour line up to a point 15 cm behind the top of the streambank
        (1) Bank covered
          (a) No evidence of disturbance ....CS
          (b) Evidence of disturbance (e.g., erosion, slumping, bank shearing).................................... CU
        (2) Bank **NOT** covered
          (a) Bank angle within 10 degrees (22%) of vertical or slough actively entering stream .... UU
          (b) Bank angle NOT within 10 degrees (22 %) of vertical or slough is **not** actively entering stream...US
      b. A crack or fracture feature is visible within 15 cm (6 inches) of the top of the streambank—slump block is not attached to the bank
        (1) Bank is Covered... CU
        (2) Bank is NOT Covered .... UU
    2. Streambank is fractured *with* the slump block feature still attached
      a. The bottom of the slump block feature is below (elevationally) the scour line (view only the fracture feature behind the slump block)
        (1) Bank NOT covered
          (a) Bank angle is within 10 degrees (22 %) of vertical or slough actively entering stream .... UU
          (b) Bank angle is NOT within 10 degrees (22 %) of vertical or slough is **not** actively entering the stream..US
        (2) Bank covered ....CS
      b. The bottom of the fracture feature behind the slump block is above (elevationally) the scour line (view the bank as a slump block and the fracture feature as a vertical, exposed bank)
        (1) Bank or fracture feature NOT covered........................ UU
        (2) Bank or fracture feature covered
          (a) Fracture feature not covered .... CU
          (b) Fracture feature covered and reconnected .... FB

APPENDIX K—Streambank Stability

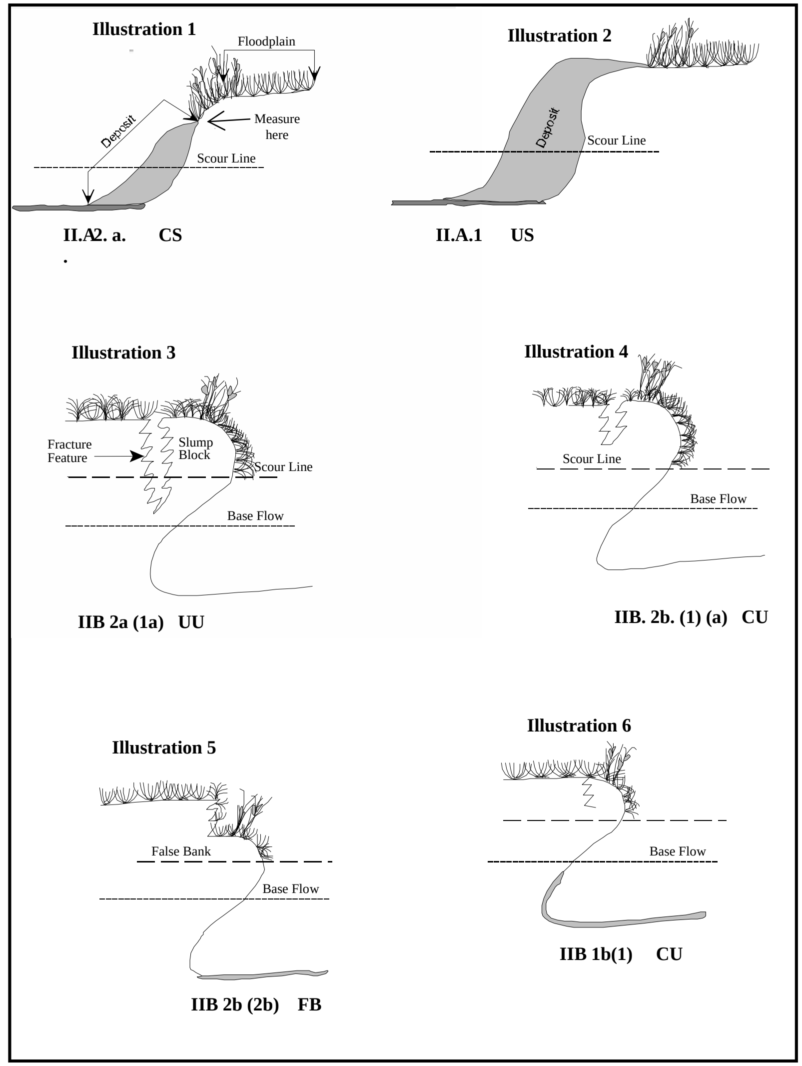

Figure 1—Illustrations of streambank stability classes - Covered stable(CS), Uncovered stable (US), Covered unstable (CU), and Uncovered unstable (UU). Adapted from Kershner *et al*. 2004

