Using Stubble Height to Monitor Riparian Vegetation

A Team of Experts Concludes That Some Past Uses Have Been Inappropriate.

By The Stubble Height Review Team

In late 2003 and early 2004, a team of experts, consisting of individuals experienced in monitoring, management, and/or research on riparian areas, was assembled to study the use of stubble height as a standard for livestock grazing effects upon riparian-dependant resources. The Team was asked to evaluate current uses of stubble height by federal land management agencies in the Pacific Northwest and to compare those uses to its limitations and assumptions in the scientific literature. This article summarizes the Team's findings.

Riparian vegetation plays a critical role in stream function and the development of streamside and in-stream characteristics beneficial to aquatic species.[1–6] Livestock typically impact stream condition either indirectly by altering vegetative condition (vigor or community composition) or directly through mechanical disturbance of stream banks. In recent years, measures of vegetation stubble height remaining after the grazing period have been used to indicate the degree to which plants were grazed in a given season and as an index of grazing effect on riparian functions, including streamside and in-stream characteristics.

A well-vegetated stream bank.

Stubble (vegetation height) has been shown to be a good indicator of 2 primary factors: 1) the effect of grazing on the physiological health of the individual plant, and 2) the ability of the vegetation to provide stream-bank protection and to filter out and trap sediments from overbank flows.

A summary of the literature showed how stubble height remaining after grazing can be, in addition to the above indicators, an indirect indicator of stream-bank trampling and shrub (willow) browsing on the stream banks. Clary and Leininger[7] proposed a 10-cm residual stubble height criterion as a "starting point for improved riparian grazing management." However, they acknowledged that, in some instances, 7 cm may provide adequate riparian protection and that, in others, 15 to 20 cm may be required to limit stream-bank trampling or to reduce willow browsing. Thus, the criteria could vary depending upon local environmental variables and the timing, duration, and intensity of livestock use. Unfortunately, the linkages between stubble height and riparian functions have had limited experimental examination. For this reason, stubble height as an annual indicator of grazing use in riparian areas should only be used where existing science suggests that it is appropriate and should be used in combination with longer-term monitoring of vegetation and channel parameters. This article shows where stubble height indicators and criteria can and should be used in riparian

Stubble Height Can Be Used as an Annual Indicator of Livestock Utilization Effects on Stream/Riparian Areas

- Associated with perennial streams or intermittent streams that support hydric vegetation on the greenline
- Near the stream edge or along the stream margins—commonly at the first perennial vegetation above the water line
- In areas of hydrophilic or potential hydrophilic vegetation—wet areas adjacent to the stream; NOT in dry vegetation types at the tops of stream banks above the influence of water in the rooting zone; depositional banks are more favorable to hydric vegetation; erosional banks whose tops are above the bank-full level are not favorable to hydric vegetation
- Where herbaceous vegetation is dominant along the stream edge and controls stream bank stability; stubble height does NOT apply where woody vegetation and/or rock control bank stability

Where these environmental conditions do not occur, direct monitoring of shrub browsing or stream-bank disturbance, rather than stubble height, will be necessary to assess annual livestock grazing impacts.

management. If riparian conditions are not meeting resource objectives, are degraded and static, or in a downward trend due to livestock grazing, changes in management should be implemented and monitoring of the riparian responses should be required. An "adaptive management" approach is recommended to refine the grazing strategy through time, as needed, to meet the long-term riparian resource objectives.

Appropriate Use of Stubble Height

Environmental Constraints

The use of stubble height is restricted to sites near the stream edge, that is, areas that can be described as streamside, or near-stream, typically represented by hydrophilic (water-loving) or potentially hydrophilic vegetation.[7] At this interface between vegetation and water (the green line), riparian and stream habitats are most sensitive and dynamic. This is where moist vegetation communities are mostly likely to occur and where the erosive energy of the stream plays a major role, affecting both the riparian vegetation and channel form. Because hydrophilic vegetation is often heavily rooted, with creeping underground stems (Rhizomatous), and tends to form complete bank cover along the channel margins, it can be very resistant to stream erosion. This resistance lends itself to channel stability and helps to create stream habitat structure and complexity favorable to aquatic organisms. It is here where stubble heights must be measured to assess hydrophilic plant vigor, which, in turn, reflects plant influences upon stream bank and channel stability. Because stubble height applies only to herbaceous vegetation, its use applies only where herbaceous vegetation currently controls bank stability (Sidebar 1).

