BRITISH COLUMBIA

Ministry of Forests and Range Range Branch

MEMORANDUM

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February 17/2009

To: Whom It May Concern

From: Ministry of Forests and Range, Range Branch

Re: Update and Erratum for:

Fraser, D.A. 2007. Rangeland Health Field Guide. B.C. Min. For. Range, Range Br., Kamloops, B.C. www.for.gov.bc.ca/hfd/pubs/Docs/Mr/Mr117.htm

Update (2009):
Update pages 1 to 13 have been added to this publication. Please remove pages 13 to 23 from the guide and insert the update.

This update also replaces the November 2008 Erratum.

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1.8 Function Checklists

How to complete the function checklists

The term PFC refers to both the assessment process and the onground condition of an ecosystem (Lewis et al. 2003). The condition of riparian and upland areas is a result of interaction among geology, soil, water, vegetation, and animals. An ecosystem is functioning properly when biotic, edaphic, and hydrologic attributes:

- dissipate stream and raindrop energy, protect the soil from erosion, filter sediment, capture bedload, and aid floodplain development;
- improve water infiltration and retention; and
- provide diverse habitats and support greater biodiversity.

PFC assessments are qualitative and provide the starting point for determining and prioritizing areas that require more intensive monitoring, restoration, or management. The assessments provide a consistent approach for assessing ecosystems by considering physical, hydrologic, biotic, and edaphic attributes of an ecosystem. Although a properly functioning ecosystem may or may not be at the desired future condition, it is a prerequisite to achieving desired condition. PFC assessments indicate the condition of the ecosystem; more intensive monitoring and assessments may be required to determine the cause of the condition.

A PFC assessment is not a replacement for intensive methodologies and protocols or those that target specific components of an ecosystem. It does, however, complement more detailed methods and protocols.

When conducting PFC assessments, it is important to have a reference site for comparison; for example, an ungrazed or slightly grazed site.

The checklists should be reviewed in advance of field work, and any necessary file or historic information should be gathered and recorded at that time. Generally, you should get a feel of the area by walking a stream reach or traversing an upland area before filling in the checklists or forms; this will help to gain a broader perspective, which otherwise

may be lost if you become too concerned with making notes.

Use the following table to score the area being assessed. Pay particular attention to categories that give borderline answers, because these indicate trend, and may serve as either early warnings or indicators of recovery in damaged systems.

% of Yes answers	Rating
≥80%	PFC
61–79%	Slightly at risk
41–60%	Moderately at risk
20–40%	Highly at risk
<20%	Non-functional

Lakes, Ponds, and Wetlands - Riparian Function Checklist

To complete the following Checklist, observe and consider the following parameters.

Hydrology

Parameter 1. Riparian soil moisture conditions are maintained.

Note: Do soils remain saturated and anaerobic for part of the growing season or have they dried and now function as upland soils? Anaerobic conditions are important in the denitrification processes. Consider upland species growing in the wetlands, a decrease in obligate wetland/hydrophytic plants, reduced plant vigour, or mottles or gleyed horizons in the soil. Where possible dig a hole to look for evidence of mottles or gleying.

Parameter 2. Water levels have remained unchanged over time (willow fringe or willow skeletons).

Note: Willows indicate the average high-water mark for many wetland types. Check for vigour and recruitment of phreatophytes. What is the source of water for this wetland? Is it overland flow, groundwater, or channel flow? Is this a beaver-influenced wetland? Has the hydrology been influenced by land management practices in the watershed? Look at both the riparian and upland areas for evidence of land use change. Distinguish seasonal draw-down from changes in water level due to land use.

Lakes, Ponds, and Wetlands Riparian Function Checklist

Range Unit:			Range Agreement Holder:
UTM Coordinates:			BEC Subzone:
Name of Riparian-Wetland Area:			
Date:			Segment ID:
Classification of Lake or Pond (>2 m depth):			or Class and type of Wetland (<2 m depth):
Observers:			
Yes	**No**	**N/A**	**Parameters**
			Hydrology
			Riparian soil moisture characteristics are maintained.
			Water levels have remained unchanged over time (willow fringe or willow skeletons).
			Biotic/Vegetation
			Diversity and structure of the riparian and emergent vegetation has been maintained.
			The plant community is adequate to filter sediments and pollutants.
			Soils/Erosion-Deposition
			Bank shearing, soil compaction, and bare ground are uncommon.
			Soil erosion and deposition in the wetland and riparian area are at natural levels.
			Hummocks are rounded and completely vegetated.
			Shoreline characteristics (vegetation, rocks, woody debris) are adequate to dissipate wave and wind event energies.
			Nutrient Inputs and Water Quality
			Inputs of fine organic matter for the detritus good chain are appropriate.
			Nutrient inputs are normal (there is a lack of algae mats).
			Vertebrate and invertebrate life indicate good water quality.

Check one

- ☐ PFC
- ☐ Slightly at risk
- ☐ Moderately at risk
- ☐ Highly at risk
- ☐ Non-functional

Notes:

Describe the current plant community:

Describe the desired plant community if different than the above:

Are the riparian soils subjected to prolonged saturation and anaerobic conditions?

Is this wetland part of a beaver-influenced riparian system?

Have land uses beyond the control of the range user altered the dynamics of the system?

Biotic/Vegetation

Parameter 3. Diversity and structure of the riparian and emergent vegetation has been maintained.

Note: Widths of riparian and emergent native vegetation bands will fluctuate annually. Monitor for long-term changes.

Parameter 4. The plant community is adequate to filter sediments and pollutants.

Note: Healthy bands of riparian and emergent vegetation are effective in reducing turbidity and capturing pollutants.

Soils/Erosion-Deposition

Parameter 5. Bank shearing, soil compaction, and bare ground are uncommon.

Note: If bank shearing, soil compaction, and bare ground are evident, is it to a watering site, or does it occur around the entire wetland?

Parameter 6. Soil erosion and deposition in the wetland and riparian area are at natural levels.

Note: If not, it may indicate a problem in the surrounding uplands. Infer natural soil erosion and deposition levels from the reference conditions.

Parameter 7. Hummocks are rounded and completely vegetated.

Note: Hummocks can be created by livestock trampling. However, some species of sedge create their own hummocks to avoid prolonged saturation. Hummocks should be rounded and completely vegetated.

Parameter 8. Shoreline characteristics (vegetation, rocks, woody debris) are adequate to dissipate wave and wind event energies.

Note: There should be adequate vegetation to protect the banks from the actions of wind and waves.

Nutrient Inputs and Water Quality

Parameter 9. Inputs of fine organic matter for the detritus food chain are appropriate.

Note: Does detritus form an integral part of the food chain? Look for build-up of leaves and organic matter. Note presence or lack of accumulation of organic matter and leaves.

Parameter 10. Nutrient levels are normal (there is a lack of algae mats).

Note: Is there excessive livestock dung? Are there thick algae mats? Is there evidence of organism die-offs? Does the invertebrate population indicate a worsening in habitat or water quality (species shifts, lower diversity)? Potential sources of nutrient input include manure, urine, nutrients from agricultural operations, and erosion.

Parameter 11. Vertebrate and invertebrate life indicate good water quality.

Note: Amphibians, fish, and aquatic macro-invertebrates are indicators of water quality and habitat. Low species diversity may indicate a problem. Consider both the wetland and the riparian zone. Refer to Fraser (2007) for a description, and the pollution tolerance, of some common macro-invertebrates.

Notes:

Current and Desired Plant Communities: Describe both the current and desired plant communities in enough detail to create a word picture.

Anaerobic soils are important in filtering and modifying pollutants. Willows will not grow under totally anaerobic conditions. They will withstand some flooding, but will die in the absence of oxygenated conditions. Willows will usually root over coarse-textured materials where oxygenation is possible.

Land uses that are beyond the control of the range user must be identified. For example, a road might sever a shrub carr from a wetland complex, thereby affecting the wetland's hydrology/water levels.

Streams Riparian Function Checklist

To complete the following Checklist, observe and consider the following parameters.

Channel Structure, Function and Diversity

Parameter 1. Channel characteristics (rocks, large woody debris) and associated floodplain (access to overflow areas) are adequate to dissipate energy.

Note: Is stream energy naturally dissipated through the presence of rocks/boulders, large woody debris, shrubs/sedges, or natural sinuosity? Does the stream have easy access to its floodplain during high flow?

Parameter 2. Lateral movement is associated with natural sinuosity.

Note: Do not confuse natural sinuosity with accelerated lateral movement across the floodplain. Lateral erosion leads to an increase in channel width. Channels and banks are not static; it is natural for channels to move and evolve over time. Do not confuse natural channel movement with accelerated change. Bank undercutting should be balanced by bank building on the opposite side. Channels that migrate laterally through meandering without changing their width-to-depth ratio are dynamically stable. Channels that move laterally with an increase in the width-to-depth ratio are generally unstable and have lost deep-rooted riparian vegetation.

Parameter 3. Erosion, deposition, embeddedness, and movement of bed materials are normal for this reach.

Note: Is meander erosion balanced by point bar deposition? Are point bars revegetating? Is there evidence of excessive movement of bed materials as indicated by extensive riffles? Check to see if cobbles and boulders are embedded with fine sediments.

Parameter 4. Aspects of channel geometry are in balance with the landscape position.

Note: Sinuosity should be balanced with the slope and landscape position of the stream. Is the channel deep relative to its width? Pools should

Streams Riparian Function Checklist

Range Unit:			Range Agreement Holder:
UTM Coordinates:			BEC Subzone:
Name of Stream:			Classification:
Date:	Segment/Reach ID:		Gradient of Segment: Low, Medium, High
Stream Type: Perennial, Intermittent, or Ephemeral / Continuous or Interrupted			
Observers:			
Yes	**No**	**N/A**	**Parameters**
			Channel Structure, Function, and Diversity
			Channel characteristics (rocks, large woody debris) and associated floodplain (access to overflow areas) are adequate to dissipate energy.
			Lateral movement is associated with natural sinuosity.
			Erosion, deposition, embeddedness, and movement of bed materials are normal for this reach.
			Aspects of channel geometry are in balance with the landscape position.
			Inputs of large organic debris and incorporation into the channel are normal for area.
			Banks are undercut (meandering or riffle-pool streams).
			Riffle-bed materials and gravels are free of sediment. Fish spawning and use of rock undersides by insects and other invertebrates are possible.
			Boulders in streambed are moss-covered (step-pool streams).
			Biotic Community
			Roots of trees, shrubs, and graminoids extend into the stream. Root masses are capable of withstanding high streamflow events and allowing formation of overhanging banks.
			There is recruitment of riparian tree and shrub species that will contribute to replacement of woody debris in the foreseeable future.
			Riparian habitat and structure have been maintained.
			Hydrology/Soils
			Riparian soil moisture characteristics are maintained.
			Bank shearing, soil compaction, and bare ground are uncommon.
			Nutrient Inputs and Water Quality
			Vertebrate and invertebrate life indicate good water quality.
			Nutrient inputs are normal (there is a lack of algae mats).
			Inputs of fine organic matter for the detritus food chain are appropriate.

Check one

- ☐ PFC
- ☐ Slightly at risk
- ☐ Moderately at risk
- ☐ Highly at risk
- ☐ Non-functional

Notes:

Describe the current plant community:

Describe the desired plant community if different than the above:

Does the substrate make this stream susceptible to either vertical or lateral erosion?

Soils types and textures?

Are the riparian soils subjected to prolonged saturation and anaerobic conditions?

Is the stream beaver-influenced or controlled?

Have land uses beyond the control of the range user altered the dynamics of the system?

represent 2/3 the length of any reach; riffles should represent 1/3 the length of any reach. The sequence of pools and riffles should repeat itself every five to seven bank widths. Pools should be fine-textured and deep, and riffles should be coarse-textured and shallow. Excessive riffle length is evidence of excessive movement of bed materials. Channel bars should be at the margins, not in mid-channel.

Parameter 5. Inputs of large organic debris and incorporation into the channel are normal for the area.

Note: Are trees and shrubs being incorporated by natural mortality and windfall at a normal rate?

Parameter 6. Banks are undercut (meandering or riffle-pool streams).

Note: Are undercut banks appropriate for the stream segment? Consider the gradient, bank texture, and bed materials.

Parameter 7. Riffle-bed materials and gravels are free of sediment. Fish spawning and use of rock undersides by insects and other invertebrates are possible.

Note: Looks at rock undersides for evidence of invertebrate life. Water temperature, purity, and turbidity will influence the invertebrate species found there.

Parameter 8. Boulders in streambed are moss-covered (step-pool streams).

Note: This indicates that boulders have not been moved by high flow or by ice scouring.

Biotic Community

Parameter 9. Roots of trees, shrubs, and graminoids extend into the stream. Root masses are capable of withstanding high streamflow events and allowing formation of overhanging banks.

Note: Consider stream type and site potential when answering this question. Are there overhanging banks? Are there deep-rooted sedges as opposed to shallow-rooted grasses on the streambank? Do the root masses of shrubs or trees extend into the channels, influencing its depth and

direction of flow? Check the soil texture. Willows require coarse-textured substrates and will not grow in oxygen-poor soils. Sedges will grow in anaerobic conditions.

Parameter 10. There is recruitment of riparian tree and shrub species that will contribute to replacement woody debris in the foreseeable future.

Note: The plant community exhibits high vigour and indicates maintenance of riparian soil moisture characteristics. Woody species are present and able to contribute to the stream system. There are new recruits to replace those that have fallen.

Parameter 11. Riparian habitat and structure have been maintained.

Note: Are the species present vigorous riparian species, or have other species (e.g., upland and invasive alien species) encroached?

Hydrology/Soils

Parameter 12. Riparian soil moisture characteristics are maintained.

Note: Do soils remain saturated and anaerobic for part of the growing season or have they dried and now function as upland soils? Anaerobic conditions are important in the denitrification processes.

Parameter 13. Bank shearing, soil compaction, and bare ground are uncommon.

Note: Excessive trampling leads to soil compaction and poor water infiltration.

Nutrient Inputs and Water Quality

Parameter 14. Vertebrate and invertebrate life indicate good water quality.

Note: Amphibians, fish, and aquatic macro-invertebrates are indicators of water quality and habitat. Low species diversity may indicate a problem. Refer to Fraser (2007) for a description and the pollution tolerance of some common macro-invertebrates.

Parameter 15. Nutrient inputs are normal (there is a lack of algae mats).

Note: Is there excessive livestock dung? Are there thick algae mats? Is there evidence of organism die-offs?

Parameter 16. Inputs of fine organic matter for the detritus food chain are appropriate.

Note: Does detritus form an integral part of the food chain?

Notes:

Current and Desired Plant Communities: Describe both the current and desired plant communities in enough detail to create a word picture.

Anaerobic soils are important in filtering and modifying pollutants. Willows will not grow under totally anaerobic conditions. They will withstand some flooding, but will die in the absence of oxygenated conditions. Willows will usually root over coarse-textured materials where oxygenation is possible.

Land uses that are beyond the control of the range user must be identified. For example, roads, culverts, and dams will affect stream function.

Uplands Function Checklist

To complete the following Checklist, observe and consider the following parameters.

Hydrology and Soils

Parameter 1. Organic matter protects the soil surface from raindrop impact and evaporative effects of sun and wind.

Note: Most of the ground surface should be protected by live vegetation (including biological soil crusts) or dead plant material.

Parameter 2. Water will easily infiltrate the soil surface (absence of physical soil crusting, capping).

Note: Soil surface conditions should allow for precipitation to penetrate. Soil crusting or capping should not occur. Do not confuse physical crusting with biological soil crusts.

Uplands Function Checklist

Range Unit:			Range Agreement Holder:
UTM Coordinates:			BEC Subzone:
Name of Upland Area:			
Date:			Location:
Hectares:			
Observers:			
Yes	**No**	**N/A**	**Parameters**
			Hydrologic and Soils
			Organic material protects the soil surface from raindrop impact and evaporative effects of sun and wind.
			Water will easily infiltrate the soil surface (absence of physical soil crusting, capping).
			Subsurface soil conditions support infiltration (compaction layers are uncommon).
			Vegetation and plant litter detain overland water flow.
			Biotic/Vegetation
			The plant community is showing good vigour (including recruitment of decreasers).
			A diversity of habitat structure for vertebrate and invertebrate life is evident
			Erosion/Deposition
			Evidence of rills, gullies, pedestalling, and other excessive soil movement is uncommon.
			Mineral Cycle
			Plant cover and litter create a micro-site environment conducive to biological breakdown.
			Biological soil crusts and nitrogen-fixing forbs and shrubs are present as in the reference condition.

Check one

- ☐ PFC
- ☐ Slightly at risk
- ☐ Moderately at risk
- ☐ Highly at risk
- ☐ Non-functional

Notes:

Describe the current plant community:

Describe the desired plant community if different than the above:

Do springs and seeps support phreatophytic plants?

Have land uses beyond the control of the range user altered the dynamics of the system?

Parameter 3. Subsurface soil conditions support infiltration (compaction layers are uncommon).

Note: Check for soil compaction or impenetrable layers.

Parameter 4. Vegetation and plant litter detain overland water flow.

Note: No sign of rilling. Sediment is trapped.

Biotic/Vegetation

Parameter 5. The plant community is showing good vigour (including recruitment of decreasers).

Note: Proper growth form and stature, community structure, and species composition of *native decreaser species*.

Parameter 6. The plant community reflects a fully occupied root zone.

Note: Dig a soil pit. Roots should penetrate deeply into the soil profile.

Parameter 7. A diversity of habitat structure for vertebrate and invertebrate life is apparent.

Note: If you build it they will come. Consider soil organisms, insects, and vertebrates.

Erosion/Deposition

Parameter 8. Evidence of rills, gullies, pedestalling, and other excessive soil movement is uncommon.

Note: Vegetation should prevent formation of these erosional features Old rills and gullies should be revegetated.

Mineral Cycle

Parameter 9. Plant cover and litter create a micro-site environment conducive to biological breakdown.

Note: Dead plant material should decompose rather than oxidize on the stem. In order for this to happen it needs contact with the soil surface. Is dung breaking down rapidly, or does it remain intact for years?

Parameter 10. Biological soil crusts and nitrogen-fixing forbs and shrubs are present as in the reference condition.

Note: Nitrogen-poor grasslands will be yellow-green in colour and dung/urine patches will show up as a deep green. Biological soils crusts are essential in the carbon and nitrogen cycles.

Notes:

Land uses that are beyond the control of the range user must be identified.

Current and Desired Plant Communities: Describe both the current and desired plant communities in enough detail to create a word picture.

Seeps, springs, and microsites. Do springs and seeps support phreatophytic plants?

References

Lewis, L., L. Clark, R. Krapf, M. Manning, J. Staats, T. Subirge, L. Townsend, and B. Ypsilantis. 2003. Riparian area management: riparian-wetland soils. Bureau of Land Management, Denver, Colo. Technical Reference 1737-19.

Prichard, D., J. Anderson, C. Correll, J. Fogg, K. Gebhardt, R. Krapf, S. Leonard, B. Mitchell, and J. Staats. 1998. Riparian area management: a user guide to assessing proper functioning condition and the supporting science for lotic areas. Bureau of Land Management, Denver, Colo. Technical Reference 1737-15.

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Preface

This guide is intended for field use and to supplement the Ministry of Forests and Range training courses in rangeland monitoring, rangeland assessments, designing remedial measures, rangeland soils, and grass identification. It is modified from the Ministry of Forests and Range Rangeland Health series of brochures available at http://www.for.gov.bc.ca/hra/brochures/.

Electronic versions of the function checklists for use with ArcPad 6.03 are available on the Coastal Resource Management web site at http://www.crmltd.ca/Crm948/.

Table of Contents

Figures

Section 1 Assessing Rangeland Resources

1.1 Introduction

This Field Guide gives instructions on how to evaluate and monitor the health of rangeland in British Columbia.

The overall objectives for range management are:

- to maintain healthy functioning riparian and upland systems
- to restore and maintain desired plant communities through proper management
- to ensure that there will be no net loss of native species
- to allow safe levels of use

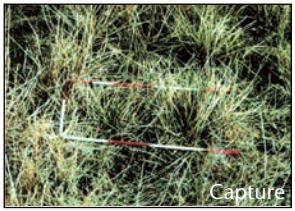
The range use plan identifies how range will be managed to achieve goals related to production, biodiversity, and integrated resource management. The initial range use plan and management prescription is developed from an interpretation of baseline information and records of historic use. Follow-up monitoring is required to evaluate the effectiveness of the management prescription and tenure holder compliance.

1.2 Definitions and Principles

1.2.1 What is a watershed?

A watershed is land on which water falls from the atmosphere, is stored within the soil, and over a period of time is released downslope to other locations. Each watershed is a catchment area divided from the next watershed by topographic features.

A watershed's primary functions are to capture, store, and safely release water.



Capture is the process of water getting from the atmosphere into the soil. As a general principle, precipitation should infiltrate the soil where it falls.

Storage. Water that has infiltrated the soil is stored between particles in the soil profile. The storage capacity of the soil depends on soil texture, depth, and structure. Water in excess of field capacity will either percolate deeply, or run off the soil surface.

Safe release. Water moves through the soil profile to seeps, springs, and finally to streams and rivers. The amount and rate of water released depends on two factors:

- the water already in the soils of the uplands, riparian areas, and streambanks in excess of field capacity
- precipitation that exceeds the infiltration rate and flows over the soil surface

1.2.2 Riparian areas

The **riparian area** is defined in the *Forest and Range Practices Act*, Range Planning and Practices Regulation as an area of land that: "(a) is adjacent to a stream, river, lake or wetland, and (b) contains vegetation that, due to the presence of water, is distinctly different from the vegetation of adjacent upland areas." Riparian areas vary in width and may extend beyond the bounds of the **Riparian Management Area** defined for timber harvesting and silvicultural activities. Livestock grazing is allowed within riparian areas.

Presence of water with distinct vegetation.

1.2.3 Desired plant community (DPC)

The DPC is defined as a plant community that produces the kind, proportion, and amount of vegetation necessary for meeting range use plan and higher-level plan objectives. The DPC must be consistent with the site's capability.