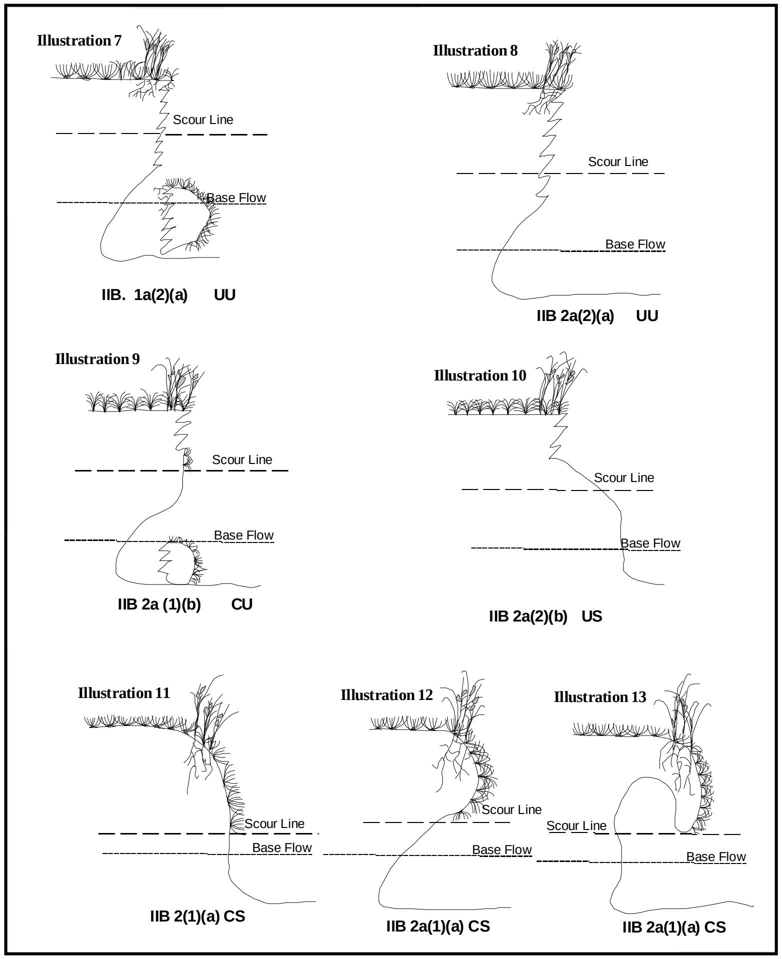

Figure 1 (continued)

APPENDIX K—Streambank Stability

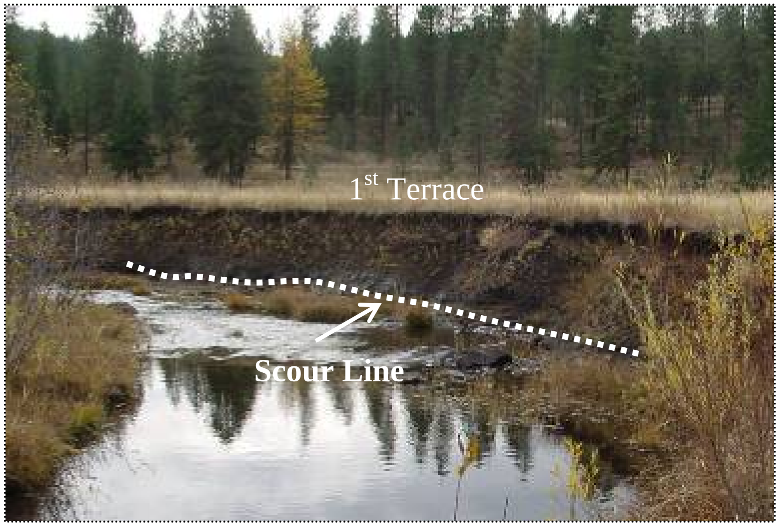

Figure 2—the 1st terrace is the first relatively flat area above the scour line or edge of the water. An abrupt steep face from the edge of the terrace to the scour line is a characteristic of a terrace. Slough from the terrace wall has direct access to the stream.