Sampling Constraints

Stubble height sampling is quick, simple, and reasonably accurate. It can be used to monitor large areas in less time than is needed with traditional utilization study protocols. In some situations, however, accuracy can be adversely affected by stand characteristics. Difficulties with stubble height arise, for example, in irregularly grazed bunch grasses or stands of inconsistent plant composition with varying palatability. For these reasons, stubble height measurements should focus on key riparian plant species or species groups important to bank stability. Stubble height monitoring should report the average use by similar key species, not integrated across all available species. Because plants have varying growth height potential, averaging stubble height across multiple, dissimilar species can skew the results in favor of taller or shorter growing species that predominate in a sample area. Grouping the data should only be done among species with relatively similar growth forms.

Stubble height measurements should be derived from a population of samples statistically adequate to reflect actual grazing use. The selection of species groups, where appropriate, may reduce the total sampling requirements or may increase precision within a given sample number. The selection of monitoring sites (Designated Monitoring Areas, [DMAs]) should be based on the endpoint indicator being

Stubble Height Can Be Used as an Annual Indicator of Livestock Grazing in Riparian Areas

- Where it is applied to individual key species or community types used by livestock, which also play an important role in maintaining stream-bank stability
- Where it is statistically applied to individual key species or to groups of species with similar growth characteristics
- Where enough observations are collected to reflect grazing use variability across the extent of the monitoring area. A sequential sampling method, such as Turner and Clary[9] has the advantage of being rapid, avoiding skewness, and providing statistically accurate answers

The monitoring site(s) (DMAs) must reflect management impacts on all major riparian cover types of the stream/riparian area within the pasture, be representative of overall grazing use within the entire riparian area of the pasture, and occur only where livestock are using the riparian area. The DMA should not be located where the vegetation community type is not an important contributor to stream function or where cattle concentrate (eg, stream crossings). The DMA should include stream segment(s) critical to important riparian-dependant resources (eg, spawning and early rearing segments).

monitored. They should be representative of grazing use specific to the riparian area being assessed and should reflect what is happening in the overall riparian area as a result of on-the-ground management actions (Sidebar 2).

Process for Adaptive Management

Although stubble height is easy to use, it is not a resource objective and therefore inappropriate as a prescriptive standard in grazing permits and land use plans.[7,8] It should be used as a guideline or indicator for changing annual management in the Annual Operating Instructions/Plan. Because it is an estimate of the amount of livestock use, it can be used to control how much use takes place within the riparian zone of a grazing unit in any given year. As such, it is often used in the annual operating plan as a "trigger" for when livestock should be moved from the grazing unit. However, such a "trigger" needs to be validated to ensure that it actually achieves desired riparian resource objectives within a reasonable time frame.

Stubble height, stream-bank disturbance, and woody-stem use are all short-term indicators of grazing use and may or may not reflect the meeting of long-term riparian management objectives such as the composition of desirable hydric green-line vegetation or stream-bank stability. Each short-term indicator, like stubble height, can be used in the appropriate situation, as criteria for achieving desired grazing-use levels in the annual operating plan. To properly manage the grazing operation, the current condition and trend of the long-term riparian management objectives would be compared with the desired condition of those objectives to assess the need to adjust grazing use. The land manager and grazing operator would work to make adjustments, as needed, to meet the long-term riparian management objectives. The permit standard for compliance would then be based upon the operators' demonstrated effort to meet those adjustments. The Allotment Management Plan would have, as its long-range objective, the requirement to achieve the desired long-term riparian management objectives within a reasonable time frame. Such a time frame would be approximated by the near-natural rate of recovery, taking into account year-to-year variability in environmental processes that control recovery. Under this approach, it would be inappropriate to use stubble height numeric values as the sole means to manage toward achieving the long-term riparian management objectives.

Users should modify the wording in permits and Land Use Plans to use stubble height criteria, not as a compliance standard, but as 1) a "trigger" to assess when livestock should be moved from a grazing unit, and/or 2) an annual "prompt" to investigate and assess the riparian resource condition and to help inform decisions concerning the need to make appropriate changes in annual management. If stubble height at the end of the growing season indicates that the grazing management is not achieving use levels compatible with desired riparian resource objectives, then identify appropriate and timely action to correct the root cause. This would be accomplished through adaptive management.

Steps in the Adaptive Management Process

I. Define the resource objectives (riparian management objectives).
II. Develop a grazing plan to accomplish the objectives.
III. Identify trigger and endpoint indicators and the numeric criteria for these monitoring indicators used to assess success.
IV. Implement the grazing plan and monitor the indicators.
V. Annually evaluate the success of the grazing plan.