1.2.4 Stream channel characteristics

- steep-gradient streams need boulders, deep-rooted trees or shrubs for stability
- low-gradient streams can be stabilized by strongly rooted grasses, sedges, and rushes
- some stream channels are controlled by coarse woody debris (look for the presence of woody debris with deposition of sediments)
- some stream channels are controlled by large cobbles and boulders; these do not need vegetation for bank stability
- some streams are naturally unstable because of gradient and confinement

1.3 Assessment Procedures

(*See also Procedures for Environmental Monitoring in Range and Wildlife Habitat Management Guidelines [HMGs], Chapters 2.3 and 3.*)

1.3.1 Pre-assessments

- gather historic records (photos, maps, monitoring records, field inspection reports, grazing schedules, current range use plans)
- using maps or aerial photos, pre-stratify the range agreement area by areas of primary use, secondary use, and non-use
- identify areas requiring special treatment or demanding special attention (riparian areas, wildlife habitat areas, recreation areas, recently planted cutblocks, community watersheds, etc.)

- identify (mark) range developments on the maps
- develop/review desired plant community descriptions for the major vegetation types within the tenure area
- inquire of appropriate agencies re: special needs, new concerns, etc.

1.3.2 Field assessments

- the level of detail will be dictated by the actual livestock use
- do not spend a lot of time on areas that livestock use lightly
- focus on areas of primary use (of particular interest will be areas of early spring use, riverine riparian zones, and individual significant wetlands and wetland complexes)
- carry out a reconnaissance of the area:
  - verify locations of developments (update)
  - verify patterns of use by livestock
  - use the appropriate checklists to determine if uplands and wetlands are functioning properly and whether desired plant community goals are being achieved
  - note any changes in conditions of range and riparian areas (do visual estimates of plant species cover; compare to benchmarks)
- get a general overview of how well current management is working
- make field notes and compare to inspection reports from previous years
- establish some fixed photo-points where needed
- compare observations over time
- if a reconnaissance indicates some problems, establish some permanent transects or sampling points using the HMGs or other approved methods
- review the data
- compare to range reference areas if they exist

Figure 1 is an example of how a range agreement area might be zoned during an inspection.

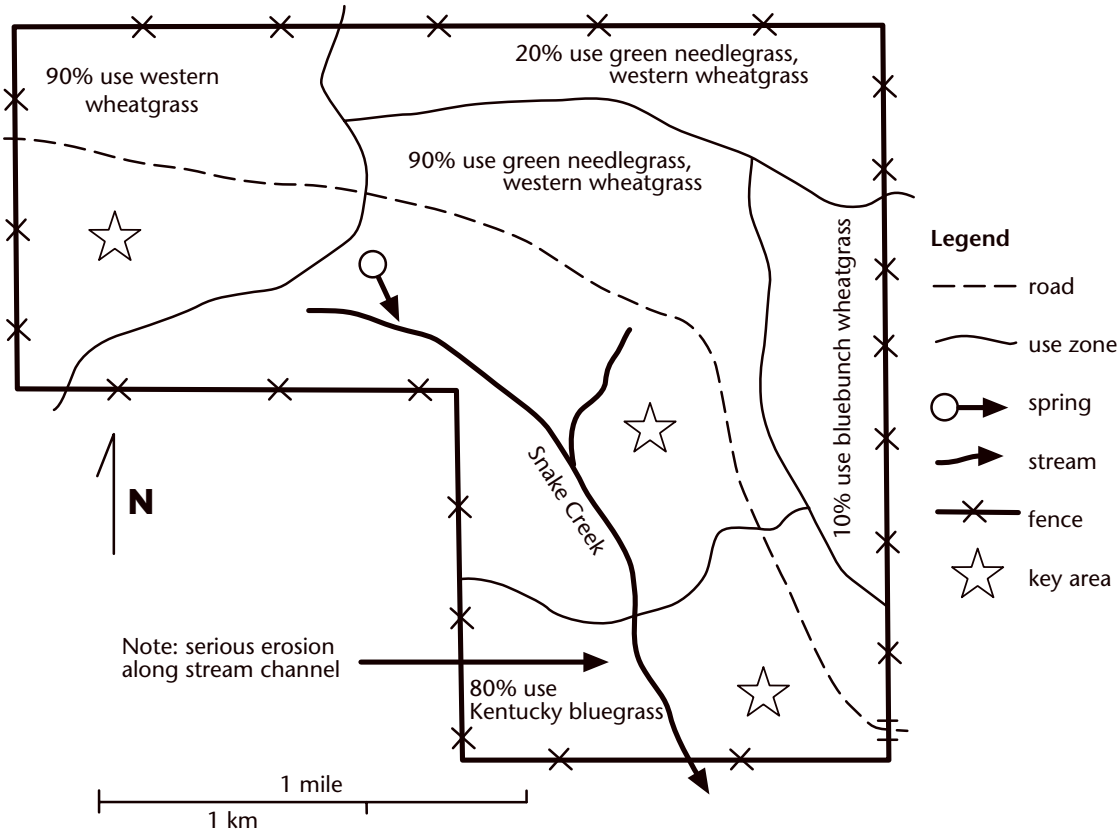
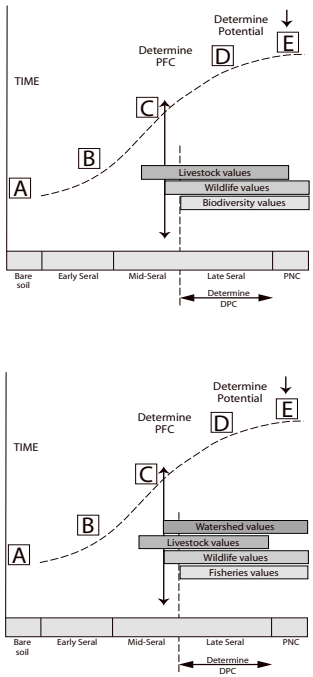


Figure 1 A sketch map of a pasture illustrating a typical pattern of use as represented by zones and data recorded during a reconnaissance.

1.4 Determining Site Potential

Knowledge of site potential is essential to the setting of realistic management goals and the development of appropriate management prescriptions.

- consider the regional climate and site micro-climate
- consider the disturbance regime of the site
- look for comparable relic areas (exclosures, reserves)
- search the files for notes and historic photos. These records are not necessarily something to strive for, but may give insight into the current condition of the site. Photos may show evidence of forest encroachment or ingrowth, changes in wetlands and streams, and the results of changes in management.
- examine the profile and texture of the soils
- examine stream floodplains and channels and observe changes that have occurred; note whether or not a stream seems to have experienced frequent or infrequent catastrophic flooding events
- look for evidence of large organic debris collecting sediment
- determine potential natural community (PNC) based on above information



Determining DPC in upland and riparian areas.

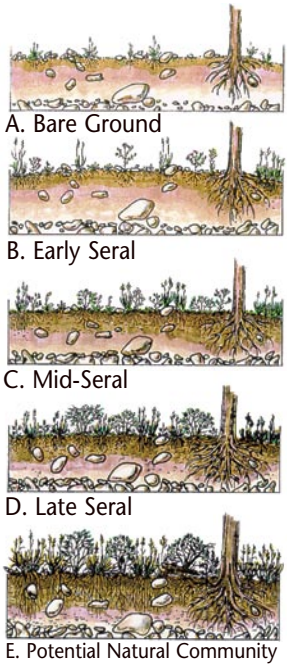
The **PNC** is defined as the community that would become established on an ecological site if all successional sequences were completed without interference by humans under present environmental conditions. Natural disturbances are inherent in its development. The PNC may include naturalized non-native species.

A **desired plant community (DPC)** must be described in the range use plan for each major riparian and upland vegetation type and ideally should include:

- the seral stage (early-seral, mid-seral, late-seral, and PNC-climax)
- the mix of species and species' age-classes (including regenerating plants)

- the horizontal and vertical distribution of foliage (structural characteristics determined by the development of vegetation layers and plant growth forms)
- connectivity
- the amount and distribution of residual cover, basal cover, surface litter, and coarse woody debris

1.5 Questions Concerning a Riparian or Upland Assessment

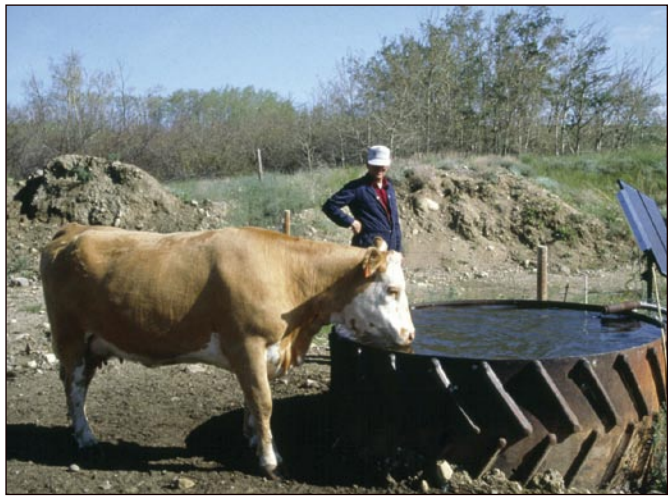


Succession on uplands.

- is the range use plan being followed?
- have recent events (drought, fire, grasshoppers, logging, failed beaver dams, flooding, etc.) influenced the watershed?
- which areas have the greatest potential for positive vegetation response (increased productivity and species diversity)?
- in which areas will vegetation succession occur quickly?
- what pathways will succession take? (seral stages, PNC)
- on degraded sites, how long will recovery take in the absence of livestock use? how long will it take with improved livestock management?
- which areas have the greatest potential for increased AUMs? (animal unit months; for more information on AUMs see Section 5.)
- which riparian zones have the greatest capacity for storing subsurface water and regulating stream flow? (this relates to soil texture, soil depth, and field capacity)
- which streams or wetlands have the greatest potential for filtering and storing sediment and improving water quality? (this relates to soil texture and depth)

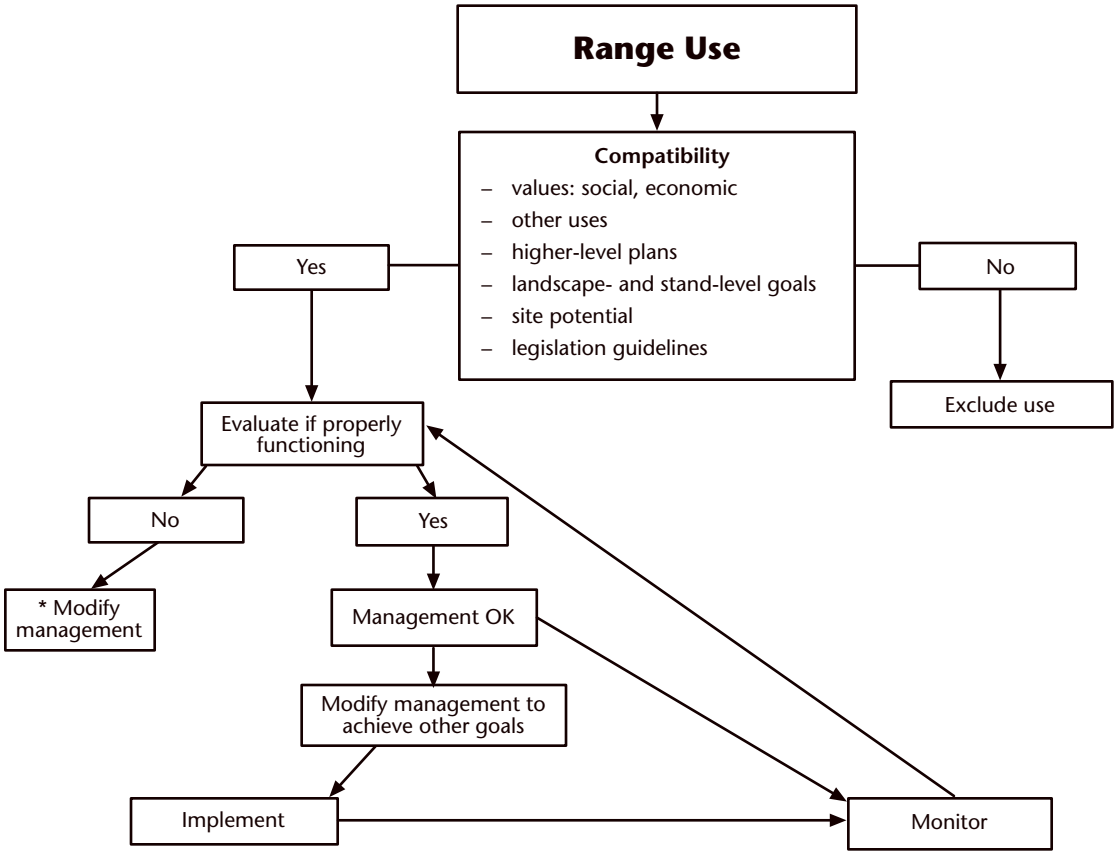
- how can the preferred timing and intensity of livestock use be determined?
- what constitutes overgrazing[1] on any given area?
- to what degree do geologic and hydrologic events operate independently of grazing? (natural down-cutting of stream channel, landslides, flooding)
- what positive effects might we expect from initiating new grazing systems, changing season of livestock use, and modifying livestock or wild ungulate behaviour?

Figure 2 indicates the relationship between monitoring and management of livestock use in range and riparian areas.



Water is an effective attractant.

1 Overgrazing is defined as defoliation that is so severe and/or frequent that the grazed plant is unable to fully recover before being defoliated again. This leads to reduced vigour and competitiveness and eventually to death and replacement of the plant by other, more adapted species. Overgrazing may apply to individual plants and/or to the plant community as a whole.



* Tools (more on tools in section 1.7)
- Time (season, duration, frequency)
- Rest
- Intensity (level of use)
- Distribution (fence, salt, ride, water development, electronic stimuli)
- Other disturbances (fire, mowing, clearing, spraying, scarifying, planting, seeding)
- Bank stabilization
- Stock rate

Figure 2 Evaluating livestock use of riparian and upland areas.

1.6 The Concept of Properly Functioning Condition

Upland and riparian-wetland areas influence aquatic resources; therefore, grazing management must be integrated with the management of the entire watershed. The achievement of properly functioning condition and desired plant communities in riparian-wetland areas and uplands contributes the physical and biological characteristics necessary to restore and maintain aquatic habitats.

1.6.1 Assessing for properly functioning condition

A number of forms and checklists are found in Section 1.8. These should be reviewed in advance of fieldwork, and any necessary file or historic information should be gathered and recorded at that time. Generally, you should get a feel of the area by walking a stream reach or traversing an upland area before filling in the checklists or forms; this will help to gain a broader perspective that otherwise may be lost if you become too concerned with making notes. Look for relic areas or areas where livestock use has been light in order to determine site potential.

The **function checklists** may be used to quickly assess for properly functioning condition at a reconnaissance level. To qualify as functioning properly, riparian (including the feature) and upland areas must satisfy the above general conditions, and the answers to the majority of statements in the checklists must be "Yes."

The **forms for extensive monitoring of stream channels, wetlands, and associated riparian areas** are designed for a slightly more detailed level of monitoring, but allow for estimations rather than detailed measurements.

Guidelines for detailed monitoring of riparian and upland Range Reference Areas are being developed.

1.7 Range Management Practices

Riparian and upland systems not functioning properly will require remedial measures (see Section 3). Several tools are available to ensure that cattle are properly managed within and adjacent to riparian areas. Tool selection depends on site suitability, management goals, and overriding regulations. Management options will be discussed through the normal referral process. Improvements must be detectable both visually and quantitatively.

The **key principle** in riparian and upland management is **management of disturbances**:

current plant community + disturbance + time = desired plant community

The following is a list of tools available to the manager.

1.7.1 Time

- season of use
- duration or length of grazing period
- frequency (how often grazing is repeated)

1.7.2 Intensity of use

- level of utilization of key plant species (stubble heights)

1.7.3 Distribution of use

- fencing
- access trails
- barrier placement to prevent trailing, trampling, and congregating
- salting
- riding or herding
- water development outside the riparian zone
- electronic stimuli
- manipulation of upland vegetation to make it more attractive to livestock

1.7.4 Rest

- allow adequate time for plants to recover from grazing events
- allow plants to complete specified phenological stages
- allow soils to dry to the point where hoof damage will not occur
- allow bare soils to revegetate
- allow banks to restabilize

1.7.5 Applied disturbances (subject to regulations and referrals)

- prescribed fire
- mowing
- herbicide spraying
- seeding of herbaceous species
- planting trees and shrubs
- canopy modification through clearing, selective harvesting, thinning, and pruning
- scarification/aeration

1.7.6 Bank stabilization (subject to regulations and referrals)

- mechanical and structural
- rest from use
- plantings and seeding
- use of natural, narrow rocky areas for livestock watering to reduce trampling damage and loitering; if none exists, create one

1.7.7 Channel modification (subject to regulations and referrals)

- restoration of normal channel functions and patterns
- removal of channel obstructions
- placement of channel obstructions

1.8 Function Checklists

How to use the function checklists

The checklists should be reviewed in advance of fieldwork, and any necessary file or historic information should be gathered and recorded at that time. Generally, you should get a feel of the area by walking a stream reach or traversing an upland area before filling in the checklists or forms; this will help to gain a broader perspective that otherwise may be lost if you become too concerned with making notes. Look for relic areas or areas where livestock use has been light in order to determine site potential.

Use the field checklists in assessing properly functioning condition (PFC) at the reconnaissance level. To qualify as functioning properly, riparian (including the feature) and upland areas must satisfy the general conditions outlined in Section 6 of this guide, and the answers to most of statements in the checklists must be "Yes."

An area is "at risk" when functioning at some level, but when a combination of attributes makes it vulnerable. A score of "at risk" may trigger some follow-up action (e.g., more detailed monitoring or a change in management) or, if an upward trend emerges, may verify that the management prescription is working.

An area is "non-functional" when the criteria in Section 6 are not met and degradation is occurring.

The following table can be used to score the area being assessed. Pay particular attention to categories that give borderline answers, because these indicate trend and may serve as either early warnings or indicators of recovery in damaged systems.

% of "Yes" answers	Rating
80%	PFC
61–79%	Slightly at risk
41–60%	Moderately at risk
20–40%	Highly at risk
20%	Non-functional

To complete the Function Checklists, observe and consider the following in addition to the indicators listed on the checklists.

Lakes, Ponds, and Wetlands—Riparian Function Checklist

Hydrologic

1. Water levels have remained unchanged over time.

   Note: What is the source of water for this wetland? Is it overland flow, groundwater, or channel flow? Is this a beaver-influenced wetland? Has the hydrology been influenced by land management practices in the watershed? Willows indicate the average high watermark for many wetland types.

Biotic/Vegetation

1. The plant community is showing good vigour and maintenance of riparian soil moisture characteristics.

   Note: Check for vigour and recruitment of phreatophytes.

2. Diversity and structure of the riparian and emergent vegetation has been maintained.

   Note: Widths of riparian and emergent vegetation bands will fluctuate annually. Monitor for long-term changes.

3. The plant community is adequate to filter sediments and pollutants.

   Note: Healthy bands of riparian and emergent vegetation are effective in reducing turbidity and capturing pollutants.

4. Occurrences of trampling, rubbing, or browsing are uncommon.

Lakes, Ponds, and Wetlands Riparian Function Checklist

Range Unit:		Range Agreement Holder:	
		Range Agreement Number:	
UTM Coordinates:		BEC Subzone:	
Name of Riparian-Wetland Area:			
Date:		Segment ID:	
Classification of Lake or Pond:			
Type of Wetland (<2 m depth): Marsh ☐ (beaver-ponded; fresh water; saline; closed basin) Swamp ☐ Bog ☐ Fen ☐ Shrub-carr ☐			
Observers:			
Yes	**No**	**N/A**	**Parameters**
			Hydrologic
			Water levels have remained unchanged over time (willow fringe or willow skeletons)
			Biotic/Vegetation
			The plant community is showing good vigour and maintenance of riparian soil moisture characteristics
			Diversity and structure of the riparian and emergent vegetation has been maintained
			The plant community is adequate to filter sediments and pollutants
			Occurrences of trampling, rubbing, or browsing are uncommon
			Adequate vegetation cover is present to protect banks
			A diversity of vertebrate and invertebrate life is evident
			The riparian plant community is an adequate source of large woody debris, both now and for the foreseeable future
			Erosion/Deposition
			Bank shearing, soil compaction, and bare ground are uncommon
			Soil erosion and deposition in the wetland and riparian area are within natural levels
			Hummocks are rounded and completely vegetated
			Nutrient Inputs and Water Quality
			Nutrient levels are normal (there is a lack of algal mats and organism die-offs and there is a good aquatic species diversity)
			Inputs of fine organic matter are appropriate (leaves, small branches, and twigs)

Check one

☐ PFC

☐ At risk

☐ Non-functional

Notes:

Is the desired plant community present (diversity—species, composition, age classes, structure, form)?

Soil types and textures?

Are the riparian soils subjected to prolonged saturation and anaerobic conditions?

Is this wetland part of a beaver-controlled riparian system?

Note: Is the vigour of the vegetation being reduced by these? Is trampling occurring around the entire perimeter, or is it limited to a few watering locations?

5. Adequate vegetation is present to protect banks.

   Note: There should be adequate vegetation to protect the banks from the actions of winds and waves.

6. A diversity of vertebrate and invertebrate life is evident.

   Note: Low species diversity may be an indication of a problem. Consider both the wetland and the riparian zone.

7. The riparian plant community is an adequate source of large woody debris, both now and for the foreseeable future.

   Note: Woody species are present and able to contribute to the stream system. There are new recruits to replace those that have fallen.

Erosion/Deposition

1. Bank shearing, soil compaction, and bare ground are uncommon.

   Note: If evident, is it to a watering site, or does it occur around the entire wetland?

2. Soil erosion and deposition in the wetland and riparian area are within natural levels.

   Note: Soil erosion and deposition outside natural levels may indicate a problem with the surrounding uplands.

3. Hummocks are rounded and completely vegetated.

   Note: Hummocks can be created by livestock trampling. However, some species of sedge create their own hummocks to avoid prolonged saturation. Hummocks should be rounded and completely vegetated.

Nutrient Inputs and Water Quality

1. Nutrient levels are normal.

   Note: Is there excessive livestock dung? Are there thick algal mats? Is there evidence of organism die-offs? Does the invertebrate population indicate a worsening in habitat or water quality (species shifts, lower diversity)?

2. Inputs of fine organic matter are appropriate.

   Note: Does detritus form an integral part of the food chain?