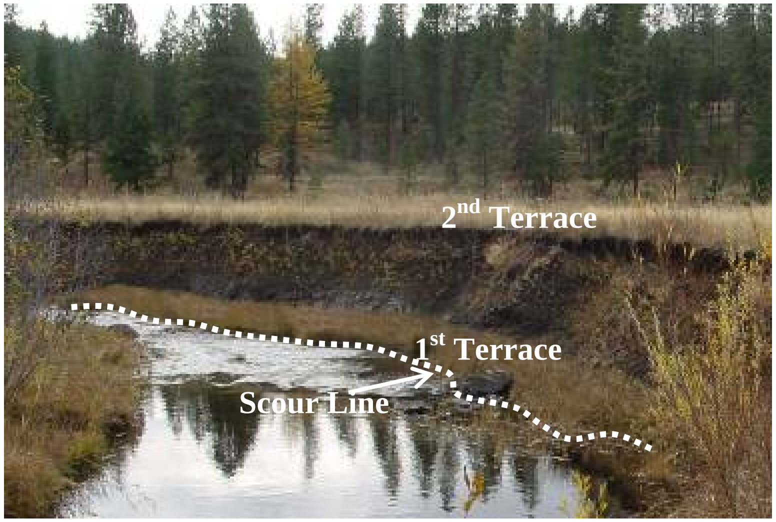

Figure 3—a new floodplain has developed creating the 1st terrace at a lower elevation. Slough from the 2nd terrace does not go directly into the stream as it is filtered by the 1st terrace.

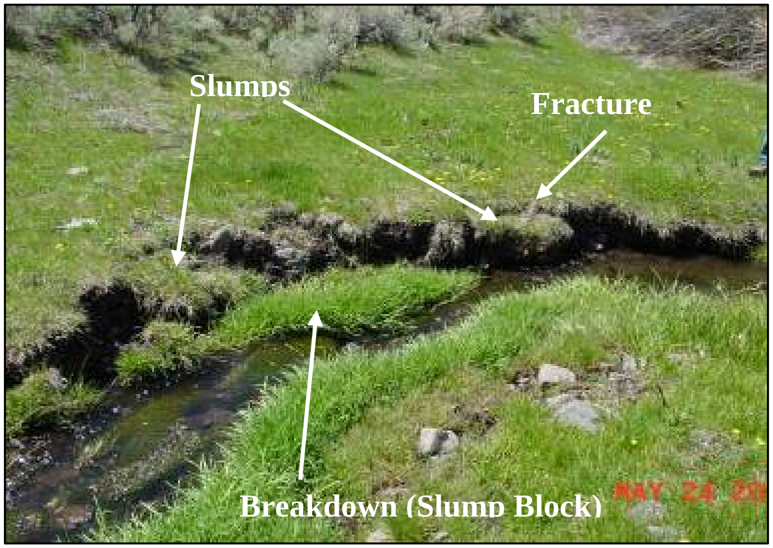

Figure 4—Erosional features help determine the stability of a streambank. Breakdown or slump blocks that are detached from the streambank are not considered part of the streambank. Slumps must be obviously sliding down of a part of the streambank. Fractures are obvious breaking of a portion of the streambank (see Illustrations 3, 4, 6 and 7 above).

Figure 5—the photo above shows a fracture and a large slump that is still attached to the streambank. Vegetation cover is at least 50 percent cover and is classified as covered/unstable (CU). (See Illustration 4.)

Figure 6—the stream in this photo is flowing at the scour line. Slumps "A" are still attached tothe bank above the scour line and would be classified as covered/unstable (CU) (see Illustration 4). "B" has no vegetation along the streambank and is uncovered/unstable (UU) (see Illustration 3).