Adaptive management is an interdisciplinary planning and implementation process that identifies desired riparian conditions, defines criteria for modifying grazing operations when progress toward achieving the desired conditions is not being made, and specifically defines the monitoring strategy and protocols. Monitoring can determine whether the project-level decision is being implemented as planned (implementation monitoring) and, if so, whether the objectives are being achieved in a timely manner (effectiveness monitoring). The process invites participation from rangeland users and other interested parties, where feasible. The following summarizes the process of adaptive management (Sidebar 3).

Step I. Determining riparian resource objectives is defining the goals for the riparian/aquatic communities at the pasture scale. Because livestock grazing primarily influences the status of riparian vegetation along the stream margins, stream bank stability, and woody species regeneration, the objectives often focus on these 3 resource characteristics. Objectives for riparian vegetation status and bank stability are normally quantitative, and qualitative for woody species regeneration.

Step II. Developing a grazing resource plan means designing a plan to achieve the riparian resource objectives within a reasonable period of time. The plan should be at the pasture and allotment scale and identify timing, intensity, and duration of use expected to achieve the desired objectives.

Step III. Identifying the monitoring indicators pinpoints the markers used to gauge success of the Grazing Plan. *Trigger monitoring* is used to determine when livestock should be relocated from an area or pasture to achieve desired use levels. It is the responsibility of grazing permittees and herd managers to achieve the desired grazing use levels. Stubble height measures trigger answers to key questions: ie, "Is it time to either ride harder to keep cows in the uplands away from the creek or move them to another area of the pasture or even completely remove them from the pasture?" Such "triggers" are used by permittees as indicators of allowable use in a given riparian area and are designed to limit livestock impacts on riparian vegetation and disturbance of stream banks. Site variability ensures that a single trigger (eg, stubble height value), will not be appropriate in all situations.

Other use indicators may also be appropriate in "trigger" monitoring. An Interdisciplinary Team might select 3 triggers (eg, stubble height, bank disturbance, level of use on woody plants) to start with and as they gain experience find that only

1 or 2 are needed. When any 1 of the selected triggers is reached first, the permittee should take appropriate action.

Endpoint indicators are the responsibility of agencies in assessing resource impacts of the current year's grazing. However, grazing permittees and, where there are Endangered Species Act (ESA)-listed species, the consulting agencies should be involved in the annual grazing assessment. The appropriate time to measure and evaluate endpoint indicators is typically between the end of the growing season after livestock grazing has been terminated and before the next high-flow event that will reach or exceed bank-full stream-flow levels. The purpose of the assessment is to determine if the actual grazing use in the current year's grazing season left the stream and associated riparian area in a condition likely to result in a desired trend toward meeting the long-term riparian management objectives. Most appropriate endpoint indicators for stream/riparian areas center on vegetation (herbaceous and/or woody riparian species) for protection and building of stream banks and on amounts of mechanical disturbance leaving stream banks vulnerable to increased erosive energies experienced during high flows. The primary purpose is to assess the condition of the stream/riparian area before the next high stream-flow event or annual flood, when bank erosion is most likely to occur.

It is a relatively common practice to factor in expected regrowth when setting within-season triggers for vegetation, particularly herbaceous stubble height. In these cases, end-of-season monitoring is of critical importance to evaluate the appropriateness of the regrowth factor. All too often, expected regrowth does not materialize, either because of lower-than-expected precipitation or overly optimistic estimates of the actual length of the growing season. The critical point for discussing the criteria for triggers is at the end of the growing season when the results are apparent.

When using both within-season triggers and endpoint indicators, allowable numeric values must be established. The monitoring strategy must not only measure and evaluate whether or not the allowable numeric value is met but also whether the value is correct. Because of site-specific differences across the landscape, the determination of allowable numeric values must rely to a large part on professional judgment. Current research can give the manager a starting point but may not be precise enough to apply in a "cookbook fashion." One approach is to begin with default values in current applicable research, then factor in site-specific characteristics to arrive at a reasonable allowable numeric value. The initial allowable resource value is estimated and subject to refinement through time. This reinforces the value of adaptive management. At each stage of the monitoring cycle, ie, within-season trigger, endpoint indicator, and short-term, midterm, and long-term evaluations, assessments must include whether triggers, endpoint indicators, and associated allowable numeric values are useful in driving adjustments to management that lead to desired improvements in riparian and aquatic habitat conditions. In other words, the manager will be continuously seeking to refine triggers, endpoint indicators, and management to achieve the desired results.