To complete the Function Checklists, observe and consider the following in addition to the indicators listed on the checklists.

Streams Riparian Function Checklist

Channel Structure, Function, and Diversity

1. Channel characteristics and associated floodplain are adequate to dissipate energy.

   Note: Is stream energy naturally dissipated through the presence of rocks/boulders, large woody debris, shrubs/sedges, or natural sinuosity? Does the stream have easy access to its floodplain during high flow?

2. Channel and banks are relatively stable.

   Note: Channels and banks are not static; it is natural for channels to move and evolve over time. Do not confuse natural channel movement with accelerated change. Bank undercutting should be balanced by bank building on the opposite side.

3. Lateral movement is associated with natural sinuosity.

   Note: Do not confuse natural sinuosity with accelerated lateral movement across the floodplain. Lateral erosion leads to an increase in channel width.

4. Erosion, deposition, and movement of bed materials are normal for this reach.

Streams Riparian Function Checklist

Range Unit:			Range Agreement Holder:
			Range Agreement Number:
UTM Coordinates:			BEC Subzone:
Name of Stream:			
Date:		Segment/Reach ID:	Gradient of Segment: Low ☐ Medium ☐ High ☐
Stream Type:			Perennial ☐ Intermittent or Ephemeral ☐ Continuous or Interrupted ☐
Observers:			
Yes	**No**	**N/A**	**Parameters**
			Channel Structure, Function, and Diversity
			Channel characteristics (rocks, large woody debris) and associated floodplain (access to overflow areas) are adequate to dissipate energy
			Channel and banks are relatively stable
			Lateral movement is associated with natural sinuosity
			The segment is vertically stable
			Erosion, deposition, and movement of bed materials are normal for this reach
			Bank shearing, soil compaction, and bare ground are uncommon
			Sinuosity, width/depth ratio, gradient, pool/riffle ratio, and other aspects of channel geometry are in balance with the landscape setting (e.g., landform, geology)
			Inputs of organic debris from adjacent riparian area and subsequent incorporation into the channel are normal for area
			Banks are undercut
			Riffle-bed materials and gravels are free of sediment. Fish spawning and use of rock undersides by insects and other invertebrates are possible
			Flow Regime
			Flow rates and timing remain unchanged over time (i.e., perennial to intermittent or ephemeral; continuous to interrupted)
			Biotic Community
			Roots of trees, shrubs, and grasses extend into the stream. Root masses are capable of withstanding high streamflow events and allowing formation of overhanging banks
			The plant community exhibits high vigour and indicates maintenance of riparian soil moisture characteristics
			Occurrences of trampling, rubbing, or browsing are uncommon
			Riparian plant communities are an adequate source of replacement woody debris, both now and in the foreseeable future
			A diversity of vertebrate and invertebrate life is evident
			Nutrient Inputs and Water Quality
			Nutrient levels are normal (there is a lack of algal mats and organism die-offs, and there is a good aquatic organism diversity)
			Inputs of fine organic matter are appropriate (leaves, small branches, and twigs)

Check one

☐ PFC

☐ At risk

☐ Non-functional

Notes:

Is the desired plant community present (diversity—species, composition, age classes, structure, form)?
Does the substrate make this stream susceptible to either vertical or lateral erosion?
Soil types and textures?
Are the riparian soils subjected to prolonged saturation and anaerobic conditions?
Is the stream beaver-controlled?
Is the stream effluent or influent?
Have land uses altered the dynamics of the system?

Note: Is meander erosion balanced by point bar deposition? Are point bars revegetating? Is there evidence of excessive movement of bed materials, as indicated by extensive riffles?

5. Bank shearing, soil compaction, and bare ground are uncommon.

   Note: Some bank collapse will be related to natural undercutting, but, on the whole, bank collapse, compaction/trampling, and bare ground should be minimal. Is trampling to a point water source or along the entire reach?

6. Sinuosity, width/depth ratio, gradient, pool/riffle ratio, and other aspects of channel geometry are in balance with the landscape setting.

   Note: Sinuosity should be balanced with the slope and landscape position of the stream. Is the channel deep relative to its width? Pools should represent 2/3 of the length of any reach; riffles should represent 1/3 the length of any reach. The sequence of pools and riffles should repeat itself every five to seven bankfull widths. Pools should be fine-textured and deep, and riffles should be coarse-textured and shallow. Excessive riffle length is evidence of excessive movement of bed materials. Channel bars should be at the margins, not in mid-channel.

7. Inputs of organic debris from the adjacent riparian area and subsequent incorporation into the channel are normal for the area.

   Note: Are trees and shrubs being incorporated by natural mortality and windfall at a normal rate?

8. Banks are undercut.

   Note: Are undercut banks appropriate for the stream segment? Consider the gradient, bank texture, and bed materials.

9. Riffle-bed materials and gravels are free of sediment. Fish spawning and use of rock undersides by insects and other invertebrates are possible.

Note: Look at rock undersides for evidence of invertebrate life. Water temperature, purity, and turbidity will influence the invertebrate species found there.

Flow Regime

1. Flow rates and timing remain unchanged over time.

   Note: Any water control structures will influence flow rates, timing, and sediment loads (and the ability to rebuild banks). Has the stream changed from permanent to intermittent or ephemeral, or from continuous to interrupted?

Biotic Community

1. Roots of trees, shrubs, and grasses extend into the stream. Root masses are capable of withstanding high-streamflow events and allowing formation of overhanging banks.

   Note: Are there overhanging banks? Are there deep-rooted sedges as opposed to shallow-rooted grasses on the streambank? Do the root masses of shrubs or trees extend into the channel, influencing its depth and direction of flow? Check the soil texture. Willows require coarse-textured substrates and will not grow in oxygen-poor soils. Sedges will grow in anaerobic conditions.

2. The plant community exhibits high vigour and indicates maintenance of riparian soil moisture characteristics.

   Note: Are the species present vigorous riparian species, or have upland species encroached?

3. Occurrences of trampling, rubbing, or browsing are uncommon.

   Note: Excessive trampling leads to soil compaction and poor water infiltration. Trampling, rubbing, and browsing will reduce the vigour of the plant community.

4. Riparian plant communities are an adequate source of replacement woody debris, both now and in the foreseeable future.

Note: Woody species are present and able to contribute to the stream system. There are new recruits to replace those that have fallen.

5. A diversity of vertebrate and invertebrate life is evident.

   Note: This diversity occurs in both the stream itself and in the riparian zone.

Nutrient Inputs and Water Quality

1. Nutrient levels are normal.

   Note: Is there excessive livestock dung? Are there thick algal mats? Is there evidence of organism die-offs? Does the invertebrate population indicate a worsening in habitat or water quality (species shifts, lower diversity)?

2. Inputs of fine organic matter are appropriate.

   Note: Does detritus form an integral part of the food chain?

To complete the Function Checklists, observe and consider the following in addition to the indicators listed on the checklists.

Uplands Function Checklist

Hydrologic and Soils

1. Organic matter protects soil surfaces from raindrop impact and evaporative effects of sun and wind.

   Note: Most of the ground surface should be protected by live vegetation or dead plant material.

2. Water will easily infiltrate the soil surface.

   Note: Soil surface conditions should allow for precipitation to penetrate. Soil crusting or capping should not occur.

3. Subsurface soil conditions support infiltration.

   Note: Check for soil compaction or impenetrable layers.

Uplands Function Checklist

Range Unit:			Range Agreement Holder:
			Range Agreement Number:
UTM Coordinates:			BEC Subzone:
Name of Upland Area:			
Date:			Location:
Hectares:			
Observers:			
Yes	**No**	**N/A**	**Parameters**
			Hydrologic and Soils
			Organic material (plant litter, standing vegetation) protects soil surface from raindrop impact and evaporative effects of sun and wind
			Water will easily infiltrate the soil surface (absence of physical soil crusting, capping)
			Subsurface soil conditions support infiltration (compaction layers are uncommon)
			Standing vegetation and plant litter detain overland water flow and trap sediment
			Non-stream ephemeral drainages are stable (sufficient vegetation is present to protect against downcutting)
			Biotic/Vegetation
			The plant community is showing good vigour
			There is recruitment of desirable plant species (new seedlings)
			The plant community reflects a fully occupied root zone
			Seeps, springs, and ephemeral drainages support vigorous stands of phreatophytic* plants
			Biological breakdown of plant residues / organic material is apparent (decomposition as opposed to oxidization)
			Biological breakdown of livestock dung is rapid
			A diversity of vertebrate and invertebrate life is evident
			Erosion/Deposition
			Evidence of rills, gullies, pedestalling, and other excessive soil movement is uncommon
			There is little visual evidence of pedestalling of plants or rocks. Pedestals present are sloping or rounding and accumulating litter

Check one

☐ PFC

☐ At risk

☐ Non-functional

Notes:

Is the desired plant community present (diversity—species, composition, age classes, structure, form)?

Soil types and textures?

* Phreatophytic plants obtain their water from the water table

4. Standing vegetation and plant litter detain overland flow and trap sediment.

   Note: There is no sign of rilling.

5. Non-stream ephemeral drainages are stable.

   Note: These drainages are well vegetated and show no sign of rills.

Biotic/Vegetation

1. The plant community is showing good vigour.

   Note: Proper growth form and stature. Good seed production.

2. There is recruitment of desirable plant species. Deep-rooted perennial plants should dominate the plant community.

   Note: This refers to native decreaser species.

3. The plant community reflects a fully occupied root zone.

   Note: Dig a soil pit. Roots should penetrate deeply into the soil profile.

4. Seeps, springs, and ephemeral drainages support vigorous stands of phreatophytic plants.

   Note: These are plants that place their roots in the water table.

5. Biological breakdown of plant residues/organic material is apparent.

   Note: Dead plant material should decompose rather than oxidize on the stem. For for this to happen, it needs to make contact with the soil surface.

6. Biological breakdown of livestock dung is rapid.

   Note: Is dung breaking down rapidly, or does it remain intact for years?

7. A diversity of vertebrate and invertebrate life is evident.

   Note: Consider soil organisms, insects, and vertebrates

Erosion/Deposition

1. Evidence of rills, gullies, and other excessive soil movement is uncommon.

   Note: Vegetation should prevent formation of these. Old rills and gullies should be revegetated.

2. There is little evidence of pedestalling of plants or rocks. Pedestals present are sloping or rounding and accumulating litter.

   Note: This is evidence of recovery.

How to fill out "Description of Plant Communities and Habitats"

1. Browse utilization and form class

At each site, record the major shrub species, estimate the current browse use, and describe the form class (an indication of past use).

2. Current and desired plant community descriptions

At each site, describe the current and desired plant community by layers, and by dominant and co-dominant species, and estimate the current seral stage. Seral stage is defined as the plant community's similarity to the potential natural community (PNC)-climax, which is considered to be the site's potential. Seral stage categories have the following ranges:

	Early-seral	**Mid-seral**	**Late-seral**	**PNC-climax**
% similarity to PNC-climax	0–25%	25–50%	50–75%	>75% climax

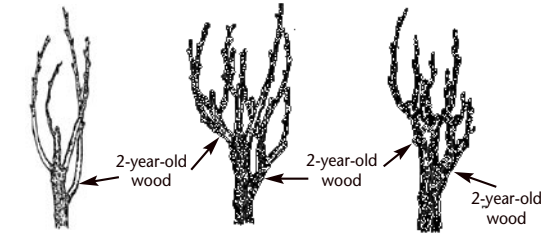
3. Stubble height measurements

Surveyors establish a line transect and use a "point" sampling procedure. The surveyor walks a transect and, at an interval of five paces, records the indicator grass or sedge species that lies closest to the toe of the right boot. Depending on the uniformity of stubble height, from 20

Description of Plant Communities and Habitats

Browse Utilization

List of Preferred Browse Species On Site	Browse Use Categories—Current Year's Growth		
	Light 0–10%	Moderate 11–40%	Heavy >40%



Current Plant Community

Desired Plant Community

Stubble Height

____ m transect. Measurements taken every ____ paces.

Pattern of Use:

Measurements:

Max. height ☐ Min. height ☐ Avg. height ☐

Max. height ☐ Min. height ☐ Avg. height ☐

Max. height ☐ Min. height ☐ Avg. height ☐

Max. height ☐ Min. height ☐ Avg. height ☐

Robel Pole Measurements

___ m transect.

Measurements taken every ___ paces.

Max: ____ Min: ____ Average: ____

Photo Numbers: _____

Invasive Plants
Species: _____

Size of Infestation: <100 m^2 ☐
100–2500 m^2 ☐
>1 ha ☐

Distribution: Rare individuals ☐
Scattered patches ☐
Continuous stands ☐

Notes – (Plant community, structure, recruitment, litter, bare ground, invasive species)

to 80 measurements are taken along each transect. Leaf length is recorded for each plant sampled.

Stubble height is reported as a minimum, a maximum, and an average. This assumes that, under normal grazed conditions, there will be a patchy pattern of use with some plants grazed completely, some moderately, and some not at all. This stubble height is compared to the minimum stubble heights criteria in the range use plans and to the recommended stubble heights tables in the guidebooks.

4. Visual obscurity (VO) measurements[2,3]

In addition to the stubble height measurements, 10 VO measurements are taken using a Robel pole along the same transect. A VO reading is taken every 20 paces.

A Robel pole is a modified surveyor's range pole, 3 cm in diameter and 120 cm in length. The pole is marked in alternating 2.54 cm (1") coloured bands. A 4-m cord is attached to the pole at a height of 1 m on one end and to a metre stick at the other end. This standardizes the distance and height at which readings are taken. One surveyor holds the Robel pole while another surveyor extends the cord and takes two readings along the transect line, following the ground contour. The reading or VO measurement is recorded as the highest band that is totally obscured. Readings are averaged at each location.

VO is a good measure of hiding cover for ground-nesting birds and small mammals. For example, sharp-tailed grouse and upland-nesting

2 U.S. Bureau of Land Management. 1999a. Utilization studies and residual measurements. Interagency Tech. Ref. 1734-3.

3 U.S. Bureau of Land Management. 1999b. Sampling vegetation attributes. Interagency Tech. Ref. 1734-4.

ducks such as mallards and pintails need a VO reading of 10 for adequate nesting. Smaller species require less cover.

5. Invasive plant species

List invasive plants where found, and record the size and distribution of the infestation.

6. Photos

Take representative photos at each site and record the photo numbers on the form.

1.9 Forms for Extensive Monitoring of Stream Channels, Wetlands, and Associated Riparian Areas

Forms for extensive monitoring of stream channels, wetlands, and associated riparian areas are designed for a slightly more detailed level of monitoring, but allow for estimations rather than detailed measurements.

It is important to monitor stream channels, wetland features, and adjacent riparian areas to assess whether livestock use is affecting riparian functions (stream channel dynamics, water quality, plant communities, and soils). These forms can be used as tools for extensive (rather than intensive) monitoring of riparian features and zones; for example:

- to acquire an overview of riparian health within a range tenure or larger range unit
- to identify areas with serious, but correctable, livestock management problems
- to identify areas where problems and solutions are not readily apparent and therefore require more detailed monitoring
- to detect change, early on, before serious damage occurs

Wetlands in properly functioning condition.

Poorly functioning.

Non-functioning.

Where possible, do annual inspections along with representative photos.

After several years of observations, you should be able to determine if the stream channel or wetland and associated riparian zones are on a upward, stable, or downward trend.

For streams, management changes and remedial measures may be required if you observe:

- a widening channel
- channel downcutting
- more than 10% eroding or trampled banks
- increasing frequency of new streambars, noxious weeds, or unvegetated streambanks
- a change in plant species composition (encroaching upland grass or shrub species)
- lack of shrub and tree regeneration
- hedged shrubs

For wetlands, observe any changes:

- in the widths of emergent and riparian vegetation bands
- in plant species composition, structure, or form
- in soils (trampling, bare ground, hummocks)

Consistency is the key to obtaining useful information; the same person should collect the information at the same time each year. Monitoring should be done immediately after livestock grazing in the streamside area. If you rest the pasture, collect the information at about the same time of year as you did the previous year. If the pasture is very large or if stream characteristics vary considerably, sample by stream reach (a length of relatively homogeneous channel and vegetation). If possible, compare your findings with an ungrazed portion of the same stream or a similar riparian range reference area.

Where large segments (>10%) of a stream/wetland and associated riparian area fail to meet the *Riparian Management Area Guidebook* recommendations, permanent and more detailed monitoring transects and photo-points should be established.

The forms should be reviewed in advance of field work, and any necessary file or historic information should be gathered and recorded at that time. Generally, you should get a feel of the area by walking a stream reach or traversing an upland area before filling in the checklists or forms; this will help to gain a broader perspective that otherwise may be lost if you become too concerned with making notes. Look for relic areas or areas where livestock use has been light in order to determine site potential.

Observer _____

Date _____

STREAM AND RIPARIAN AREA MONITORING - Extensive

Stream Name _____

BCGS Map Number _____ Air Photo Number(s) _____

Sampling Site Location (stream reach) _____

Permanent Photo-points (describe locations):

(1) Channel cross-section: _____

(2) Channel and riparian area overview (take from high point): _____

Current Year Weather Conditions: Dry □ Normal □ Wet □

I. STREAM CHARACTERISTICS

1. Channel gradient (Circle)

   a. Low (<2%) b. Medium (2–4%) c. High (>4%)

2. Channel characteristics (Circle)

   a. Entrenched b. Non-entrenched

   (*See glossary*)

3. Floodplain characteristics (Circle)

   a. Confined b. Non-confined

   (*See glossary*)

4. Type of stream in a normal year (from historical records) (Circle)

   a. Perennial b. Intermittent c. Ephemeral

   (i) Continuous (ii) Interrupted

   (*See glossary*)

5. Streambed texture (Circle)

   a. Silt b. Sand c. Gravel d. Cobble

6. Stream meander pattern (Circle)

   a. Straight b. Slightly sinuous c. Meandering d. Braided

   (*See glossary*)

7. Estimate channel width (to the closest .5 m). Estimate between high water-marks on straight sections of stream.

   a. Narrowest ____m b. Widest _____m c. Average _____m

   (*Do a series of estimates to obtain an average width. Channel widening may indicate lack of adequate stabilizing vegetation, increased streamflows, and/or increased sediment.*)

8. Estimate bank height on the outside of each meander, from the current water level to the top of the bank.

   _____m

   (*Steep, raw banks may indicate that the channel is deepening or downcutting due to increased streamflows and/or increased sediment.*)

9. Determine streambank characteristics after walking the entire stream reach. Estimate to the closest 10%.

   _____% of banks breaking off or eroding _____% (surface area) of stream channel shaded

10. Note number of new, unvegetated streambars per 100-m stream reach. (Circle)

    a. None b. Occasional c. Frequent

    (*If frequency of streambars is increasing, streamflows and/or sediment may be increasing.*)

II. VEGETATION INFORMATION

11. Estimate foliar cover in a 2-m strip outward from the streambank edge to within 10% (can sum to >100%).

    _____% Conifer or deciduous trees _____% Shrubs

    _____% Herbaceous (grasses, sedges, forbs)

    (*Recent aerial photos may be helpful.*)

12. Estimate amount of bare ground or rock (non-vegetated surface) exposed along a 2-m strip outward from the streambank edge (to the nearest 10%).

    _____ %

13. Estimate the average width of the riparian community (from the streambank to the beginning of the upland community).

    _____ m

    (*Encroachment of upland species may indicate a dropping watertable.*)

14. Are small shrub and tree seedlings present? (Circle)

    a. None b. Occasional c. Frequent

    (*If no regeneration is occurring, the area is either being overgrazed or site conditions have changed for some reason.*)

15. Note shape of shrubs. Is there evidence of hedging, high-lining, or umbrella-shaped shrubs? (Circle)

    a. None b. Occasional c. Frequent

    (*If occasional or frequent, some overgrazing is occurring.*)

III. UTILIZATION INFORMATION

16. Time of grazing this year (dates)

    from _____ to _____

17. Number of AUMs harvested this year

    _____ AUMs

18. Class of livestock using area

    _____ Yearling _____ Cow/calf _____ Sheep _____ Other

    Specify _____

    _____

19. Estimate amount of wildlife use of shrubs (i.e., as a % of current year's growth). (Circle)

a. None	b. Occasional			c. Frequent		
	light	moderate	heavy	light	moderate	heavy

    (*It is important to distinguish between livestock and wildlife effects to design a proper grazing management system. What signs were used to determine wildlife use?*)

20. Type of wildlife using area

_____ Elk _____ Deer _____ Moose _____ Other

Specify _____

_____

Season(s) of use _____

(*What signs were used to determine wildlife presence?*)

NOTES: Mark location on an aerial photo or map. Make a sketch of the area. Describe any circumstances that may have influenced your findings.

Observer _____

Date _____

WETLAND/LAKE AND RIPARIAN AREA MONITORING - Extensive

Wetland or Wetland Complex Name _____

Sampling Site Location _____

BCGS Map Number _____ Air Photo Number(s) _____

Permanent Photo-points (describe locations):

(1) Transect: _____

(2) Wetland and riparian area overview (take from high point): _____

Current Year Weather Conditions: Dry □ Normal □ Wet □

I. WETLAND CHARACTERISTICS

1. Type of wetland in a normal year (Circle)

   a. Permanent b. Semi-permanent c. Ephemeral

   (*See glossary*.)

2. Wetland characteristics (Circle)

   a. Saline b. Fresh c. Beaver-ponded d. Closed basin

3. Estimate wetland size. _____ ha

4. Estimate width of emergent band of vegetation (reeds and cattails). _____ m

   (*A sketch may be useful*.)

5. Determine wetland edge characteristics after walking the entire perimeter (nearest 10%).

   _____ % of edge severely trampled _____ % of edge banks shaded by shrubs and/or trees

6. Estimate trampling of shallow wetland basin, if applicable. _____ %

II. VEGETATION INFORMATION

7. Estimate foliar cover in riparian area to within 10% (can sum to >100%).

   _____ % Conifer or deciduous trees _____ % Shrubs

   _____ % Herbaceous (grasses, sedges, forbs)

   (*Recent air photos may be helpful*.)