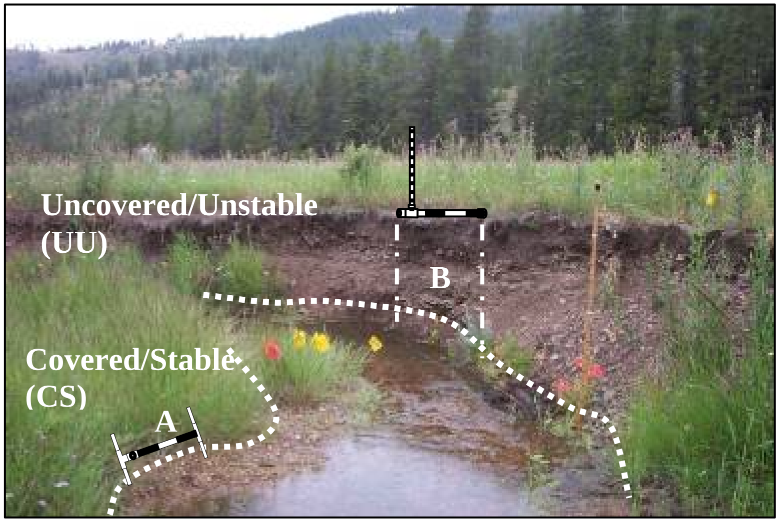

Figure 7—the dotted line represents the scour line. "A" shows a monitoring frame placed on the greenline, just above the scour line. The streambank is covered/stable (CS). Frame at "B" is located on the greenline. Since it is not usually practical to pace along or near the scour line, the length of the frame is projected to the scour line and the streambank is classified. At "B" the streambank is uncovered/unstable (UU). Photo - PIBO, U.S. Forest Service

Figure 8—slump banks "A" are still attached to the streambank above the scour line and is classified as cover/unstable (CU). The dashed line is the greenline. Photo - PIBO, U.S. Forest Service

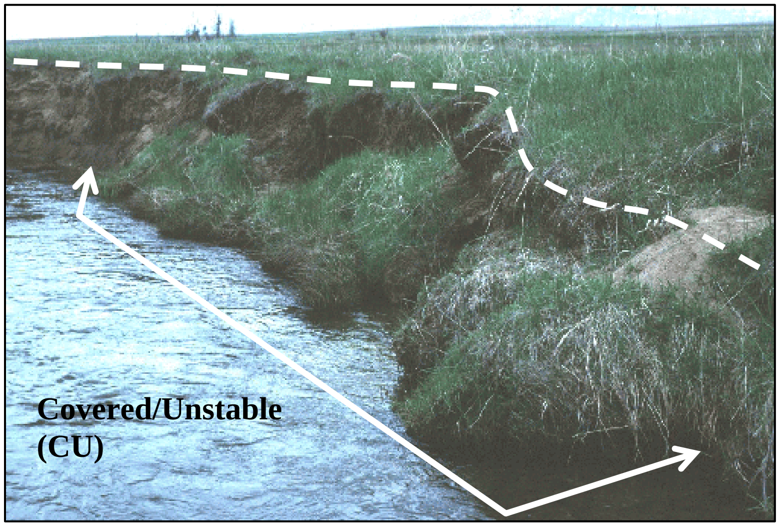

Figure 9—slump blocks and slumping banks with the blocks and attached bank above the scour line are covered/unstable (CU).

Figure 9—false banks (FB) are reattached slump features covered with deep-rooted vegetation. They are an indicator of recovery and are considered stable.

Figure 11—the streambank on one side of the stream is uncovered/unstable (UU) and the other side is covered/stable (CS).

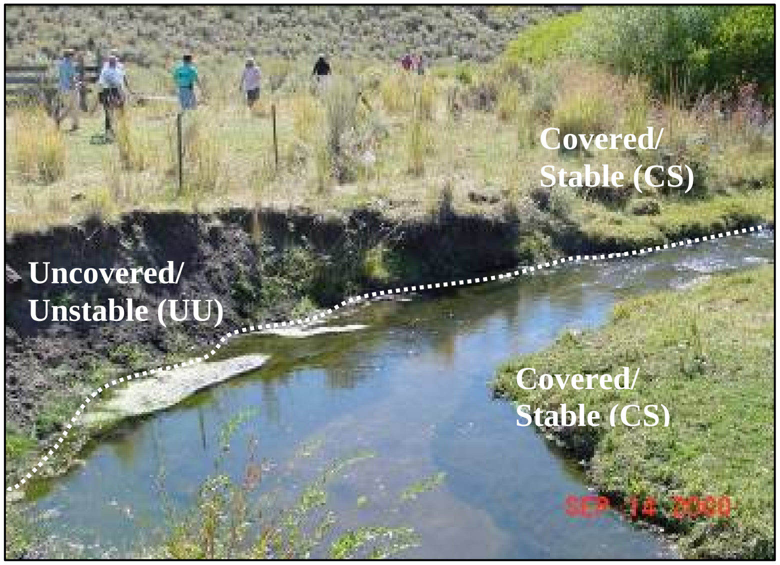

Figure 12—the scour line is near the current water level. The streambank classification reflects the bank from scour line to first terrace. The bar is covered, therefore stable.