A riparian stream bank that would benefit from residual vegetation stubble.

A riparian site that would not benefit from residual stubble height because it is dominated by woody vegetation.

Step IV. Implementing the monitoring plan should follow established monitoring protocols. The plan should be included as part of the Grazing Plan and be updated through time as new monitoring information becomes available. If, for example, the monitoring data suggest that stubble height does not trigger the need to relocate livestock before allowable levels of bank disturbance are reached, stubble height monitoring might be eliminated or reduced in intensity.

Step V. Evaluating success annually of the grazing plan is carried out by the interdisciplinary team (ID Team) that assesses compliance with the management criteria and, in cases where the criteria were not met (including the end-of-season use criteria), the ID Team makes recommendations for changes to the grazing plan. The ID Team will use input from the Level 1 Team where ESA is relevant to noncompliance. The line manager then meets with the permittee to adjust the annual grazing plan accordingly. Where the grazing operation was not in compliance with any portion of the

Table 1. Timing, responsibility, and participation in the Adaptive Management Process for livestock management in riparian areas.

Action	Timing and frequency	Responsibility	Participants
I. Set Riparian Objectives	During planning phase	Action agency	Permittees and consulting agencies
II. Develop the Grazing Plan	During planning phase	Action agency	Permittees and consulting agencies
IIIa. Selection of TRIGGER INDICATORS	Planning and potentially after annual management evaluations	Permittees and action agency	Consulting agencies
IIIb. Selection of ENDPOINT INDICATORS	Planning phase, or potentially after periodic evaluations	Action agency	Permittees and consulting agencies
IIIc. Selection of Long-Term Monitoring Indicators to assess meeting RIPARIAN OBJECTIVES	Planning phase, or after RIPARIAN OBJECTIVE evaluations	Action agency	Permittees and consulting agencies
IIId. Selection of the Designated Monitoring Area	First field season and after periodic evaluations	Action agency	Permittees and consulting agencies
IVa. Monitor TRIGGER INDICATORS	Field season annually	Permittee	Action agency
IVb. Monitor ENDPOINT INDICATORS	Field season annually at end of growing season	Action agency	Permittee and consulting agencies
Va. Evaluate ENDPOINT INDICATORS	Annually after ENDPOINT INDICATOR monitoring and before next bank-full event	Action agency	Permittee and consulting agencies
Vb. Determine and implement management changes	Annually after ENDPOINT INDICATOR monitoring and before next bank-full event	Action agency and permittee	Consulting agencies
IVc. Monitoring Long-Term indicators—RIPARIAN OBJECTIVES	Once every 3 to 5 years	Action agency	Permittee and consulting agency
Vc. Evaluate Long-Term indicators—RIPARIAN OBJECTIVES	After RIPARIAN OBJECTIVES monitoring	Action agency	Permittee and consulting agencies
Vd. Determine and implement management changes resulting from RIPARIAN OBJECTIVES assessment.	After RIPARIAN OBJECTIVES monitoring	Action agency	Permittee and consulting agencies

permit, the manager consults with the ID Team (and Level 1 Team where ESA consultation measures were not met) and determines whether a letter of noncompliance or permit action is warranted (Table 1).

Monitoring Guide

A monitoring guide has been prepared to assist field managers with selection of appropriate "trigger" and "endpoint" indicators for monitoring. The guide can be used to prescribe

Sample from the Monitoring Guide

- TRIGGER monitoring: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers, use the following:
  - Stubble height on key riparian species, or key species groups on the greenline
  - Use compliance (livestock numbers and time in pasture)
  - Bank disturbance or alteration
- ENDPOINT Monitoring: End-of-season indicator of proper use to maintain or ensure increased composition of key hydric stabilizers:
  - Stubble height on key riparian species, or species groups on the greenline
  - Bank disturbance or alteration
- RIPARIAN OBJECTIVE monitoring: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives:
  - Streambank stability
  - Greenline composition maintained or trend toward hydric stabilizers

streamside monitoring methods appropriate for various channel types[3] and existing and potential vegetative conditions along the margins of the stream channel at the green line. As an example, for "C" (low gradient) channel types with herbaceous vegetation dominant and potential vegetation herbaceous or mixed herbaceous and shrubs, the guidelines are given in Sidebar 4.

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