8. Estimate amount of bare ground or rock (non-vegetated surface) in riparian area (nearest 10%).

   _____ %

9. Estimate the average distance from the wetland edge to outer riparian area boundary (the beginning of the upland plant community indicated by dryland species). _____ m (*Encroachment of upland species may indicate a dropping watertable.*)

10. Are small shrub and tree seedlings present? (Circle)

    a. None b. Occasional c. Frequent

    (*If no regeneration is occurring, the area is either being overgrazed or site conditions have changed for some reason.*)

11. Note shape of shrubs. Is there evidence of hedging, high-lining, or umbrella-shaped shrubs? (Circle)

    a. None b. Occasional c. Frequent

    (*If occasional or frequent, some overgrazing is occurring.*)

III. UTILIZATION INFORMATION

12. Time of grazing this year (dates)

    from _____ to _____

13. Number of AUMs harvested this year _____ AUMs

14. Class of livestock using area

    _____ Yearling _____ Cow/calf _____ Sheep _____ Other

    Specify _____

    _____

15. Estimate amount of wildlife use (i.e., as % of current year's browse).

a. None	b. Occasional			c. Frequent		
	light	moderate	heavy	light	moderate	heavy

    (*It is important to distinguish between livestock and wildlife effects to design a proper grazing management system. What signs were used to determine wildlife use?*)

16. Type of wildlife using area

_____ Elk _____ Deer _____ Moose _____ Other

Specify _____

_____

Season(s) of use

(*What signs were used to determine wildlife presence?*)

NOTES: Mark location on an aerial photo or map. Make a sketch of the area. Describe any circumstances that may have influenced your findings.

1.10 Examples of Completed Function Checklists and Extensive Monitoring Forms

Lakes, Ponds, and Wetlands Riparian Function Checklist

Range Unit: Stump Lake CRTP Unit			Range Agreement Holder: Joe Rancher Range Agreement Number: RAN1234
UTM Coordinates:			BEC Subzone: IDFdk1
Name of Riparian-Wetland Area: Smith Lake (East)			
Date: Aug 17 / 1996 Segment ID:			
Classification of Lake or Pond:			
Type of Wetland (<2 m depth):			Marsh ☐ (beaver-ponded; fresh water; saline; closed basin) Swamp ☐ Bog ☐ Fen ☐ Shrub-carr ☒
Observers:			
Yes	**No**	**N/A**	**Parameters**
			Hydrologic
X			Water levels have remained unchanged over time (willow fringe or willow skeletons)
			Biotic/Vegetation
X			The plant community is showing good vigour and maintenance of riparian soil moisture characteristics
X			Diversity and structure of the riparian and emergent vegetation has been maintained
X			The plant community is adequate to filter sediments and pollutants
X			Occurrences of trampling, rubbing, or browsing are uncommon
X			Adequate vegetation cover is present to protect banks
X			A diversity of vertebrate and invertebrate life is evident
X			The riparian plant community is an adequate source of large woody debris, both now and for the foreseeable future
			Erosion/Deposition
X			Bank shearing, soil compaction, and bare ground are uncommon
		X	Soil erosion and deposition in the wetland and riparian area are within natural levels
X			Hummocks are rounded and completely vegetated
			Nutrient Inputs and Water Quality
X			Nutrient levels are normal (there is a lack of algal mats and organism die-offs and there is a good aquatic species diversity)
X			Inputs of fine organic matter are appropriate (leaves, small branches, and twigs)

Check one	
PFC	☑
At risk	☐
Non-functional	☐

Notes;

Is the desired plant community present (diversity—species, composition, age classes, structure, form)?

Soil types and textures?

Are the riparian soils subjected to prolonged saturation and anaerobic conditions?

Is this wetland part of a beaver-controlled riparian system?

Streams Riparian Function Checklist

Range Unit: Stump Lake			Range Agreement Holder: Joe Rancher Range Agreement Number: RAN 1234
UTM Coordinates:			BEC Subzone: IDF dk1
Name of Stream: Stumplake Creek			
Date: Aug 6/96 Segment/Reach ID: above road Gradient of Segment: Low ☒ Medium ☐ High ☐			
Stream Type: Perennial ☐ Intermittent or Ephemeral ☐ Continuous or Interrupted ☐			
Observers: Nancy & Lavonne Zwaygardt and Tamsen Stringham			
Yes	**No**	**N/A**	**Parameters**
			Channel Structure, Function, and Diversity
X			Channel characteristics (rocks, large woody debris) and associated floodplain (access to overflow areas) are adequate to dissipate energy
X			Channel and banks are relatively stable
X			Lateral movement is associated with natural sinuosity
X			The segment is vertically stable
X			Erosion, deposition, and movement of bed materials are normal for this reach
X			Bank shearing, soil compaction, and bare ground are uncommon
X			Sinuosity, width/depth ratio, gradient, pool/riffle ratio, and other aspects of channel geometry are in balance with the landscape setting (e.g., landform, geology)
X			Inputs of organic debris from adjacent riparian area and subsequent incorporation into the channel are normal for area
X			Banks are undercut
	X		Riffle-bed materials and gravels are free of sediment. Fish spawning and use of rock undersides by insects and other invertebrates are possible
			Flow Regime
	X		Flow rates and timing remain unchanged over time (i.e., perennial to intermittent or ephemeral; continuous to interrupted)
			Biotic Community
X			Roots of trees, shrubs, and grasses extend into the stream. Root masses are capable of withstanding high streamflow events and allowing formation of overhanging banks
X			The plant community exhibits high vigour and indicates maintenance of riparian soil moisture characteristics
X			Occurrences of trampling, rubbing, or browsing are uncommon
X			Riparian plant communities are an adequate source of replacement woody debris, both now and in the foreseeable future
X			A diversity of vertebrate and invertebrate life is evident
			Nutrient Inputs and Water Quality
X			Nutrient levels are normal (there is a lack of algal mats and organism die-offs, and there is a good aquatic organism diversity)
X			Inputs of fine organic matter are appropriate (leaves, small branches, and twigs)

Check one	
PFC	☑
At risk	☐
Non-functional	☐

Notes:

Is the desired plant community present (diversity—species, composition, age classes, structure, form)?

Does the substrate make this stream susceptible to either vertical or lateral erosion?

Soil types and textures?

Are the riparian soils subjected to prolonged saturation and anaerobic conditions?

Is the stream beaver-controlled?

Is the stream effluent or influent?

Have land uses altered the dynamics of the system?

Uplands Function Checklist

Range Unit: Stumplake CRMP Unit			Range Agreement Holder: Joe Rancher Range Agreement Number: RAN 1234
UTM Coordinates:			BEC Subzone: IDFdk1
Name of Upland Area: Stumplake Creek			
Date: August 17, 1996			Location: above road
Hectares:			
Observers: Lance and Lavanne Zweygardt and Tamzen Stringham			
Yes	**No**	**N/A**	**Parameters**
			Hydrologic and Soils
X			Organic material (plant litter, standing vegetation) protects soil surface from raindrop impact and evaporative effects of sun and wind
X			Water will easily infiltrate the soil surface (absence of physical soil crusting, capping)
X			Subsurface soil conditions support infiltration (compaction layers are uncommon)
X			Standing vegetation and plant litter detain overland water flow and trap sediment
		X	Non-stream ephemeral drainages are stable (sufficient vegetation is present to protect against downcutting)
			Biotic/Vegetation
X			The plant community is showing good vigour
X			There is recruitment of desirable plant species (new seedlings)
X			The plant community reflects a fully occupied root zone
		X	Seeps, springs, and ephemeral drainages support vigorous stands of phreatophytic plants
X			Biological breakdown of plant residues / organic material is apparent (decomposition as opposed to oxidization)
X			Biological breakdown of livestock dung is rapid
X			A diversity of vertebrate and invertebrate life is evident
			Erosion/Deposition
X			Evidence of rills, gullies, pedestalling, and other excessive soil movement is uncommon
			There is little visual evidence of pedestalling of plants or rocks. Pedestals present are sloping or rounding and accumulating litter

Check one	
PFC	☑
At risk	☐
Non-functional	☐

Notes:

Is the desired plant community present (diversity—species, composition, age classes, structure, form)?

Soil types and textures?

Observer Lance Giovanne Zwaggardo and Taegan Stringham

Date August 17/96

WETLAND/LAKE AND RIPARIAN AREA MONITORING - Extensive

Wetland or Wetland Complex Name Smith Lake

Sampling Site Location East side of hydro line

BCGS Map Number _____ Air Photo Number(s) _____

Permanent Photo-points (describe locations):

(1) Transect: _____

(2) Wetland and riparian area overview (take from high point): _____

Current Year Weather Conditions Dry ☐ Normal ☐ Wet ☒

I. WETLAND CHARACTERISTICS

1. Type of wetland in a normal year (Circle)

   a. Permanent b. Semi-permanent (c.) Ephemeral

   (See glossary.)

2. Wetland characteristics (Circle)

   a. Saline (b.) Fresh c. Beaver-ponded d. Closed basin

3. Estimate wetland size.

   _____ ha

4. Estimate width of emergent band of vegetation (reeds and cattails).

   _____ m solid

   (A sketch may be useful.)

5. Determine wetland edge characteristics after walking the entire perimeter (nearest 10%).

   10 % of edge severely trampled 80 % of edge banks shaded by shrubs and/or trees

6. Estimate trampling of shallow wetland basin, if applicable.

   5 %

II. VEGETATION INFORMATION

7. Estimate foliar cover in riparian area to within 10% (can sum to >100%).

   20 % Conifer or deciduous trees 40 % Shrubs 45 % Herbaceous (grasses, sedges, forbs)

   (Recent air photos may be helpful.)

8. Estimate amount of bare ground or rock (non-vegetated surface) in riparian area (nearest 10%).

   10 %

9. Estimate the average distance from the wetland edge to outer riparian area boundary (the beginning of the upland plant community indicated by dryland species).

   5 m

   (Encroachment of upland species may indicate a dropping watertable.)

10. Are small shrub and tree seedlings present? (Circle)

    a. None (b.) Occasional c. Frequent

    (If no regeneration is occurring, the area is either being overgrazed or site conditions have changed for some reason.)

11. Note shape of shrubs. Is there evidence of hedging, high-lining, or umbrella-shaped shrubs? (Circle)

    a. None (b.) Occasional c. Frequent

    (If occasional or frequent, some overgrazing is occurring.)

III. UTILIZATION INFORMATION

12. Time of grazing this year (dates)

    from June 1 to June 20
    Sept 20 Oct 22

13. Number of AUMs harvested this year

    _____ AUMs

14. Class of livestock using area

    _____ Yearling X Cow/calf _____ Sheep _____ Other
    Specify _____

15. Estimate amount of wildlife use (i.e., as % of current year's browse).

a. None	b. Occasional			c. Frequent		
	light	moderate	heavy	light	moderate	heavy

(It is important to distinguish between livestock and wildlife effects to design a proper grazing management system. What signs were used to determine wildlife use?)

16. Type of wildlife using area

_____ Elk X Deer droppings X Moose some highlining _____ Other Specify _____

Season(s) of use Continuous

(What signs were used to determine wildlife presence?)

NOTES: Mark location on an aerial photo or map. Make a sketch of the area. Describe any circumstances that may have influenced your findings.

Observer Lance & Lavanne Zweygardt and Tawzen Stringham
Date August 17, 1996

STREAM AND RIPARIAN AREA MONITORING - Extensive

Stream Name Stumplake Creek

BCGS Map Number _____ Air Photo Number(s) _____

Sampling Site Location (stream reach)_____

Permanent Photo-points (describe locations):

(1) Channel cross-section: _____

(2) Channel and riparian area overview (take from high point): _____

Current Year Weather Conditions ☐ Dry ☐ Normal ☐ Wet ☒

I. STREAM CHARACTERISTICS

1. Channel gradient (Circle)

(a.) Low (<2%) b. Medium (2– 4%) c. High (>4%)

2 Channel characteristics (Circle)

a. Entrenched (b.) Non-entrenched

(See glossary.)

3. Floodplain characteristics (Circle)

a. Confined (b.) Non-confined

(See glossary.)

4. Type of stream in a normal year (from historical records) (Circle)

(a.) Perennial b. Intermittent c. Ephemeral

(i) Continuous (ii) Interrupted

(See glossary.)

5. Streambed texture (Circle)

a. Silt b. Sand c. Gravel d. Cobble

6. Stream meander pattern (Circle)

a. Straight (b.) Slightly sinuous c. Meandering d. Braided

(See glossary.) more than one channel

7. Estimate channel width (to the closest .5 m). Estimate between high water-marks on straight sections of stream.

   a. Narrowest 2 m b. Widest 4 m c. Average 3 m

   (Do a series of estimates to obtain an average width. Channel widening may indicate lack of adequate stabilizing vegetation, increased streamflows, and/or increased sediment.)

8. Estimate bank height on the outside of each meander, from the current water level to the top of the bank.

   2.5 m

   (Steep, raw banks may indicate that the channel is deepening or downcutting due to increased streamflows and/or increased sediment.)

9. Determine streambank characteristics after walking the entire stream reach. Estimate to the closest 10%.

   <10 % of banks breaking off or eroding _____% (surface area) of stream channel shaded

10. Note number of new, unvegetated streambars per 100-m stream reach. (Circle)

    (a.) None b. Occasional c. Frequent

    (If frequency of streambars is increasing, streamflows and/or sediment may be increasing.)

II. VEGETATION INFORMATION

11. Estimate foliar cover in a 2-m strip outward from the streambank edge to within 10% (can sum to >100%).

    _____% Conifer or deciduous trees _____% Shrubs _____% Herbaceous (grasses, sedges, forbs)

    Creek was not accessible ∴ no estimate was made

    (Recent aerial photos may be helpful).

12. Estimate amount of bare ground or rock (non-vegetated surface) exposed along a 2-m strip outward from the streambank edge (to the nearest 10%).

    <10 %

13. Estimate the average width of the riparian community (from the streambank to the beginning of the upland community).

    <75 m = average widen of stream influence

    (Encroachment of upland species may indicate a dropping water table.)

14. Are small shrub and tree seedlings present? (Circle)

    a. None (b.) Occasional c. Frequent

    (If no regeneration is occurring, the area is either being overgrazed or site conditions have changed for some reason.)

15. Note shape of shrubs. Is there evidence of hedging, high-lining, or umbrella-shaped shrubs? (Circle)

    a. None (b.) Occasional c. Frequent

    (If occasional or frequent, some overgrazing is occurring.)

III. UTILIZATION INFORMATION

16. Time of grazing this year (dates)

from June 21 to Sept 10

17. Number of AUMs harvested this year

_____ AUMs

18. Class of livestock using area

_____ Yearling ___X___ Cow/calf _____ Sheep _____ Other
Specify _____

19. Estimate amount of wildlife use of shrubs (i.e., as a % of current year's growth). (Circle)

a. None	(b.) Occasional			c. Frequent		
	(light)	moderate	heavy	light	moderate	heavy

(It is important to distinguish between livestock and wildlife effects to design a proper grazing management system. What signs were used to determine wildlife use?)

20. Type of wildlife using area

_____ Elk _____ Deer ___X___ Moose _____ Other
Specify _____

Season(s) of use Summer and Fall

(What signs were used to determine wildlife presence?)

Notes: Mark location on an aerial photo or map. Make a sketch of the area. Describe any circumstances that may have influenced your findings.

Section 2 Monitoring Rangeland

2.1 Introduction

Monitoring is the collection and analysis of repeated measurements or observations to assess changes in condition, to assess progress towards a management objective, or to support management change or continuation.[4] On rangelands, monitoring is a management tool that assists in assessing the effects of management practices and/or environmental variation over time.

Monitoring identifies management impacts on rangeland communities. Results from monitoring can promote awareness, facilitate assessment, indicate trends, and support decision-making.

On Crown range, monitoring will focus on plant community structure and composition (seral stage), utilization zone determination, and permanent photo-points.

2.2 Monitoring Frequency

Range Use Plans (RUPs) and Range Stewardship Plans (RSPs) have a 5-year term. To assess management effects within the term of a plan, agreement holders are encouraged to monitor during the first and fourth year of a plan. Results from the first year provide baseline information on which to assess the management effects on the fourth year. Stubble heights, however, should be measured each year to assist in determining when to move livestock from a pasture or other area.

4 Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. Measuring and monitoring plant populations. USDI Bureau of Land Management, National Applied Resource Sciences Center, Denver, Colo. BLM Technical Reference 1730-1.

2.3 Getting Started—Gathering Background Information

Before monitoring, collect the following information:

- Historical plant community information (e.g., past monitoring records).
- Lists of dominant species, invader species, and invasive alien plants.
- Maps and aerial photographs.
- Soils and geography.
- Records of past livestock use and management activities (e.g., seeding, clearing, and invasive alien plant control). (Figure 3)
- Disturbances (e.g., fire, drought, pestilence, logging, and flood events).

2.4 Site Selection

Agreement areas are often comprised of several plant communities representing primary, secondary, and tertiary range. Select monitoring sites to represent distinct plant communities within primary and secondary range types.

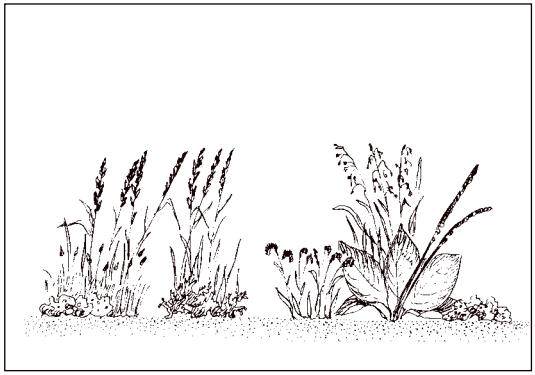
2.5 Current Plant Community

Collecting plant community information allows the description of the structural layers, the description of the species composition, and the determination of the seral stage. Layers may include lichens/mosses, litter, grasses, forbs, shrubs, and trees. Rangeland communities may not have all layers present. For example, some grassland communities lack trees and shrubs. Plant community composition is described by listing dominant species within each structural layer. Seral stage is determined by comparing current plant community composition to a site's potential

or reference community. There is a close correlation between seral stage and measures of rangeland health. Results of recent effectiveness evaluations of range practices indicate that mid- to late-seral stages have higher range health scores than early-seral stages.[5]

1) All expected layers present.

2) Tall grasses and forbs reduced



3) Tall layer absent and mid layer reduced

4) Low grasses and forbs; ground cover reduced.

Figure 3 Changes in grassland plant community structure as disturbance levels increase.[6]

5 Fraser, D. 2005. Range effectiveness evaluations 2004. British Columbia Ministry of Forests and Range, Victoria, B.C. Unpublished report.

6 Adapted from: Adams, B.W., G. Ehlert, C. Stone, M. Alexander, D. Lawrence, M. Willoughby, D. Moisey, C. Hincz, and A. Bogen. 2003. Range assessment for grassland, forest and tame pasture. Public Lands Division, Alberta Sustainable Resource Development, Edmonton, Alta. Publ. T/044.

2.5.1 How to assess the current plant community

- Determine what plants dominate the site. Mostly grasses? Mix of grasses/forbs/shrubs? Are trees present? If so, how are they distributed and what species are present? Are species within the plant community native or seeded (e.g., crested wheatgrass and meadow brome)? Are invasive alien plants present (e.g., knapweed and Canada thistle)? From this information, determine the plant community (e.g., Fescue Grassland, Open Aspen Forest, Mountain Meadow).
- List dominant species for each of the following: grasses, forbs, shrubs, and trees. Note if one or more of these layers is absent.
- Seral stage is determined by comparing dominant plants of the current community to that of a reference site, where known. When reference conditions are unknown, you are encouraged to create a small reference site or locate a relic (ungrazed) community. (For further information on seral stage determination, see Sections 2.9 and 2.10.)

2.6 Utilization Zone Determination

Due to grazing preferences, certain species are more susceptible to grazing. Stubble height is a physical measure of remaining leaf area following grazing. Measure stubble height, excluding seed stalks, of dominant and indicator grasses.

Once the recommended stubble height is reached (Table 1), livestock should be removed from the pasture or other area. If, at the end of the grazing period, average stubble height is below the recommended value, the plant community may be at risk. However, occasional over-use followed by appropriate recovery is not necessarily harmful.

Once stubble heights of dominant grasses and utilization classes are determined, this information is used to map zones of utilization (Figure 4). Since utilization is mapped repeatedly, change in use can be mapped

and correlated to changes in management, disturbance regime, or climate, or to a combination of these factors.

Table 1 Recommended average minimum stubble heights for common forage species

Common name	Scientific name	Stubble height (cm)
	Riparian species	
Bluegrasses	*Poa* spp.	10
Canada reedgrass (bluejoint)	*Calamagrostis canadensis*	12
Desert saltgrass	*Distichlis spicata*	8
Foxtail barley	*Hordeum jubatum*	10
Kobresia	*Kobresia* spp.	8
Sedges (large)	*Carex* spp.	20
Spikerush	*Eleocharis* spp.	15
Tufted Hairgrass	*Deschampsia caespitosa*	12
	Upland species	
Alpine timothy	*Phleum alpinum*	10
Altai fescue	*Festuca altaica*	18
Blue wildrye	*Elymus glaucus*	15
Bluebunch wheatgrass	*Agropyron spicatum*	17
Bluegrasses	*Poa* spp.	10
Brome (introduced forages)	*Bromus* spp.	10
Creeping red fescue	*Festuca rubra*	8
Crested wheatgrass	*Agropyron cristatum*	8
Domestic timothy	*Phleum pratense*	10
Idaho fescue	*Festuca idahoensis*	15
Needlegrasses	*Stipa* spp.	12
Northern wheatgrass	*Agropyron dasystachum*	15
Orchardgrass	*Dactylis glomerata*	10
Pinegrass	*Calamagrostis rubescens*	18
Rough fescue	*Festuca scabrella*	18
Rough-leaved ricegrass	*Oryzopsis asperifolia*	8
Slender wheatgrass	*Agropyron subsecundum*	15
Western wheatgrass	*Agropyron smithii*	12

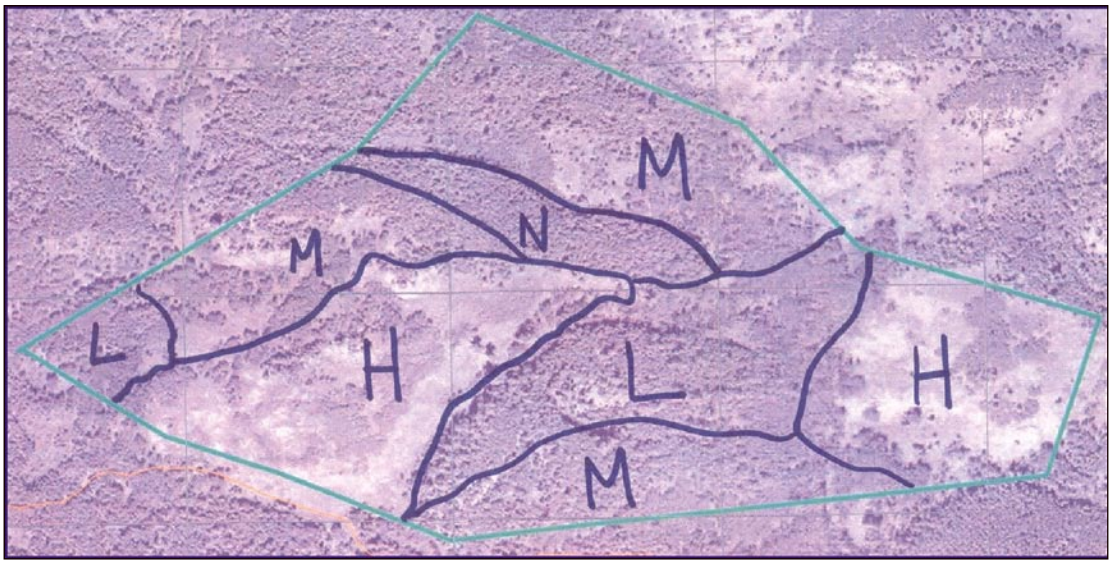


Figure 4 Map showing zones of utilization.