Figure 13—the streambank has an obvious scour line. The streambank is above the scour line to the first terrace and is uncovered/unstable (UU).

APPENDIX K—Streambank Stability

Figure 14—the streambank is not covered with vegetation, rock, or wood. It has a bank angle of more than 10 degrees from vertical with no terrace to capture the sediment, and thus the sediment enters directly into the stream making it uncovered/unstable (UU). Banks are always classified unstable where slough enters the stream.

APPENDIX L—Greenline-to-Greenline Width

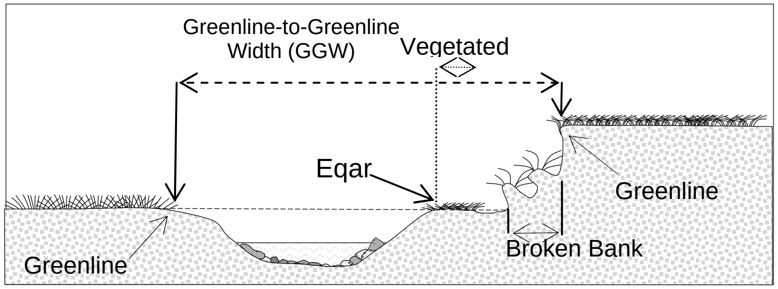

Figure 1—the greenline-to-greenline width is the horizontal distance between the greenlines on each side of the stream measured perpendicular to the flow of the stream. It is the non-vegetated stream channel. When vegetated (at least 25% vegetation cover) slump blocks or islands are encountered along the line, the vegetated portion is subtracted from the total width and only the non-vegetated portion of the width is recorded.

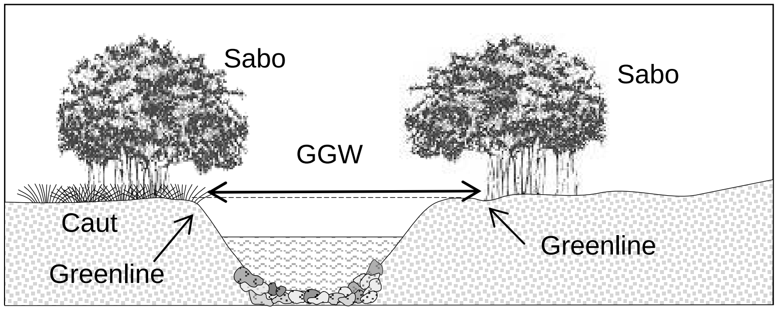

Figure 2—greenline-to-greenline width (GGW) is measured perpendicular to the water flow and from the rooted base on the greenline to the rooted base of plants on the greenline on the opposite side of the non-vegetated stream channel.

APPENDIX L—Greenline-to-Greenline Width

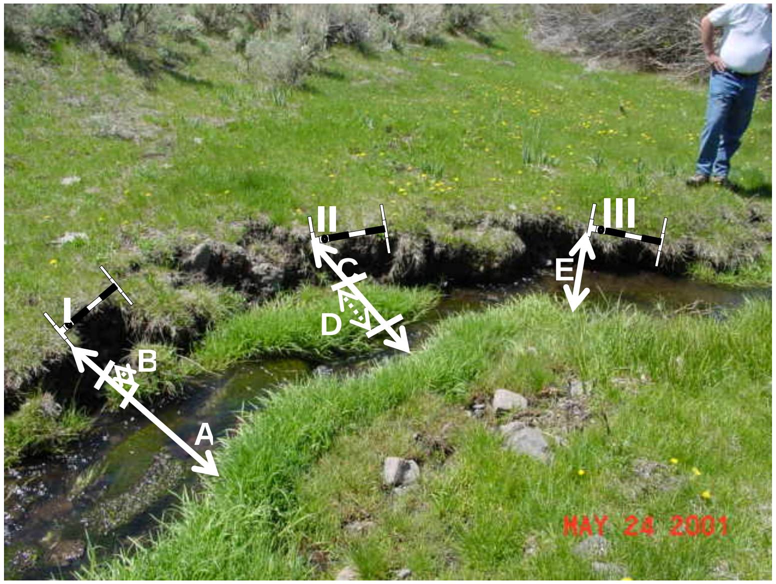

Figure 3—greenline-to-greenline width (GGW) is measured across the non-vegetated portion of the stream channel perpendicular to the direction of water flow. Location "I" is the length of line "A" minus the length of line "B." Location "II" GGW is the length of line "C" less the length of line "D." Location "III" is the length of line "E."

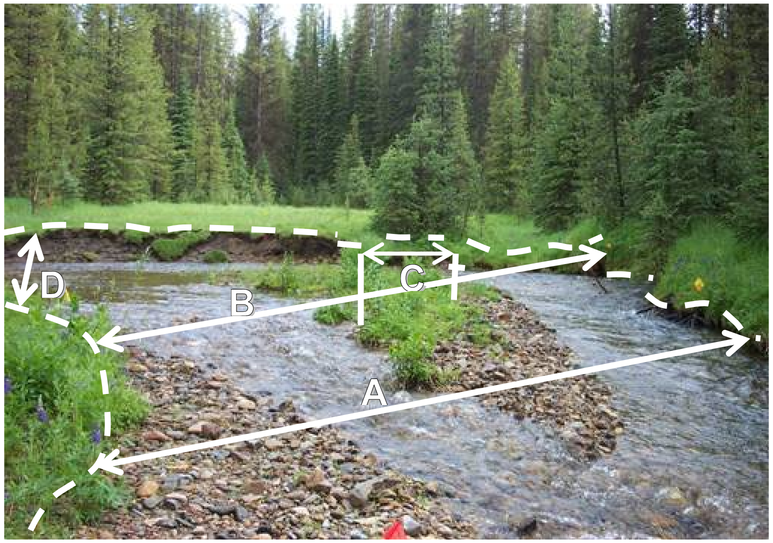

Figure 4—line "A" is the total length of the greenline-to-greenline width (GGW). The gravel bar has no vegetation. When the GGW crosses an island with at least 25 percent cover, the non-vegetative portion is calculated (total length of line "B" – line "C") to determine the non-vegetated portion of the two channels. Photo - PIBO, U.S. Forest Service

APPENDIX L—Greenline-to-Greenline Width

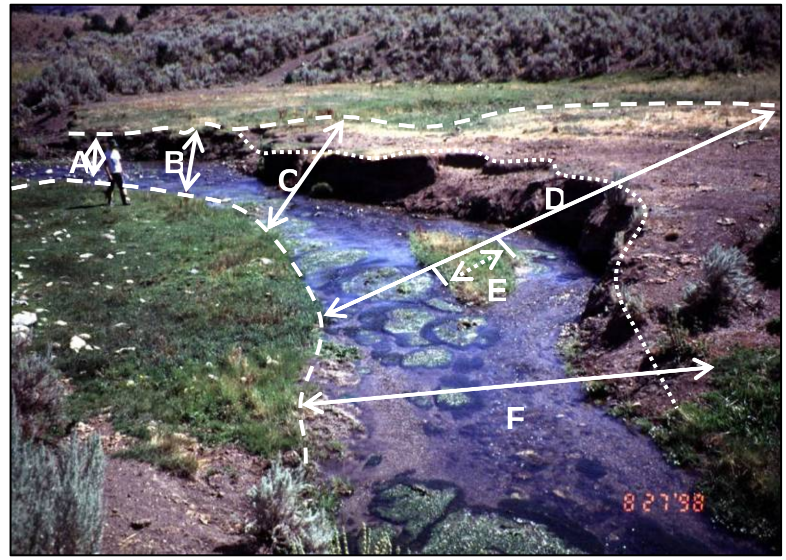

Figure 5—GGW is measured at regular intervals from one side of the stream at each plot location. Lines "A," "B," and "F" are the width of the non-vegetated stream channel measured perpendicular to the water flow direction. Line "C" shows a non-vegetated portion above the steam. The GGW is measured between the greenlines. The GGW for line "D" is the total length of the line minus the distance on the island at "E."