2.6.1 How to determine utilization zones

- Identify dominant and indicator grass species.
- Look up the stubble height threshold for these species (see Table 1).
- Measure stubble heights on individual plants (minimum of 10 per species recommended).
- Calculate average stubble height.
- Compare average stubble height to the recommended threshold stubble height for each species.
- Assign utilization class according to Table 2.
- Delineate the utilization classes on a map (see Figure 4).

Table 2 Utilization classes

Class	Description
None–Slight (N)	Average stubble height is about equal to the height of the ungrazed plants.
Light (L)	Average stubble height is about mid-way between the threshold height and the ungrazed height.
Moderate (M)	Average stubble height is about the same as the threshold height.
Heavy (H)	Average stubble height is about one half of the threshold height.
Extreme (E)	Average stubble height is one quarter of the threshold height or less.

2.7 Shrub Use (Browse) Determination

Shrubs form an important component of many rangeland communities. The *Forest and Range Practices Act* (FRPA) allows browse use to a maximum of 25% of current year's growth. On ungulate winter range, livestock utilization allowances may be lower (e.g., 10%).

On sites with a shrub layer, determine browse utilization of dominant and indicator species. This is in addition to utilization zone determinations completed for dominant and indicator grass species. On some sites, shrubs are the main forage (e.g., some riparian communities) and, therefore, utilization percentages for these areas should be mapped along with grass utilization codes (e.g., where N/40 means none–slight grass use and 40% shrub use).

It is also important to assess historical use by observing and recording shrub form class for dominant shrub species (see Figure 5).

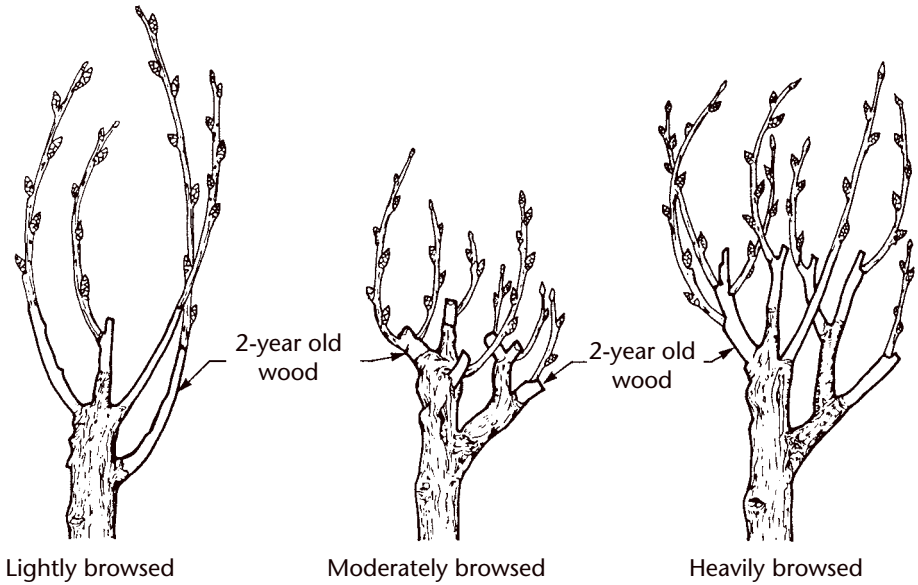


Figure 5 Browse use form classes.[7]

2.7.1 How to determine shrub use

- Identify dominant and indicator shrub species within the plant community.
- Randomly select a branch of a shrub. On this branch, examine 10 twigs and determine how many of these show use. Convert this number to percent (i.e., two twigs equals 20%, six twigs equals 60%, and so forth). Sample one branch on 10 shrubs and calculate average percent use. Repeat the process for each species.
- Assess and record browse form class for each plant sampled. Do this by relating the form class to the images in Figure 5.

7 From: Luttmerding, H.A., D.A. Demarchi, E.C. Lea, D.V. Meidinger, and T. Vold. 1990. Describing ecosystems in the field. British Columbia Ministry of Environment and British Columbia Ministry of Forests, Victoria, B.C. MOE Manual 11.

2.8 Permanent Photo-points

Establish photo-points to supplement descriptions of plant communities and measurements of utilization. Photo-points are not a substitute for monitoring. Photo-points are locations from which photographs are taken periodically to allow comparisons (Figure 6).

2.8.1 How to establish and use permanent photo-points

- Establish a permanent photo-point marker (e.g., rebar, wooden stake, painted rock).
- For new photo-points, fill out a photo-point record sheet. On the site sketch show a type point and the bearing and distance to the photo-point.
- When re-taking pictures, take the photo from the same bearing and distances as the first pictures, and record the photo number on the site monitoring form.
- Place a metre board, (e.g., 1-m metal ruler, or painted and marked stick) at the permanent point and walk 10 m away in the desired direction.
- Take a picture centred on the top of the metre board using a 50-mm lens or equivalent zoom setting.
- Move to within 2 m of the board and take two pictures (one on the left and one on the right) showing the metre board on the edge of the frame.
- Record the date, the picture number, and the compass reading.

Figure 6 Example of a photo-point.

2.9 Plant Community Description Form and Instructions

Site name or map sheet # _____*A*_____ **Date** _____

Observer _____ **Photo #** _____*B*_____

Plant community

Dominant grass species	**Dominant forb species**	**Dominant shrub species**	**Dominant tree species**
C			

Indicator grasses	**Indicator flowers**	**Indicator shrubs**	
D			

Missing layers	**Missing species**
E	*F*

Litter

G

Comments on impact of livestock grazing on the plant community

H

Stubble height (circle high and low for each species. * = ungrazed *L*)

Species	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Mean	Ungrazed height
I											*J*	*K*

Shrub use (record percent use and form class for 10 twigs)

Species	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	% use	Form L	Form M	Form H
	M										*N*	*O*		

Notes:

* See page 60 for a clean copy of the form to photocopy.

A) A name or map number is needed to match the monitoring form to the map.

B) If the site is used for a photo-point, record the photo number here. Record the details of the photo-point on a photo-point record sheet.

C) The dominant species are those that make up the highest cover for each layer.

D) An indicator species is not dominant but is important to note. This may be an increaser or invader, or a late-seral species that you want to remember to look at the next time you monitor.

E) Record if a layer that occurs in the reference condition is missing from the site.

F) Record if a species that occurs in the reference area is missing from the site. (Note: a layer may be present but contain different species.)

G) Record the amount of litter on the site compared to the reference condition. Broad classes are: about the same, slightly less, moderately less, greatly less. If the litter is greater than the reference condition, try to explain why.

H) Record the seral stage if known. Alternatively, describe differences between the site and the reference condition that can be attributed to livestock grazing.

I) For each dominant and indicator species, record stubble heights on enough plants to get a good estimate of use. Mark measured heights of ungrazed plants with an *. If you have good ability to estimate stubble heights, skip this and record an estimate in J.

J) If you measured stubble heights, enter the average for each species.

K) If you measured one or more ungrazed plants, enter the average height. If no ungrazed plants were encountered, wander around and find one to measure or enter an estimate based on memory.

L) Mark ungrazed stubble heights with an *.

M) Record percent use form class in each cell; for example, 30%-2 means that the twig was used 30% and the whole shrub is form class M.

N) Average the percent use recorded for each species.

O) Under L, M, and H, enter the number of measured shrubs that fell into form classes L, M, or H. For example,

Form		
L	M	H
2	5	3

means that two plants of the species were form class light, five were form class moderate, and three were form class heavy.

Plant community description form

Site name or map sheet # _____ **Date** _____

Observer _____ **Photo #** _____

Plant community

Dominant grass species	**Dominant forb species**	**Dominant shrub species**	**Dominant tree species**
Indicator grasses	**Indicator flowers**	**Indicator shrubs**	

Missing layers	**Missing species**

Litter

Comments on impact of livestock grazing on the plant community

Stubble height (circle high and low for each species. * = ungrazed)

Species	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Mean	Ungrazed height

Shrub use (record percent use and form class for 10 twigs)

Species	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	% use	Form L	Form M	Form H

Notes:

2.10 Seral Stage Descriptions and Examples

PNC-climax plant communities (>75% similar to PNC)*

- Dominated by healthy and vigorous perennial plants representative of ungrazed or lightly grazed sites
- Presence of invasive alien plants is negligible

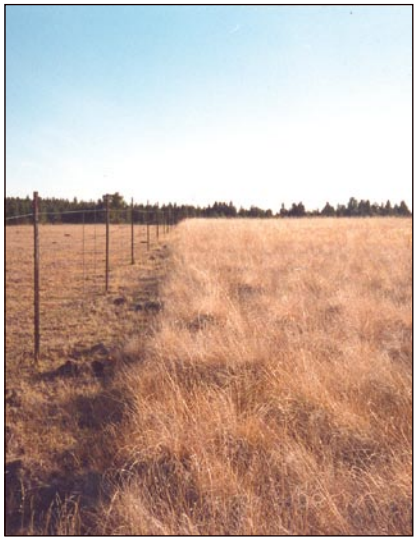


Figure 7 PNC-climax community, fence line contrast.

- Increaser plants may be present but their combined cover is <25% of the plant community
- Litter represents at least 1 year's herbage production and signs of previous year's litter decomposition is present
- Surface crust is similar to ungrazed or lightly grazed sites
- Floristic diversity (species richness and equability) may be low

In addition, PNC-climax plant communities may exhibit the following:

- High forage production for the site
- High resilience to reduction of forage production during drought
- Resistance to weed invasion

Late-seral plant communities (50–75% similar to PNC)

- Dominated by healthy and vigorous perennial plants representative of ungrazed or lightly grazed sites. Increaser plants may be co-dominant
- Presence of invasive alien plants is negligible

* PNC (Potential Natural Community) is defined as the community that would become established on an ecological site if all successional sequences were completed without interference by humans under present environmental conditions.

- Increaser plants will be present but their combined cover will be 25–50% of the plant community
- Litter represents half of the previous year's herbage production and signs of previous year's litter decomposition is present
- Surface crust is slightly degraded when compared to ungrazed or lightly grazed sites
- Floristic diversity (species richness and equability) may be high compared to ungrazed or lightly grazed sites

Figure 8 Late-seral community.

In addition, late-seral plant communities may exhibit the following:

- Moderate to high forage production for the site
- Some reduction of forage production during drought
- Resistance to weed invasion

Mid-seral plant communities (25–50% similar to PNC)

- Dominated by increaser plants; decreaser plants will be present but their combined cover will be 25–50% of the plant community
- Presence of invasive alien plants may be high
- Litter will be less than the higher seral stages but some signs of decomposition will persist for at least 1 year
- Surface crust is slightly to greatly degraded when compared to ungrazed or lightly grazed sites
- Floristic diversity (species richness and equability) may be low compared to late-seral

Figure 9 Visual obscurity measurement in a mid-seral plant community.

In addition, mid-seral plant communities may exhibit the following:

- Moderate to low forage production for the site
- Significant reduction of forage production during drought
- Low resistance to weed invasion

Early-seral plant communities (0–25% similar to PNC)

- Dominated by increaser plants and invaders; decreaser plants may be absent but their combined cover will be <25% of the plant community
- Presence of invasive alien plants may be high
- There may be very little or no litter. There may be no signs of decomposing litter from previous years
- Surface crust is slightly to greatly degraded when compared to ungrazed or lightly grazed sites
- Floristic diversity (species richness and equability) may be very low compared to late-seral

Figure 10 Early-seral community, short stubble.

In addition, early-seral plant communities may exhibit the following:

- Low forage production for the site
- Great reduction of forage production during drought
- Low or no resistance to weed invasion

Figure 11 Aspen communities in early-seral, mid-seral, and late-seral stages, showing a decrease in bare ground and an increase in surface litter.

Section 3 Remedial Measures for Rangeland

3.1 Introduction

The Remedial Measures Model will guide you in developing properly functioning of uplands and riparian zones. It is important to recognize the model as a series of steps, each one a vital part of the overall process. These steps assess and identify the tools and actions that will result in eventual restoration of a deteriorated ecosystem. The first step, properly applying the Assessment Procedures, is key to revealing the functional condition of the riparian or upland systems. It will indicate the nature of any problems encountered and provide the necessary starting point for further application of the model. The Remedial Measures Model depends on sound resource assessment to lead the user to the best remediation tools and actions.

3.2 Functioning of the Model

The basic Remedial Measures Model (Figure 12) is a general representation of an approach for making well-informed resource management decisions. The user begins at Step 1 and follows a clockwise pattern, addressing issues in each section of the model. The user is eventually cycled back to the beginning at Step 1.

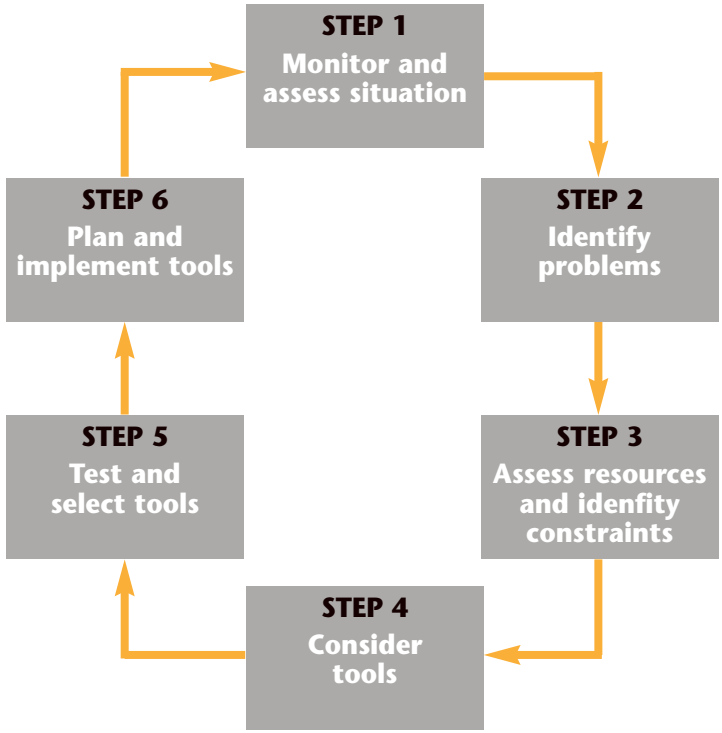


Figure 12 The Basic Remedial Measures Model.

3.3 Basic Instructions for Using the Remedial Measures Model

Step 1. Monitor and assess situation

Use the Assessment Procedures and function checklists (see Section 1) to identify the current health or status of the site. If you find that your goals for the site are met, then you are in an enviable position. Continue to periodically monitor and assess the situation and be on the alert for indications that your management for the site is trending downwards. However, if you find that your goals for the site are not being met and there appears to be a problem, go to Step 2.

Step 2. Identify problems

What is the situation? Review the Assessment Procedures function checklists to identify the nature of the problem.

Be sure that you are distinguishing between a symptom and the cause or source of the problem. When you are fairly certain that the problem has been determined, go to Step 3.

Step 3. Assess resources and identify constraints

Assess the resources available to you in tackling the problem. What can slow you down or stop you from achieving a solution? Is it people, money, or an especially harsh or brittle environment? This is sometimes called the "weak-link test." After you have identified any weak links, go to Step 4.

Step 4. Consider tools

What tools and actions would potentially remedy the situation, solve the problem, and reach your goal for the site? The tools you just listed must be filtered to select those that are most appropriate for the situation and that have the greatest chance of success. There may be only one or two or there may be many. When you have filtered the best tools available, go to Step 5.

Step 5. Test and select tools

Now that you have your tools reduced to those with the greatest chance of success, put them through the four tests to arrive at the potential tool or tools. Go to Step 6.

Step 6. Plan and implement tools

Plan the application of the tool(s) and apply them. After remediation, reassess the site as in Step 1, using the Assessment Procedures function checklist. If the site has reached Properly Functioning Condition (see Section 1.6) or is on its way there, success has been achieved. If your

goals have not been reached, go through Steps 2 to 6 again.

Note: in one case an "at risk" rating of 70% with an upward trend might be deemed a success, given the overall management objectives for the area. In that case, the manager would continue to assess the area according to a normal monitoring schedule and continue present management.

Success may not be achieved quickly because limiting factors such as weather or lack of funds may greatly slow the remediation process. Despite this, chances for success are greatly enhanced by applying the model. For example, this model helps you identify those factors that directly limit success, so that new or better resources can be brought into the situation. Perhaps expertise in a particular field is needed, but is not locally available. Bringing in a specialist can remove this "weak link" and speed the process toward a successful conclusion. Maybe available funding is the weak link. Funds might be available from sources not previously considered, such as a conservation group interested in helping to achieve a particular land management goal.

3.4 The Detailed Remedial Measures Model

Now you're ready to review an enhanced version of the Remedial Measures Model (Figure 13). The steps are exactly the same as the ones we've just gone through. However, we'll spend a bit more time on each step and introduce some screening devices that make using the model still easier and more effective. The detailed Remedial Measures Model is designed to relate appropriate tools and outcomes directly to problems identified by the Assessment Procedures function checklists.

Step 1 Monitor and assess situation

The assessment checklists are designed to assess the functionality of ecosystem processes in upland and riparian areas. Properly Functioning Condition (PFC) is seen as a minimum target for which we manage. Since it is possible to reach PFC before some other societal goals (e.g., biodiversity, water quality, and habitats for fish and perching songbirds) are met, the plant community must also be considered. The Desired Plant Community (DPC) for any site is additional to the PFC and is

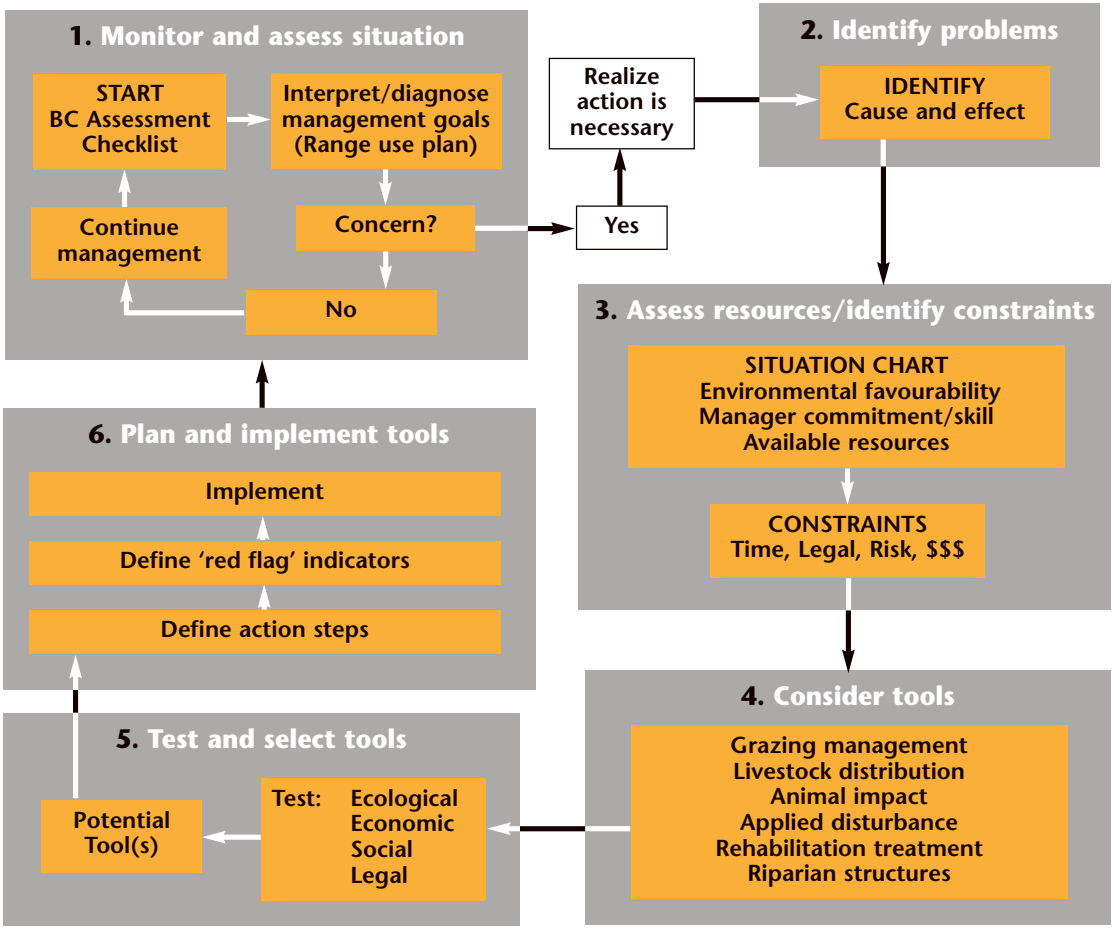


Figure 13 The Detailed Remedial Measures Model.

determined based on society's goals and values for that site.

If the site meets Properly Functioning Condition and the plant community is the desired plant community or is moving in that direction, then a continuation of management practices would be recommended. If a site is "at risk," then a decision to modify management would normally be made. This is when the Remedial Measures Model would be used to

identify new management options. The Remedial Measures Model is designed to help guide the manager through the process of finding these tools and options.

A Word About Goals

While Properly Functioning Condition will probably be the ecological goal to achieve, you should consider other goals as well. A successful management program hinges on inclusion rather than exclusion of people and their desires as affected by your management. Don't forget to review associated land uses such as recreation, logging, and agriculture and think about the goals of the many people who are part of the **Whole**.

Step 2. Identify problems

If a decision to take management action has been made, then a few preliminary actions will help you better understand and manage the situation. Analysis of "cause and effect" relationships is essential.

Identify what may and may not be the fundamental cause of the problem. If the creek's banks are washing away, is it a riparian problem, or is it caused by a management action on the uplands? If there is a weed infestation, is it because of new seed sources, or because an environment was created that favoured weedy plants? If cattle are trampling a stream bank, is it because there are too many cattle or because there is not a good grazing management plan in place? Distinguishing between a genuine cause and its symptom or effect can make the difference between success or failure of your efforts.

It is not always easy to trace the root cause of a problem; some "detective work" may be required. A simple exercise can be to list all apparent problems on an area and then ask if these "problems" are truly the source of the concern, or are there larger, more deeply rooted causes involved?

Step 3. Assess resources and identify constraints

Identify what resources you have working in your favour and try to recognize where weaknesses lie. A tool to help you do this is shown in Figure 14. This Situation Chart provides a means of scoring human, environmental, and physical resources available for applying tools in a management situation. It will help you identify weak links and limiting factors. Here are the three elements considered in the chart:

1. Environmental favourability

This category is meant to provide some sense of the recovery rate to be expected in a particular situation. What is the nature of the local environment, especially in terms of climate, soils, and factors that affect growing conditions and animal behaviour? Some ecosystems (non-brittle) provide more favourable growing environments than others. Abundance or lack of moisture and heat are critical factors. The more moisture, humidity, and heat available (up to a point!), the more favourable the environment. The more favourable the environment, the faster the expected recovery period. You may ultimately be successful in a harsher (brittle) environment, but success will come at a slower pace.

2. Manager commitment/skill

Consider the strengths of your management team, especially in terms of commitment, skills, and creativity, as well as the strengths of others directly involved in management of the land. A Montana researcher found in his study of riparian management along 71 stream reaches that the "commitment of the land manager... and the degree of operator involvement" were the most important ingredients for success of a management system. The type of grazing management was not the deciding factor for success, nor was it how many water access points had been placed. If the manager had a high degree of involvement, the chance for success was much higher. Your management team must assess its commitment level, but ultimate success often rests on the person applying the day-to-day management. That person must be committed, involved, and supported by the team to enjoy full success. Collectively, the team must posses the skills necessary to carry out the management option chosen. Because commitment and skills are so important, they carry a higher numeric value in the Situation Chart than any other category.

3. Available resources

What equipment, materials, facilities, money, livestock, or other resources do you have available? How big and full is your tool chest? Sometimes creativity and ingenuity will substitute for money and equipment. But sometimes, nothing but money will do. Given that rangelands are often not "high dollar" lands, money for remediation is typically scarce. Are there alternative funding sources such as special grants or conservation organizations?

The Situation Chart

An exercise that can help you judge the condition or state of your situation is provided by working through the Situation Chart (Figure 14). This chart can also help identify the "weak links" and "limiting factors" within the situation. It works rather like a plant key. Categories are broken into Environmental favourability, Manager commitment/skill, and Available resources.

As previously discussed, "the degree of manager commitment and involvement" provides critical momentum towards project success. This attribute carries a heavier weighting than other attribute areas. Skill or expertise also enters into this category. You must use your judgement in determining how commitment and expertise balance out as you assess this category.

After working through the Situation Chart you should be relatively clear about where your strengths and weaknesses lie. You will also have gained a situation score that will help you select realistic tools for a solution.

How to use the Situation Chart

1. To start, identify the **Environmental favourability** category. Decide whether the environment involved offers very favourable (# high), intermediate (# mid), or not favourable (# low) conditions that will influence your remediation treatments. Consider the kinds

Environmental favourability	Manager commitment/skill	Available resources	Situation score
High (3)	High (4)	Many (3)	10.0
		Moderate (1.5)	8.5
		Few (0)	7.0
	Moderate (2)	Many (3)	8.0
		Moderate (1.5)	6.5
		Few (0)	5.0
	Low (0)	Many (3)	6.0
		Moderate (1.5)	4.5
		Few (0)	3.0

Environmental favourability	Manager commitment/skill	Available resources	Situation score
Mid (1.5)	High (4)	Many (3)	8.5
		Moderate (1.5)	7.0
		Few (0)	5.5
	Moderate (2)	Many (3)	6.5
		Moderate (1.5)	5.0
		Few (0)	3.5
	Low (0)	Many (3)	4.5
		Moderate (1.5)	3.0
		Few (0)	1.5

Environmental favourability	Manager commitment/skill	Available resources	Situation score
Low (0)	High (4)	Many (3)	7.0
		Moderate (1.5)	5.5
		Few (0)	4.0
	Moderate (2)	Many (3)	5.0
		Moderate (1.5)	3.5
		Few (0)	2.0
	Low (0)	Many (3)	3.0
		Moderate (1.5)	1.5
		Few (0)	0

Figure 14 The Situation Chart.

of soil involved, length of growing season, temperature extremes, precipitation timing and amounts, brittleness, animal depredation, competition from other plants, trampling by grazing animals, steepness of slopes, and other site features. Recognize that environmental favourability will greatly influence the performance of any tool(s) you wish to use in remediation. The scores for this category range from 0 to 3. Note the numerical score your decision produces and move to 2.

2. Next, you and your team must honestly assess your level of **Manager commitment/skill**, and most importantly, the level and degree of commitment of the operator who will be involved on a day-to-day basis. You will choose either low, moderate, or high categories. Note that your choice will result in a numerical score from 0 to 4. That choice will indicate which portion of the chart to use in Step 3.
3. Go to the **Available resources** category and decide what level of resources is available to you. Do you feel that you have abundant resources in terms of equipment, funds, supplies, personnel, administrative support and logistical support that will allow you to access many different tools, or are resources very limited? Will you have to make do with a very simple grazing plan and several hundred dollars worth of fencing materials? Decide on a value of 0, 1.5, or 3 for Available resources. Move to Step 4.
4. Total the score for the categories of **Environmental favourability, Manager commitment/skill**, and **Available resources**. The score will range from a possible high of 10 to a possible low of 0. You will need this number when you use the Tool Filter (Figure 15).

EXAMPLE: You have used the Situation Chart to find that in a particular situation in Vanderhoof the environment is not brittle and you have decided to give Environmental favourability a score midway between 0 and 3, which is 1.5. The managers are committed to some change. This provides a score of 2 for Manager commitment/skill. Available resources of all kinds are abundant, including funding, equipment, and labour, so that score is 3. Added altogether, the score is 1.5 plus 2 plus 3, for a total of 6.5. This is the score you will use in the Tool Filter (Figure 16).

Environmental favourability		Manager commitment/skill		Available resources		Situation score
1.5	+	2	+	3	=	6.5

Other constraints

Before we leave this area of the Remedial Measures Model, consider whether there are additional constraints not covered in the Situation Chart. There usually are. For example, are there legal obstacles to contend with? Are there time deadlines that must be met? How much risk is involved? What would be the consequences of failure? Is funding sufficient? Will anyone's paradigms prove to be serious obstacles? Note these constraints, because they will be considered in detail in one of the following steps as we continue to screen the tools and test them.

Step 4. Consider tools

At this point the team should begin listing and brainstorming potential tools. The tools are divided into categories of **Grazing management, Livestock distribution, Animal impact, Applied disturbance, Rehabilitation treatments, and Riparian structures.***

* For a detailed description of these categories and their associated tools, see Rangeland Health Brochure 4, Considering tools for remediation, pp. 3–18.

How the tools are rated

Each tool in the Tool Filter is rated on the following basis:

- level of skill or expertise required to apply it properly
- how "management intensive" the tool is
- how many resources are required to apply the tool (labour, equipment, funding, etc.)

With the Situation Chart we learned what kinds of resources were available and where our weak links and constraints were. We came up with a situation score of **6.5** in our hypothetical Vanderhoof example, which we can now use to screen potential tools. The Tool Filter (Figure 15) lists all the tools available to us and separates them into the categories of **Grazing management, Livestock distribution, Animal impact, Applied disturbance, Rehabilitation treatments,** and **Riparian structures.** The filter shows minimal scores necessary to "qualify" a tool for use in a particular situation. **If a tool has a score that exceeds your situation score, it is not available to you.** After you have determined a situation score for your particular situation, you can review the tools and pull out those that are "qualified" (example shown in Figure 16).

Here is an example of two contrasting tools: prescribed burning and long-term rest. Prescribed burning has a value of **8–10** in the Tool Filter because fire requires high levels of expertise, backup equipment, and support, and has a fairly high risk factor. Long-term rest, with a value of **0–10** doesn't need a great deal of skill to apply, requires few additional resources, and has limited risk associated with its use. Thus, prescribed burning requires a much higher score from the Situation Chart to consider its use than does long-term rest.

The Tool Filter is designed to identify viable tools for particular situations.

To give you a better idea of the overall procedure we're engaged in, Figure 17 illustrates the entire **tool screening process.** In it, many tools are poured into the top filter and allowed to trickle down through the remaining filters. Each filter, such as the limiting-factors filter, removes some tools from further consideration. By the time all the tests are applied, perhaps only a few tools will remain.

Remember: tools with high scores are more difficult to qualify because they require more expertise, greater funding, a less brittle environment, etc.

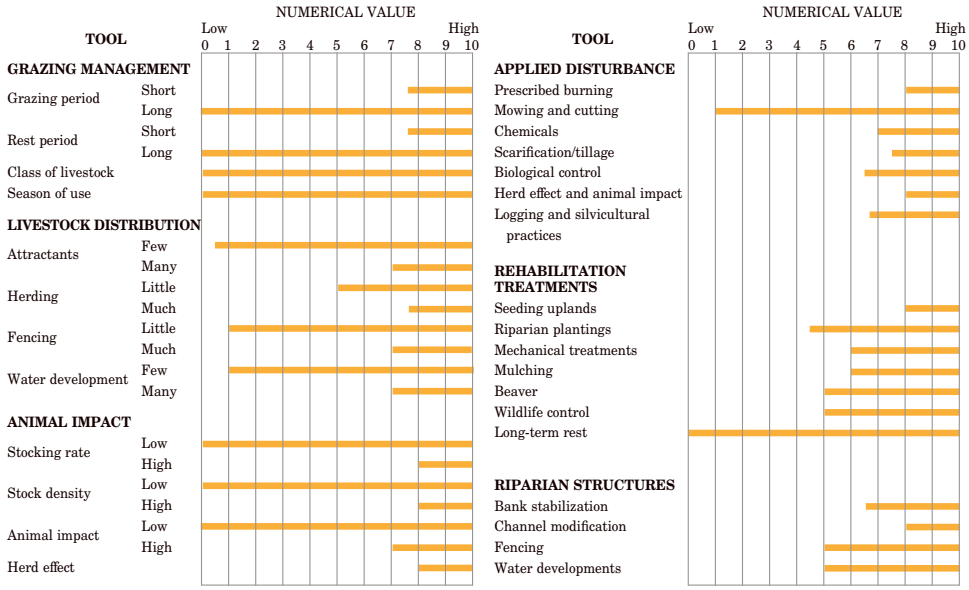


Figure 15 The Tool Filter.

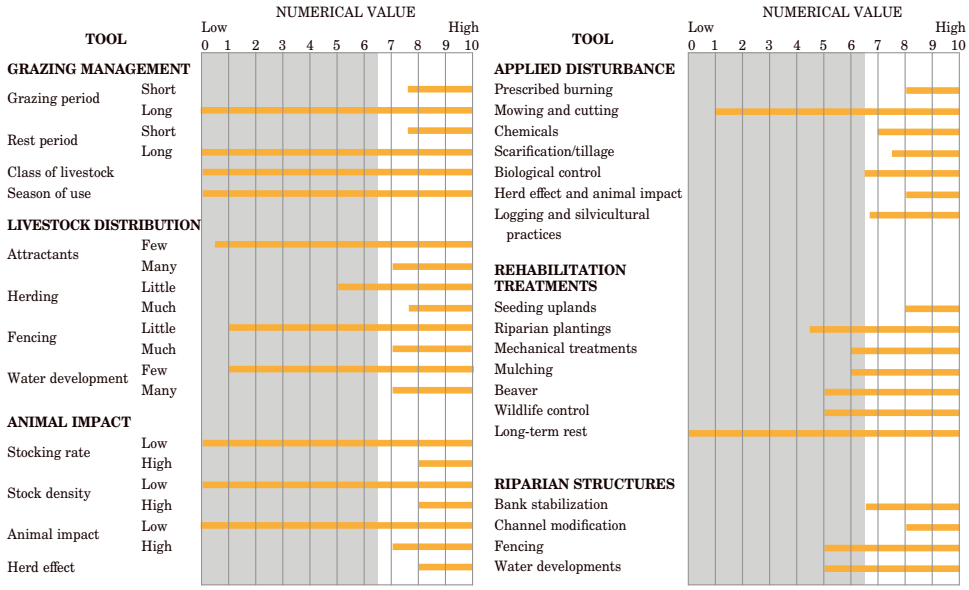


Figure 16 The Tool Filter – example situation score of 6.5.

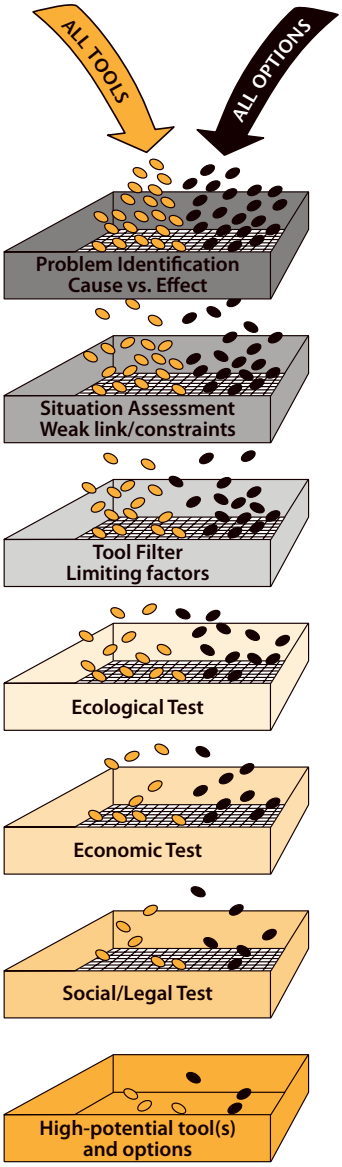


Figure 17 Remedial Measures Model tool screening process.

Final testing of tools

Compare the score for your situation to those of each tool in the Tool Filter. Then list the qualified tools available for your remediation situation. These tools will now be put through the next three tests.

Step 5. Test and select tools

The final screening of the tools comes with **Ecological, Economic,** and **Social and Legal** test questions. These questions override all other considerations because they collectively represent the concerns of all users and managers of natural resources.

Ecological testing

You must ask if the action you are about to take with the tool you are considering will have positive or negative consequence for the ecosystem. Most tools tend to affect and manipulate the four basic ecosystem processes (water cycle, mineral cycle, succession, and energy flow). Some tools have a negative effect on particular processes and others have a positive effect on those processes. Suppose the tool you are considering is a herbicide. Is it biodegradable? Will it have possible off-site consequences if it enters groundwater or a stream? Suppose the tool is cultivation, which disturbs the soil. Is there potential for stream sedimentation from erosion? Will it affect succession by opening the site to weedy plants?

By asking these questions, you anticipate consequences and preclude nasty surprises. The final question to ask is, "Will this tool move us **closer to** or **away from** our ecological goals for the site?"

Economic testing

The primary economic test to be considered is the marginal reaction test. It asks which tool will provide the most effective push toward the goal, with the least amount of time, money, and labour involved. Financial restraints are common in range settings. When money is scarce it becomes more important to ensure that each dollar is spent wisely and appropriately.

Will spending money on a tool or action have to be repeated within a few years? What is the life expectancy of the treatment or is it "self-sustaining?" If fossil fuel is required in large amounts, can the use of the non-renewable resource be well-justified? These questions overlap with the following social and legal tests.

Social and legal testing

We must ask whether the tool under consideration is socially, culturally, and legally acceptable within the community and region. Legislation and regulations tend to reflect provincial/national standards. Some tools are no longer considered appropriate, because environmental scrutiny and public pressure has challenged their use.

Ask if the tool or action will violate the cultural values and standards of the local community. Learn whether it meets standards for environmental compliance. Are permits required? Will the district manager require referral of the proposed action to other users or government agencies? If a tool is suspect in this analysis, be particularly careful in selecting and applying it.

Step 6. Plan and implement tools

After a tool has passed through all the testing stages, implementation can begin (Figure 18). Management considerations for application of the tool should be planned, action steps defined, and tasks delegated to accountable team members. You must also consider "red-flag" indicators,

Attractant.

Riparian planting.

Water development.

Figure 18 Remediation tools, once filtered and tested, enhance your efforts to achieve a properly functioning condition.

the first evidence indicating that the wrong tool was applied or the right tool was misapplied. This is an important step because it causes the land manager to consider what negative signs to look for as well as signs of success.

What "red flags" should you look for? They are dependent mostly upon the category of tool used (Table 3). If the tool is grazing-related, the signs may be subtle plant vigour or vegetation composition changes, or they may be reflected by soil surface conditions or erosion. If the tool is from the applied disturbance category, a red flag might be cloudy runoff waters or off-site damage to vegetation. If the tool was from the rehabilitation treatments category, the red flag may be dead or dying seedlings on a planted area. A red flag for a tool that involved construction of a structure might be evidenced by some structural failure. The management team should anticipate and identify red-flag indicators during the planning and implementation phases.

3.5 Reassessment

You have now completed one rotation through the decision model and have been brought back to the monitoring and assessment quadrant (Step 1). Application of the tool should be moving the site toward your intended goal. The rate of improvement is driven by environmental conditions. However, other factors will also play a role, including skill in application of the tools. Monitoring is important to document results, to determine the apparent rate of improvement, and to ascertain whether further action is needed. If further action appears unnecessary, the present management may be continued. Otherwise, the Remedial Measures Model is called upon once more and the decision-making process is repeated.

Table 3 Tools by category

CATEGORY 1 Grazing management	CATEGORY 2 Livestock distribution	CATEGORY 3 Animal impact	CATEGORY 4 Applied disturbance	CATEGORY 5 Rehabilitation treatments	CATEGORY 6 Riparian structures
Grazing period	Attractants	Stocking rate	Prescribed burning	Seeding uplands	Bank stabilization
Rest period	Herding	Stock density	Mowing and cutting	Riparian plantings	Channel modification
Class of livestock	Fencing	Animal impact	Chemicals treatments	Mechanical	Fencing
Season of use	Water developments	Herd effect	Scarification/ tillage	Mulching	Water developments
			Biological control	Beaver	
			Animal impact	Wildlife control	
			Herd effect	Long-term rest	
			Logging and silvicultural practices		

Note: some tools are in more than one category

This section has covered one model for determining appropriate tools to apply to your situation. It is not the only model you could choose and use. However, we hope that, having seen the simplicity and effectiveness of this model, you will consider using it when you are faced with developing management options to remediate unhealthy upland and riparian areas.

Section 4 Range Readiness

Range use plans (RUPs), required for all *Range Act* agreements on Crown range, were changed substantially in 2003. Many plans will now have references to range readiness criteria, average stubble heights, and browse utilization. This section discusses the concept of range readiness and the use of criteria to indicate appropriate grazing times. Assessing the leaf development of common grasses is recommended as the most useful indicator of range readiness.

4.1 What is Range Readiness?

The Society for Range Management defines range readiness as "a defined stage of plant growth at which grazing may begin under a specific management plan without permanent damage to vegetation or soils."[8]

The concept of range readiness has been questioned for the past decade as managers have experimented with refined grazing systems.

Some managers maintain that time of grazing is irrelevant. Instead, the severity of grazing (how much leaf is removed) and the time interval before regrazing are deemed important. From a plant physiology perspective, this makes sense, but managers must realize that, for many native grass species, the recovery period is more than 120 growing days, or the entire growing season in many areas.

Also, two elements of range readiness are often overlooked. Firstly, the soil must be dry enough that plants are not uprooted and that compaction is minimized. Secondly, adequate volume and quality of forage must be available to grazing animals. From an animal nutrition and production perspective, early grazing does not make sense.

8 Society for Range Management. 1989. Glossary of range terms.

4.1.1 Plants and soils

Grazing at improper times damages individual plants, plant communities, soils, and ecosystems.

Severe or frequent grazing will draw down carbohydrate reserves, weaken root systems, reduce vigour, and eventually kill plants. Dead forage plants are usually replaced by weedy plant species.

Soils are the basic resource that determines the capability of a site to support vegetation and grazing animals. If soils are damaged or lost through erosion, the potential of the site will be reduced and less forage will be produced.

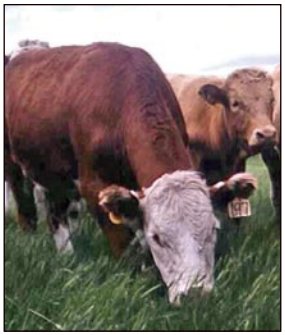


Figure 19 Cattle graze most efficiently when grass is about 15 cm high.

4.1.2 The grazing animal

Cattle graze most efficiently when plants are about 15 cm high (Figure 19). An animal on poor-condition range with short and widely spaced plants will take more bites, travel farther, and graze longer to meet nutritional requirements. If average forage height falls below 2 cm, daily intake will be reduced by 80%, and animal production will decline (Figure 20).

4.1.3 Plant phenology — not all plant species are equal

Differences in taste and palatability make some plant species preferred over others. Cattle generally prefer grasses over forbs and shrubs, and prefer green, leafy material over dry, stemmy material. Plants compete with their neighbours for moisture, light, nutrients, and space. A grazed plant has a disadvantage compared to an ungrazed neighbour.