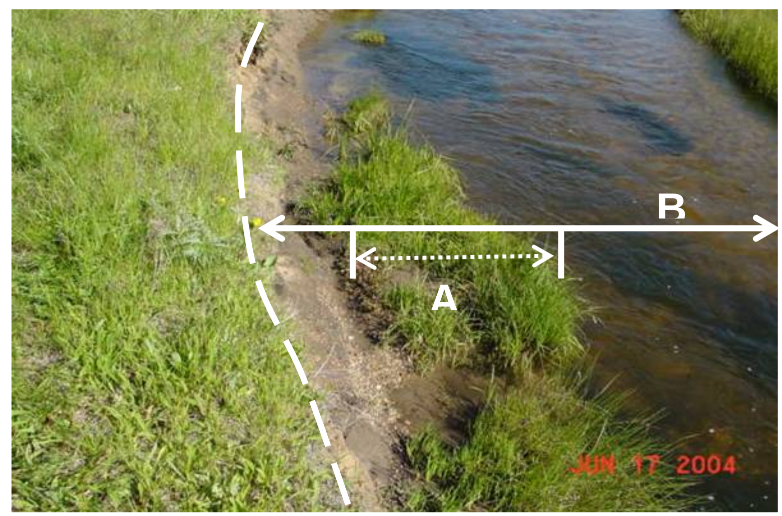

Figure 6—the slump block "A" is not attached to the streambank. The GGW is the total length of "B" less the length of the slump block.

APPENDIX M—Woody Species Use—Browse

Figure 1—None to Slight. Browse plants appear to have little or no use. Less than 10% of the available current year's leader growth is undisturbed. Mid-point is 5.

Figure 2—Slight to Light. There is obvious evidence of leader use. The available leaders appear cropped or browsed in patches and 60–89% of the available leader growth of browse plants remains intact. Mid-point is 25.

APPENDIX M—Woody Species Use—Browse

Figure 3—Moderate. Browse plants appear rather uniformly utilized, and 40–60% of available annual leader growth of the plants remains intact. Mid-point is 50.

Figure 4—Moderate. Browse plants appear rather uniformly utilized, and 40–60% of available annual leader growth of the plants remains intact. Mid-point is 50.

APPENDIX M—Woody Species Use—Browse

Figure 5—Heavy to Severe. The use of the browse gives the appearance of complete search by grazing animals. The preferred browse plants are hedged and some clumps may be slightly broken. Only between 10 and 40% of the available leader growth remains intact. Mid-point is 75.

Figure 6—Heavy to Severe. The use of the browse gives the appearance of complete search by grazing animals. The preferred browse plants are hedged and some clumps may be slightly broken. Only between 10 and 40% of the available leader growth remains

APPENDIX M—Woody Species Use—Browse

Figure 7—Extreme. There are indications of repeated grazing. There is not evidence of terminal buds. Some patches of second and third years' growth may be grazed. Hedging is readily apparent and browse plants are frequently broken. Repeated use at this level will produce a definitely hedged or armored growth form. Ten to 40% of the more accessible second and third years' growth of browse plants has been utilized. All browse plants have major portions broken. Mid-point is 95.

Figure 8—Extreme. There are indications of repeated grazing. There is not evidence of terminal buds. Some patches of second and third years' growth may be grazed. Hedging is readily apparent and browse plants are frequently broken. Repeated use at this level will produce a definitely hedged or armored growth form. Ten to 40% of the more accessible second and third years' growth of browse plants has been utilized. All browse plants have major portions broken. Mid-point is 95.

APPENDIX N—Testing Precision and Accuracy

Precision: Precision denotes the amount of agreement between repeated measurements by the same observer and/or different observers. It reflects both the expertise of the observers and the rigor of the procedure. We tested precision by evaluating repeat samples at the same sites and at the same time. We tested repeatability among the same observers and between different observers on the same reaches of stream. Observers were instructed to complete a sample at the site, and then to repeat sampling at the same site. Because plots are located at random by pacing, the likelihood of the repeat sample plots being placed at exactly the same locations on the greenline as samples taken during the initial run is low. Therefore, spatial variation may represent some of the differences observed between initial and final samples (spatial variation is described in the section on Accuracy, below). The following summarizes the ranges of variability observed both among and between observers.