Recovery of plants from grazing varies considerably. Some grasses keep their growing points low to the ground and are able to withstand close grazing (Figure 21), while others elevate their growing points (Figure 22). When the growing point is removed, new lateral buds must develop to produce new leaves (Figure 23);

Figure 20 Cattle on native range too early in the season. When grass is short, forage intake can drop by as much as 80%. Grazing that is too early, too frequent, or too severe will lead to reduced plant vigour, a shallower root system, less resistance to drought, a change in plant species composition (a decline in the number of perennial grass plants and palatable forbs and an increase in weedy plant species), and an increase in bare ground.

this delays above-ground regrowth and may stop root growth. Lateral bud formation may be delayed until the onset of the fall rains or even until the next growing season.

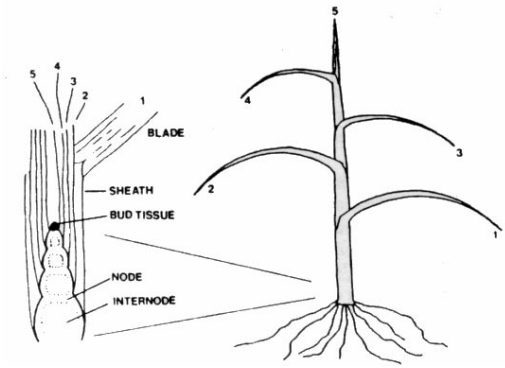


Figure 21 A grass plant in the early stages of growth. Growing points are close to the ground and cannot be removed by grazing.

Differences in season of growth exist among plant species. Some introduced grasses such as cheatgrass (*Bromus tectorum*), Kentucky bluegrass (*Poa pratensis*), and crested wheatgrass (*Agropyron cristatum*) begin their growth at very low temperatures, while others such as muhly (*Muhlenbergia* spp.) and sand dropseed (*Sporobolus cryptandrus*) begin growth later in the season and reach peak growth during the hot summer.

Figure 22 A wheatgrass plant after internode elongation. Growing points are elected and may be removed by grazing.

Figure 23 A grass plant with newly developed lateral buds. After internode elongations, new growth must come from new buds.

4.1.4 Indicators of range readiness

Typically, range readiness has been defined by the flowering of easily identified forbs or shrubs, or the average height of certain grass species. Attempts have been made to use standardized grass heights as readiness criteria. For example, 15 cm of growth has been used to indicate readiness for grazing bluebunch wheatgrass (*Agropyron spicatum*), rough fescue (*Festuca campestris*), and pinegrass (*Calamagrostis rubescens*), and 8 cm for needle-and-thread (*Stipa comata*) and Kentucky bluegrass.

These prescribed phenological stages and heights usually coincide with lowered moisture in the soil profile. The risks of uprooting grass plants and compacting the soil are therefore reduced (Figures 22 and 23).

In the Northern Great Plains, range managers have used the flowering of wild rose (*Rosa* spp.), buffalo bean (*Thermopsis rhombifolia*), and three-flowered avens (*Geum triflorum*) as indicators of range readiness. In British Columbia, balsam root (*Balsamorhiza sagittata*) in bloom, wilted Johnny-jump-up (*Fritillaria pudica*) flowers, and flowering Sandberg's bluegrass (*Poa secunda*) have all been used as indicators of readiness.

None of these indicators has proven satisfactory. Flowering stages of these plants are too early for practical use of most grass species, and the grass heights have proven arbitrary and driven more by soil moisture than by phenology. Range managers have thus often chosen fixed calendar dates. Fixed dates are not satisfactory because of large variation in weather from year to year. In British Columbia, readiness may vary as much as 6 weeks from one year to the next.

To be useful, readiness criteria must be easily recognized and consistently applied, and meet the needs of plants and grazing animals. Leaf development of grasses meets these criteria.

4.2 Using Leaf Development in Grasses as an Indicator of Readiness

J.R. Haun, a researcher working on wheat, devised a simple method of describing leaf development in grasses. Each new leaf is numbered as it appears at the growing point, and its development is described by comparing it to the length and form of a fully grown leaf. A leaf is fully developed when the collar has formed; the next leaf will then begin to emerge. A grass plant with three fully developed leaves per tiller is at the 3.0 growth stage, and one with three fully developed leaves and its fourth leaf at half the length of the previous leaf is at the 3.5 growth stage (Figure 24). Leaves are normally described by increments of 0.1.

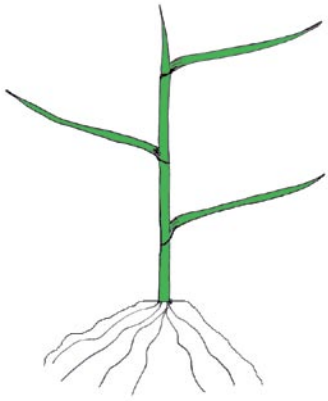


Figure 24 A grass tiller at the 3.5 growth stage. The first three leaves have fully developed collars and the fourth leaf is about 50% emerged.

The development stage is more difficult to determine in some species, such as bluebunch wheatgrass and pinegrass, because the first two leaves are usually much shorter than leaves 3, 4, and 5, and often break off or senesce early in the season (Figure 25). In these cases it is important to look for the development of the leaf collar and then to interpret how much of the next leaf has emerged, based on leaf form. Also look for evidence that the first and second leaves have dropped off—the leaf collar should still be present.

In crested wheatgrass, it is common for new tillers to develop during the previous fall and for some leaves to overwinter. These leaves, although brown along the tips, are green farther down and able to begin photosynthesis as soon as the temperature is favourable. These leaves should be included in the leaf count when determining readiness.

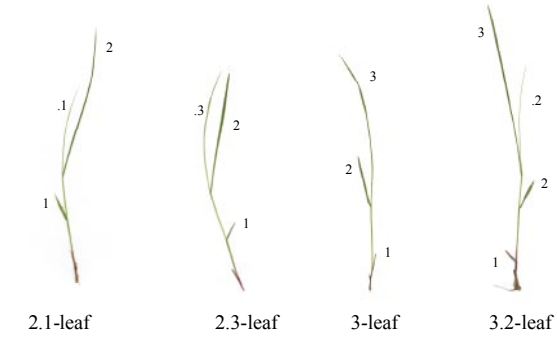


Figure 25 Pinegrass tillers at different stages of leaf development.

Leaf development is directly correlated with growing degree-days (GDDs). Species such as junegrass (*Koleria macrantha*) develop all leaves early in the season, while others such as western wheatgrass (*Agropyron smithii*), bluebunch wheatgrass, and needle-and-thread require many more growing degree-days to reach the equivalent stage of development. Leaf stage is relatively easy to determine for most grasses and removes much of the uncertainty about the safe time for grazing.

Several years of observing grasses in the spring and comparing notes with others from across western Canada has resulted in the following conclusions:

- Most introduced forages such as crested wheatgrass, meadow brome (*Bromus riparius*), and orchardgrass (*Dactylis glomerata*) are ready to graze when most (70%) plants have 3.0–3.5 leaves per tiller. The plants can be grazed without damage, and have enough volume to allow for efficient harvesting by cattle.
- More research and observation is needed on native grasses, but, in general, most (70%) indicator grasses (the most important species or the species most susceptible to grazing) should have 4.0 leaves per tiller before grazing begins.
- Northern wheatgrass (*Agropyron dasystachyum*), common in the Peace River area, is somewhat more difficult to assess because its lower leaves dry up or senesce as the season progresses. Based on observations on these rangelands, managers should be waiting for most (70%) grass plants to have 5.5 leaves per tiller before grazing begins.

Recommendations for common grasses are found in Table 4.

Table 4 Range readiness by leaf stage and by GDDs

Species	Readiness Criteria	Estimated GDDs
Native		
Bluejoint (Canada reedgrass)	4.0	
Fescue, Altai	4.5	1190
Fescue, Idaho	4.0	1070
Fescue, rough	4.5	1190
Hairgrass, tufted	4.0	
Junegrass	4.0	520
Needlegrass – Columbia, green, and stiff	3.0	580
Needlegrass – needle-and-thread	3.0	525
Needlegrass – porcupine grass	3.0	600
Pinegrass	2.25–2.5	
Wheatgrass, bluebunch	4.0	830
Wheatgrass, northern	5.5	1100
Wheatgrass, western	4.0	770
Wildrye, blue	4.0	
Wildrye, hairy	4.0	
Introduced		
Bromegrass – meadow and smooth	3.0	375
Orchardgrass	3.0	
Ryegrass – Italian and perennial	4.0	
Timothy		
Wheatgrass, crested	3.5	290

Note: Readiness criteria and GDDs requiring validations are highlighted.

4.2.1 Recommendations

- Locate key areas (monitoring sites) that fairly represent the range or pasture unit as a whole.
- Do not select sites that green-up first or last because of their slope, aspect, or soils.
- In these key areas, determine the grass species that will be used to determine readiness. These indicator species should be the most important forage species or the species most susceptible to grazing.
- Walk across the key area and the measure leaf development of about 50 grass plants.
- On most native range, use 3.5 or 4.0 leaves per tiller as the readiness criterion. On tame pastures, use 3.5 leaves per tiller as the readiness criterion.
- The pre-determined leaf stage should be reached on 70% of indicator grass plants before grazing begins.

4.2.2 A final word of caution

Range readiness observations should be part of an ongoing monitoring program. Remember to watch for changes in the plant community, as they may indicate that the range is being grazed improperly. Grazing that is too early, too frequent, or too severe will lead to:

- reduced plant vigour,
- a shallower root system and less resistance to drought,
- a change in plant species composition (a decline in the number of perennial grass plants and palatable forbs and an increase in weedy plant species), and
- an increase in bare ground.

The information gained from monitoring should be used to fine-tune our management and to help us avoid repeating past mistakes. Flexibility and adaptation are the keys to successful range management.

4.3 Using Growing Degree-days as an Indicator of Readiness

Researchers[9] in North Dakota have correlated leaf-stage development with growing degree-days (GDDs) in several native and introduced grass species. Their findings allow range managers with large districts to supplement field observations with mean daily temperature data from local weather stations to determine when various spring "turn-out" pastures will be ready for grazing in a given year.

The modified procedure for British Columbia is as follows:

- After a pasture is snow-free, and beginning not earlier than March 1 on the coast, March 15 in the southern interior, and April 1 in the remainder of the province, there must be 5 consecutive days when the daily average temperature exceeds 0°C before GDDs begin to accumulate. This is referred to as "start-up."
- GDDs are calculated by the formula:
  (daily max. + daily min.)/2 – 0°C= ___ GDDs.
- If, after start-up, the mean daily temperature does not reach 0°C for 1 or more days, enter 0 in the form for those days so as not to affect the accumulated GDD total. Do not enter a negative number. When the mean daily temperature again exceeds 0°C, the GDDs will accumulate from where they stopped.

North Dakota has information on junegrass, needle-and-thread, green needlegrass, western wheatgrass, and crested wheatgrass (see Table 4).

9 Frank, A.B and L. Hofmann. 1989. Relationship among grazing management, growing degree-days, and morphological development for native grasses on the Northern Great Plains. J. Range Manage. 42(3): 199–202.

Frank, A.B. 1996. Evaluating grass development for grazing management. Rangelands 18(3): 106–109.

Frank, A.B., K.K. Sedivec, and L. Hofmann. 1993. Determining grazing readiness for native and tame pastures. North Dakota State University, Extension Service, Fargo, N. Dak. R-1061.

The B.C. Ministry of Forests and Range maintains a network of automated fire weather stations that may provide an opportunity for people wishing to correlate the GDD concept with grass leaf-stage development. See the following website:

http://www.for.gov.bc.ca/protect/weather/stations.htm

Stations of particular interest to range managers are those:

- at lower to middle elevations;
- on south and southwest aspects; and
- in grasslands, shrublands, and open forests.

Many of these sites coincide well with range readiness turn-out pastures, as these are the first areas to become snow-free, to have spring plant growth and dry-out, and to become a fire hazard.

Daily maximum and minimum temperatures for key weather stations at lower elevations can be obtained beginning in mid-March to early April of each year. These data can be fed into an Excel spreadsheet by locality and grass species. When the accumulated GDDs are reached for the grass species in that pasture unit, the area is approaching range readiness.

The North Dakota research in mixed-grass prairie showed that past management and level of use had no appreciable effect on leaf development. However, observations of bunchgrass range in British Columbia show an apparent difference in leaf-stage development when comparing lightly grazed plants to heavily/severely grazed plants.

In the Rocky Mountain Trench in 2003, lightly grazed rough fescue and bluebunch wheatgrass plants were phenologically 1.5–2.0 leaves ahead of neighbouring heavily grazed plants of the same species.

Why the difference? The lightly grazed plants had more standing litter and therefore better insulation around the new tillers. This insulation buffered the plants from the temperature extremes experienced in spring, particularly at night when heat loss can be significant. This

resulted in higher effective GDDs for the lightly grazed plants and translated to higher leaf numbers.

There is a need to gather and correlate GDD data to leaf stage for important grass species in British Columbia, and to supplement the information from North Dakota. These species are listed in Table 5. Refer to the range readiness criteria brochure[10] for procedures on sampling and determining leaf-stage development, and for appropriate leaf stage by grass species. Ideally, specific plants should be tagged and revisited over the course of the growing season, and leaf stage should be recorded on each visit.

You can use either the attached Excel spreadsheet in Section 4.4 or enter the information manually into the table in Section 4.5. Excel provides a running total of GDDs.

10 Fraser, D.A. 2004. Using range readiness criteria. B.C. Ministry of Forests, Victoria, B.C. Rangeland Health Brochure 5.

Table 5 Important grass species in British Columbia, tabulated by Forest Region

Forest Region	Species
Coastal Region (CR)	Orchardgrass
	Ryegrass – perennial and Italian
	Wildrye, blue
Southern Interior Region (SIR)	Fescue, Idaho
	Fescue, rough
	Hairgrass, tufted
	Junegrass
	Needlegrass – Columbia, green, and stiff
	Needlegrass – needle-and-thread
	Needlegrass – porcupine grass
	Orchardgrass
	Pinegrass
	Wheatgrass, bluebunch
	Wheatgrass, crested
	Wheatgrass, western
Northern Interior Region (NIR)	Bluejoint (Canada reedgrass)
	Bromegrass – smooth and meadow
	Fescue, Altai
	Needlegrass – needle-and-thread
	Needlegrass – porcupine grass
	Timothy
	Wheatgrass, northern
	Wildrye, blue
	Wildrye, hairy

Bluebunch wheatgrass is in the 3.75-leaf stage and balsam root is 70% in bloom.

4.4 Excel Spreadsheet

Depending on locality, begin recording daily mean temperatures when pastures are snow-free, but not earlier than March 1 on the coast, March 15 in the southern interior, and April 1 in the remainder of the province.

The Excel spreadsheet has a formula allowing the entry of actual mean daily temperatures even if they are below 0°C. There must be 5 consecutive days with mean daily temperatures greater than 0°C before Excel will begin to accumulate GDDs at start-up. If, after start-up, the mean daily temperature does not reach 0°C for 1 or more days, the accumulated GDD total will not be affected. When the mean daily temperature again exceeds 0°C, the GDDs will accumulate from where they left off. When the target GDDs (if any) are reached, Excel will shade the field from that day onward. Access the Excel spreadsheet at: <http://www.for.gov.bc.ca/hfd/pubs/docs/Bro/Bro84/GDD.xls>

It is important to complement GDD data with field observations. Ideally, specific plants should be tagged and revisited over the course of the growing season, and leaf stage should be recorded on each visit.

Accumulated Growing Degree-Days Example

Year: 2003 Weather Station: Airport Aspect: SW Elevation:

Range Unit/Pasture:

Indicator Grass Species:

RCO

RNI

RSI Wheatgrass,

Required GDDs: 290

	March			April			
Day	Mean Daily Temp.	Accumulated GDDs	Leaf No.	Mean Daily Temp.	Accumulated GDDs	Leaf No.	Mean Daily Temp.
1		0		7	72		10
2		0		8	80		10
3		0		9	89		12
4		0		6	95		15
5		0		8	103		12
6		0		9	112		10
7		0		10	122		9
8		0		9	131		10
9		0		9	140		16
10		0		11	151		16
11		0		9	160		16
12		0		8	168		16
13		0		10	178		16
14		0		10	188		15
15	0	0		8	196		16
16	-1	0		12	208		18
17	2	0		4	212		18
18	3	0		9	221		15
19	0	0		10	231		14
20	4	0		14	245		15
21	0	0		15	260		18
22	0	0		12	272		18
23	5	5		12	284		15
24	7	12		12	296		14
25	7	19		4	300		14
26	8	27		8	308		14
27	8	35		10	318		15
28	7	42		10	328		15
29	6	48		10	338		15
30	8	56		12	350		16
31	9	65					17
Total		65			350		

UTM:

Leaf No. #VALUE!

Leaf No. #VALUE!

crested Leaf No. 3.5

May		June			July		
Accumulated GDDs	Leaf No.	Mean Daily Temp.	Accumulated GDDs	Leaf No.	Mean Daily Temp.	Accumulated GDDs	Leaf No.
360			800			800	
370			800			800	
382			800			800	
397			800			800	
409			800			800	
419			800			800	
428			800			800	
438			800			800	
454			800			800	
470			800			800	
486			800			800	
502			800			800	
518			800			800	
533			800			800	
549			800			800	
567			800			800	
585			800			800	
600			800			800	
614			800			800	
629			800			800	
647			800			800	
665			800			800	
680			800			800	
694			800			800	
708			800			800	
722			800			800	
737			800			800	
752			800			800	
767			800			800	
783			800			800	
800						800	
800			800			800	

4.5 Manual Calculations

Accumulated Growing Degree-Days for the Year: _____
Station: _____ UTM: _____ Aspect: ____ Elevation: _____
Range Unit/Pasture: _____ Utilization Level:_____
Indicator Grass Species: _____ Leaf Stage: _____ GDDs: _____

Depending on locality, begin recording daily mean temperatures when pastures are snow-free, but not earlier than March 1 on the coast, March 15 in the southern interior, and April 1 in the remainder of the province. There must be 5 consecutive days with mean daily temperatures greater than 0°C before beginning to accumulate GDDs at start-up. Enter the mean daily temperature in °C and add until GDDs for the grass species are reached.

A bluebunch wheatgrass tiller in the 4-leaf stage.

If, after start-up, the mean daily temperature does not reach 0°C for 1 or more days, enter 0 in the form for those days so as not to affect the accumulated GDD total. Do not enter a negative number. When the mean daily temperature again exceeds 0°C, the GDDs will accumulate from where they left off.

It is important to complement GDD data with field observations. Ideally, specific plants should be tagged and revisited over the course of the growing season, and leaf stage should be recorded on each visit.

Open south exposures are the first to green-up in spring.

Year _____

	March		April		May		June		July	
Day	**Temp**	**Leaf**	**Temp**	**Leaf**	**Temp**	**Leaf**	**Temp**	**Leaf**	**Temp**	**Leaf**
1										
2										
3										
4										
5										
6										
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29										
30										
31										
Σ										

Σ >/ GDDs on _____
(date)

Section 5 Livestock

Animal unit month equivalencies

An animal unit month (AUM) is the quantity of forage consumed by a 450-kg cow (with or without calf) in a 30-day period. The AUM is the metre-stick we use to gauge forage consumption by herbivores. Table 6 provides animal unit (AU) equivalencies for several grazing herbivores.

Table 6 Animal unit (AU) equivalencies according to body weight. Daily intake is in kilograms of dry matter per day. "Forage use" takes losses due to trampling, fouling, grazing, and insects into account.

Animal	Weight (kg)	AU equiv.	No. per AU	Intake (kg/day)*	Forage use (kg/day)*
Cow	450	1.0	1	10	13
Cow	680	1.4	0.74	14	18
Heifer	320	0.8	1.25	8	10.5
Bull	770	1.5	0.7	15	19
Horse	600	1.2	0.8	12	15.5
Sheep	55	0.2	5.0	2	2.5
Pronghorn	55	0.2	5.0	2	2.5
Deer	70	0.25	4.0	2.5	3
Elk	275	0.7	1.4	7	9
Ground squirrel	0.5	0.006	177	0.06	0.07
Jack rabbit	3	0.024	42	0.2	0.3

* Expressed in dry matter

Reductions in cattle carrying capacity

Tables 7 and 8 provide general guidelines for determining stocking rates where minimum livestock management is being employed.

Table 7 Suggested reduction in cattle carrying capacity according to percentage slope

% slope	% reduction in carrying capacity
0–10	0
11–30	30
31–60	60
>60	100 (ungrazable)

Table 8 Suggested reduction in cattle carrying capacity according to distance from water

Distance from water (km)	% reduction in carrying capacity
0–1.5	0
1.5–3	50
>3.0	100 (ungrazable)

5.1 Determining Available Forage

The following is a simple procedure to determine available forage without the need to oven-dry forage samples.

Equipment

- A circular hoop of either 0.25 m^2 or 0.5 m^2 area. You can make a hoop by joining a cable of either 1.77 m or 2.51 m length, respectively
- Clippers
- A hand-held spring scale that weighs in grams
- Paper bags

Procedure

1. Select a transect line to be representative of the pasture and plant community.

2. Place the hoop at the start of the transect and clip all plant material within the hoop to ground level. For the purpose of determining forage for cattle, do not clip shrubs or trees. If you are doing a determination for wildlife, include the current year's growth of shrubs/trees.
3. Discard unpalatable plants and old litter. Weigh the empty paper bag, then weigh the bag with the forage sample, and deduct the difference.
4. Take several samples at pre-determined distances (e.g., every 100 paces) along the transect. If there are different plant community types, keep the samples separate, as they will have different production levels and carrying capacities.
5. To determine the amount of usable dry matter, use the conversion tables provided (Tables 9, 10, and 11).
6. To determine the dry weight in kg/ha, if you are using the **0.25 m^2** hoop, multiply the weight in grams by **40** to get kg/ha. If you are using the **0.5 m^2** hoop, multiply the weight in grams by **20** to get kg/ha.

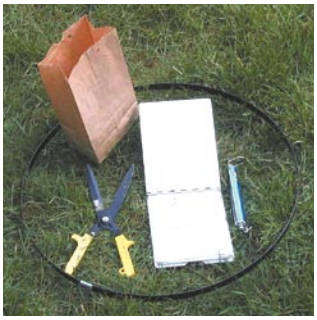


Figure 26 Required equipment.