Indicator	Number of tests	Number of streams tested	Mean difference & range of differences among the same observers	Mean difference & range of differences between different observers
Stubble height	35	6	0.6 (0 – 1.5) inch	0.8 (0 – 4.5) inch
Bank alteration	35	6	4.8 (0 – 15)%	8.2 (0 – 44)%
Woody utilization (browse)	33	5	6.3 (0 – 40)%	11.1 (0 – 40)%
Bank stability	35	6	6.3 (0 – 19)%	12.4 (0 – 40)%
% Hydric vegetation	35	6	5.5 (0 – 18)%	9.3 (.5 – 31)%
Wetland rating	35	6	4.9 (0 – 22)	12.1 (1 – 53)
Greenline-greenline width	35	6	.29 (0 – 1.7) meters	.56 (.02 – 1.52) meters

Accuracy: Accuracy is the amount of agreement between the estimate from sampling and the true mean value, usually reflecting the number of samples collected and spatial variability at the site. Sample size estimates are used to evaluate accuracy. We estimated the number of samples needed using a standard power analysis to predict the mean based on the standard normal coefficient, the measured deviation from the mean, and a desired confidence interval width, as follows:

n = (Zæ)2(s)2 / (B)2

Where:

APPENDIX N—Testing Precision and Accuracy

n = The sample size needed to accurately predict the mean.
Zæ = The standard normal coefficient.
s = The standard deviation.
B = The desired confidence level expressed statistically as half of the maximum acceptable confidence interval width. This needs to be specified in absolute terms rather than as a percentage. For example, if the desired confidence interval width is to be within 30% of the sample mean and the expected mean = 10, then B = (0.30 x 10) = 3.0.

The standard deviation and the confidence level representing a percentage of the mean value can be calculated from data as it is being collected in the field. Consequently, we have added this equation to the Data Entry Module, in Excel, so that users can input data and assess sample size needed as it is being collected in the field. The module contains a cell in the Header spreadsheet that allows users to modify the confidence level as they evaluate desired sample sizes from their data.

***Observed n values from test data*:** Using the observed standard deviations from test data, the following describes the average sample size needed to predict the mean.

Sample size needed to predict the mean with 95% confidence (values in parentheses are the numbers of plots from which the standard deviation was calculated)

SITE	**Bank Alteration**	**Bank Stability**	**Stubble Height**	**Greenline-Greenline Width**	**Woody Species Utilization**
Marks Creek	64 (328)	78 (135)	92 (315)	102 (333)	38 (100)
Long Tom	79 (268)	45 (90)	51 (156)	73 (269)	32 (297)
Shoshone Cr	80 (326)	57 (125)	51 (129)	64 (323)	76 (146)
NF Humboldt	61 (355)	55 (86)	77 (206)	64 (361)	36 (80)
Big Elk Cr	76 (228)	54 (144)	31 (56)	24 (228)	137 (136)
Dixie Cr	9 (321)	73 (145)	25 (135)	85 (200)	53 (120)
Average (range)	**62 (9–80)**	**60 (45–78)**	**55 (25–92)**	**69 (24–102)**	**62 (32–137)**

These analyses suggest that in most cases, a sample size of 80 adequately predicts mean values for the quantitative variables, for the kinds of spatial variability observed at the test streams.

APPENDIX O—Equipment List

The following equipment is needed to use the monitoring protocol.

- Monitoring frame described in Appendix D.
- Waders or wading shoes are useful. It is easier to monitor many streams by pacing in the stream rather than on the streambank.
- Laser range finder, measuring rod, or tape measure. The laser range finder is expensive ($2,400.00 for one with a precision of ±0.03 meters and about $800.00 for one with a precision of ±0.3 meters).
- Measuring rod or tape measure (metric preferred).
- Handheld computer (PDA) with Excel spreadsheet. Extra batteries or extended life batteries are required.
- Riparian monitoring data sheets (in lieu of PDA).
- Global Positioning Position (GPS) receiver with extra batteries (strongly encouraged).
- Appropriate plant identification keys for riparian plants.
- Gravelometer for substrate measurement (strongly encouraged), or ruler to measure median diameter of substrate particles.