Figure 27 Clipping a plot.

Figure 28 The bagged sample.

7. Multiply the kg/ha by a utilization factor (usually 50%) to determine the amount of forage/ha that can be safely consumed from each plant community type.
8. Multiply the total ha by the amount of available forage for each type.
9. Since each cow-calf unit will consume about 400 kg/month of dry matter, divide the total available forage by 400 kg to determine the number of animal unit months (AUMs) the area can support.

Figure 29 Weighing the sample.

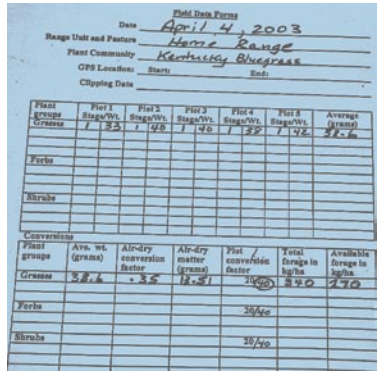


Figure 30 The completed field data forms.

Conversion tables

Table 9 Percentage of dry matter in grasses and sedges clipped at different growth stages*

	Prior to boot stage (%)	Boot stage to flowering (%)	Seed ripe (dry tips) (%)	Dry leaves and part stems (%)	Dormant (%)
Grasses and sedges	35	45	60	85	95

* Source: USDA NRCS National Range Handbook.

Table 10 Percentage of dry matter in forbs clipped at various growth stages*

	Initial growth (%)	Flowering (%)	Seed ripe; leaf tips dry (%)	Leaves dry; stems dry (%)	Dry (%)
Succulents (buttercups, violets, lilies)	15	35	60	90	100
Leafy (balsamroot, clovers, geranium, lupines)	20	40	60	90	100
Fibrous leaves (Eriogonum, Erigeron)	30	50	75	90	100

* Source: USDA NRCS National Range Handbook.

Table 11 Percentage of dry matter in shrubs and trees clipped at various growth stages*

	New leaf and twig growth (%)	Full-size green and older leaves (%)	Green fruit (%)	Dry fruit (%)
Evergreen shrubs (bigsage, ceanothus)	55	65	35	85
Deciduous shrubs (snowberry, willows)	35	50	30	85
Deciduous trees (aspen, maples, alders)	40	55	35	85

* Source: USDA NRCS National Range Handbook.

5.2 Field Data Forms

Date _____

Range Unit and Pasture _____

Plant Community _____

GPS Locations: Start:_____End _____

Clipping Data

Plant groups	Plot 1 Stage/Wt.		Plot 2 Stage/Wt.		Plot 3 Stage/Wt.		Plot 4 Stage/Wt.		Plot 5 Stage/Wt.		Average (grams)
Grasses											
Forbs											
Shrubs											

Conversions

Plant groups	Average weight (grams)	Air-dry conversion factor	Air-dry matter (grams)	Plot conversion factor (circle)	Total forage in kg/ha	Available forage in kg/ha
Grasses				20/40		
Forbs				20/40		
Shrubs				20/40		

Appendix 1 Orders of the Canadian Soil Classification System

Regosolic: Soils having insufficient A or B horizon development to meet the requirements of other orders, perhaps on young parent materials. The Order is divided into the Regosol and the Humic Regosol Great Groups.

Chernozemic: Soils that have developed under xerophytic or mesophytic grasses and forbs, or under grassland-forest transition vegetation, in cool to cold, subarid to subhumid climates. These soils have a dark-coloured surface (Ah, Ahe, Ap) horizon and a B or C horizon or both, of high base saturation. The Order consists of the Brown, Dark Brown, Black, and Dark Gray Great Groups.

Brunisolic: Soils whose horizons are developed sufficiently to exclude the soils from the Regosolic Order, but that lack the degrees or kinds of horizon development specified for soils of other Orders. These soils, which occur under a wide variety of climatic and vegetative conditions, all have brownish Bm or Btj horizons. The four Great Groups — Melanic Brunisol, Eutric Brunisol, Sombric Brunisol, and Dystric Brunisol — are separated on basis of thickness of Ah horizons and soil reaction.

Gleysolic: Soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas, or prominent mottling, or both, in some horizons. The Gleysol, Humic Gleysol, and Luvic Gleysol are the three Great Groups.

Luvisolic: Soils that may have eluvial (Ae) horizons, and must have illuvial (Bt) horizons in which silicate clay is the main accumulation product. These soils develop under deciduous or mixed forest or forest-grassland transition in a moderate to cool climate. The Order is divided into the Gray Luvisol and the Gray Brown Luvisol Great Groups.

Podzolic: Soils of coniferous forests having podzolic B horizons (Bh, Bhf, or Bf) in which combinations of amorphous Al, Fe, and organic matter have accumulated. The sola are acid and the ion exchange capacity of the B horizons is characterized by pH-dependent charge. Three Great Groups are Humic Podzol, Ferro-Humic Podzol, and Humo-Ferric Podzol.

Solonetzic: Soils developed mainly under grass or grass-forest vegetative cover in semiarid to subhumid climates. The soils have a stained brownish solonetzic B (Bn or Bnt) horizon and a saline C horizon. The surface may be an Ap, Ah, Ahe, and/or Ae horizon. The Order includes the Solonetz, Solodized Solonetz, and Solod Great Groups.

Organic: Soils that have developed in organic deposits. The majority of organic soils are saturated for most of the year. They contain more than 17% organic carbon. The four Great Groups are the Fibrisol, Mesisol, Humisol, and Folisol.

Cryosolic: Mineral or organic soils of sub-arctic and arctic regions that have permafrost within 1 m of the surface (2 m of the surface if more than one-third of the pedon has been strongly cryoturbated, as indicated by disrupted, mixed, or broken horizons). There are three Great Groups — Turbic Cryosol, Static Cryosol, and Organic Cryosol.

Vertisolic: (A newly introduced soil Order) Clay soils that lack the degree of development necessary for other Orders and that have deep, wide cracks at some time during the year and have high bulk density between the cracks. These soils have marked shrink-swell tendencies with changes in soil water content resulting in wedge-shaped aggregates and/or evidence of severe disruption of horizons in the solum.

Simplified Key to Soil Orders

1. Is the **Bf, Bhf, or Bh** at least **10** cm thick?	If this is true, then the soil belongs to **Podzolic Order**. If false, go to the next step.
2. Is the **Bg or Cg** within 50 cm of surface?	If this is true, then the soil belongs to **Gleysolic Order**. If false, go to the next step.
3. Is **Bn or Bnt** horizon present?	If this is true, then the soil belongs to **Solonetzic Order**. If false, go to the next step.
4. Is Chernozemic **Ah or Ap** present?	If this is true, then the soil belongs to **Chernozemic Order**. If false, go to the next step.
5. Is **Bt** horizon present?	If this is true, then the soil belongs to **Luvisolic Order**. If false, go to the next step.
6. Is the **Bm** at least 5 cm thick?	If this is true, then the soil belongs to **Brunisolic Order**. If false, go to the next step.
7. As all the other possibilities have been eliminated, this soil belongs to the **Regosolic Order**	

Other classification systems can also be applied to soil. For example, the Soil Capability for Agriculture Classification is an example of an interpretive or technical classification. Soil areas are placed into classes (from Class 1 to Class 7) based on the degree of limitation to the production of common agricultural crops. A similar kind of classification exists for forestry.

Appendix 2 Key to Soil Texture

Soil texture field tests

Graininess Test Rub the soil between your fingers. If sand is present, it will feel "grainy." Determining whether sand constitutes more or less than 50% of the sample is the first decision in the key.

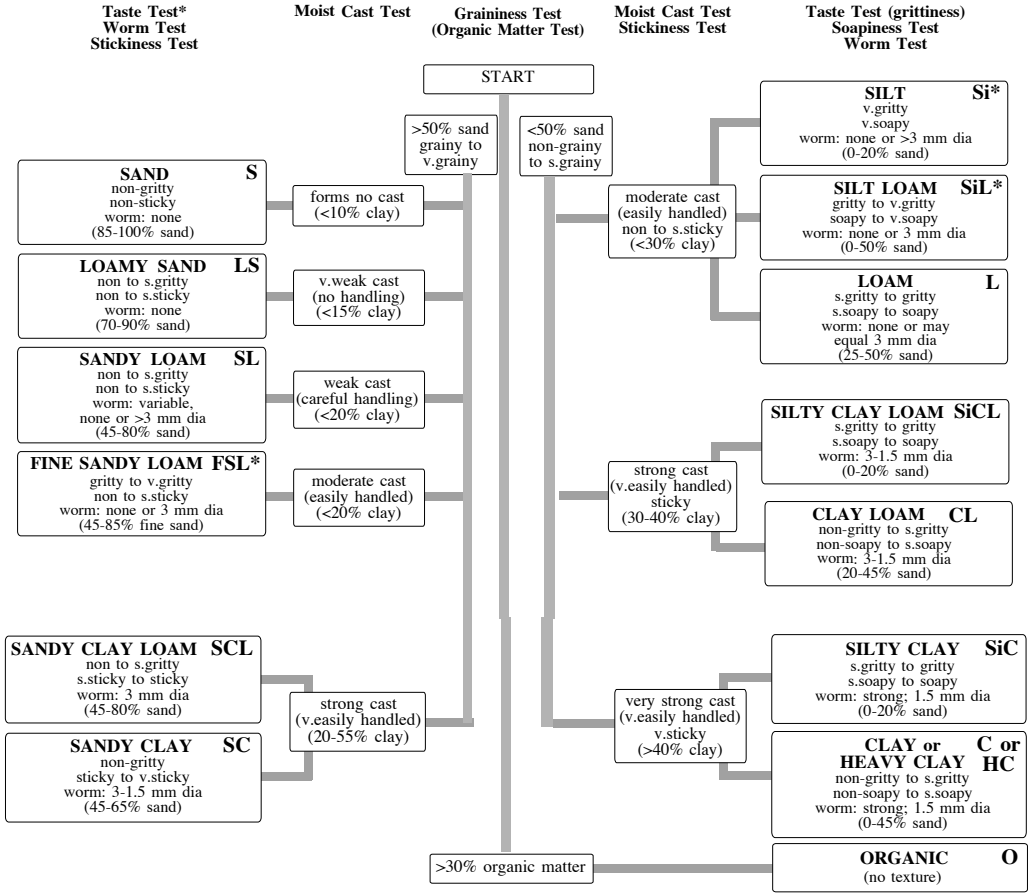
Moist Cast Test Compress some moist soil by clenching it in your hand. If the soil holds together (i.e., forms a "cast"), then test the durability of the cast by tossing it from hand to hand. The more durable it is, the more clay is present.

Stickiness Test Moisten the soil thoroughly and compress it between thumb and forefinger. Determine degree of stickiness by noting how strongly the soil adheres to the thumb and forefinger when pressure is released, and how much it stretches. Stickiness increases with clay content.

Worm Test Roll Roll some moist soil between the palms of your hands to form the longest, thinnest "worm" possible. The more clay present, the longer, thinner and more durable the worm will be.

Taste Test (Not recommended due to health concerns) Work a small amount of moist soil between your front teeth. Silt particles are distinguished as fine "grittiness," unlike sand, which is distinguished as individual grains (i.e., graininess). Clay has no grittiness. Well-decomposed organic matter imparts silt-like properties to the soil. However, when subjected to the taste test, it feels non-gritty. It is generally very dark in colour when moist or wet, and stains the hands brown or black. This organic matter is not used as a determinant of soil texture; an estimate of the silt content of humus-enriched mineral soils should be reduced accordingly.

Soapiness Test Work a small amount of wet soil between your thumb and fingers. Silt feels slick and not too sticky (i.e., clay) or grainy (i.e., sand); the greater the dominance of a slick feel, the greater the silt content.



* Silt feels slippery or soapy when wet; fine sand feels stiffer, like grinding compound or fine sandpaper.

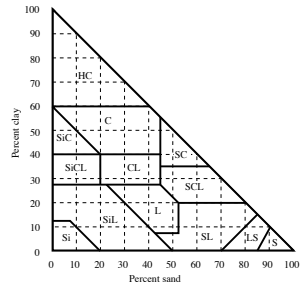
Key to Abbreviations

s = slightly
v = very
dia = diameter

Measurement Conversions

3.0 mm = 1/8"
1.5 mm = 1/16"

Fine Fraction	**(particle diameter)**
SAND ---------- (S)	2 - .05 mm
SILT ---------- (Si)	.05 - .002 mm
CLAY ---------- (C)	<.002 mm

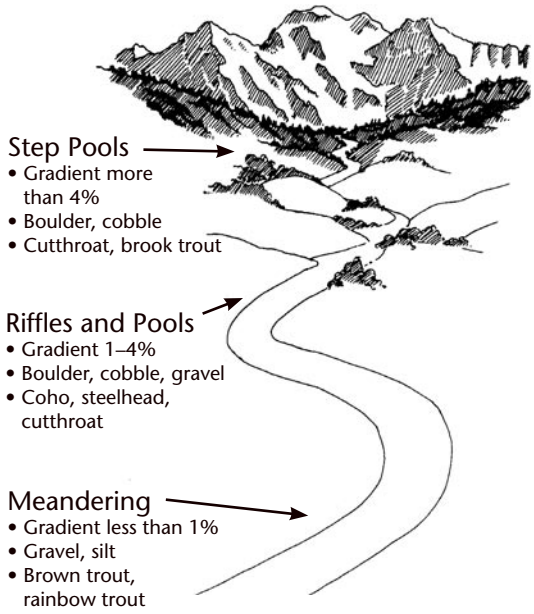


Soil texture triangle

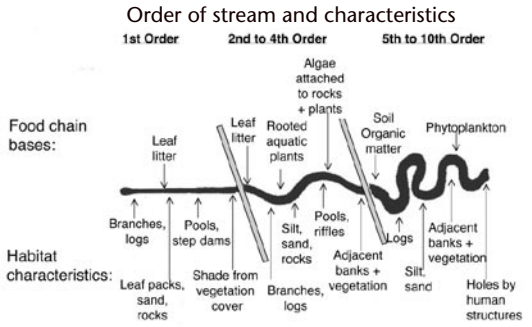
Figure A2.1 Soil texture key

Appendix 3 Stream Channel Morphology and Characteristics

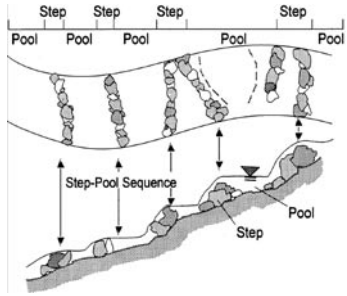
Watershed divide



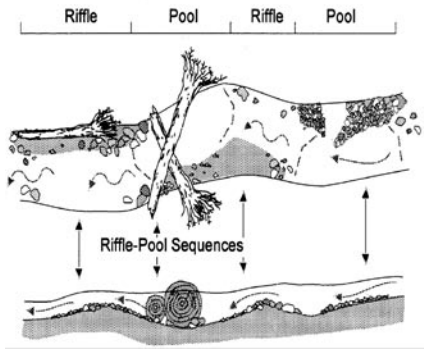
Primary food and habitat characteristics for fish along a river system



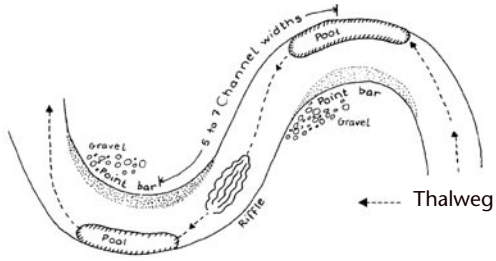
Step-pool sequence



Riffle-pool sequence



Meandering channel



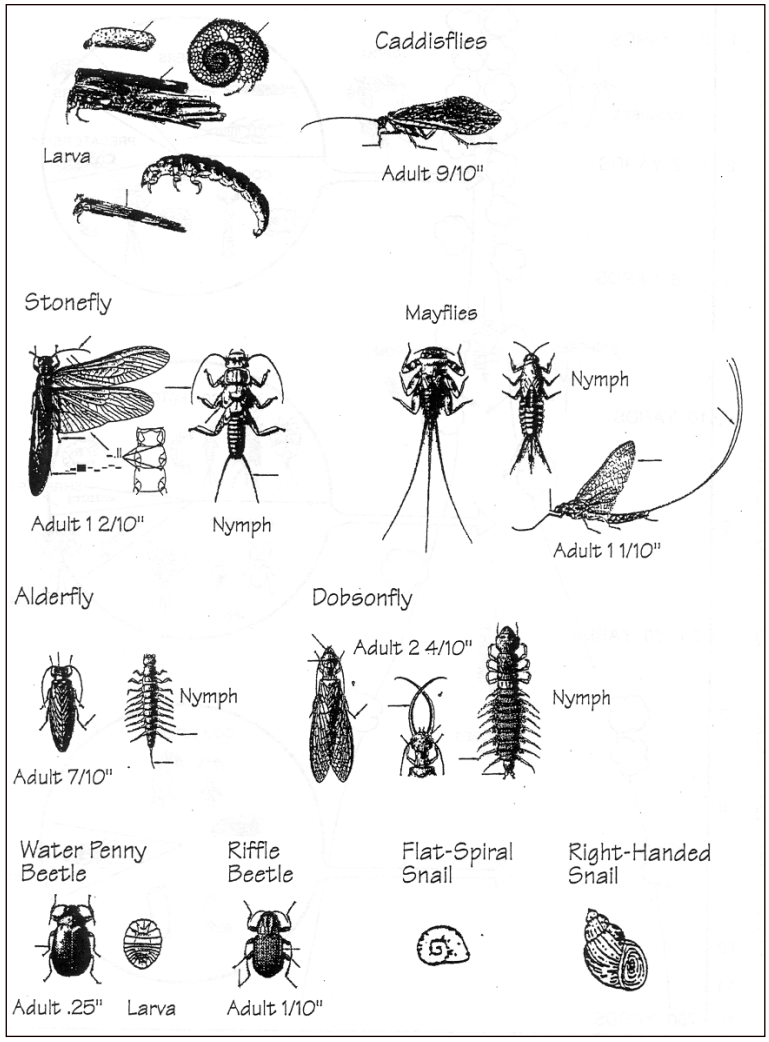
The meandering flow pattern increases the length of the channel between two points. This increased length effectively dissipates the force of the stream's energy over a longer distance than in a straight channel.

Appendix 4 Key to Aquatic Macroinvertebrates*

Insect Groups Arranged by Tolerance to Pollution

Group 1: Intolerant

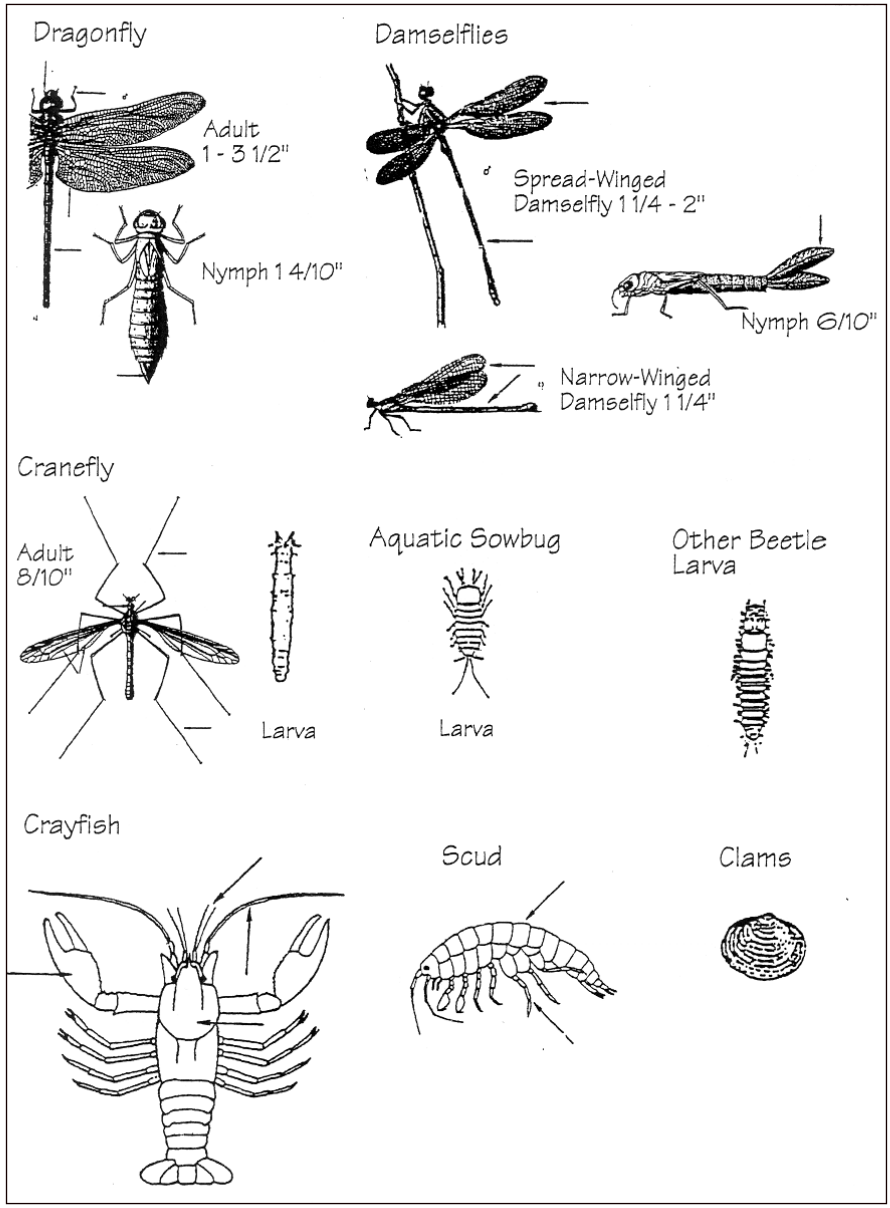
These organisms are sensitive to pollution. Their dominance generally suggests good water quality.



** Used with permission by Oregon Trout <http://www.ortrout.org>*

Group 2: Somewhat Tolerant

These organisms can tolerate a wider range of water quality conditions.



Group 3: Tolerant

These organisms are generally tolerant of pollution. Their dominance suggests poor water quality.

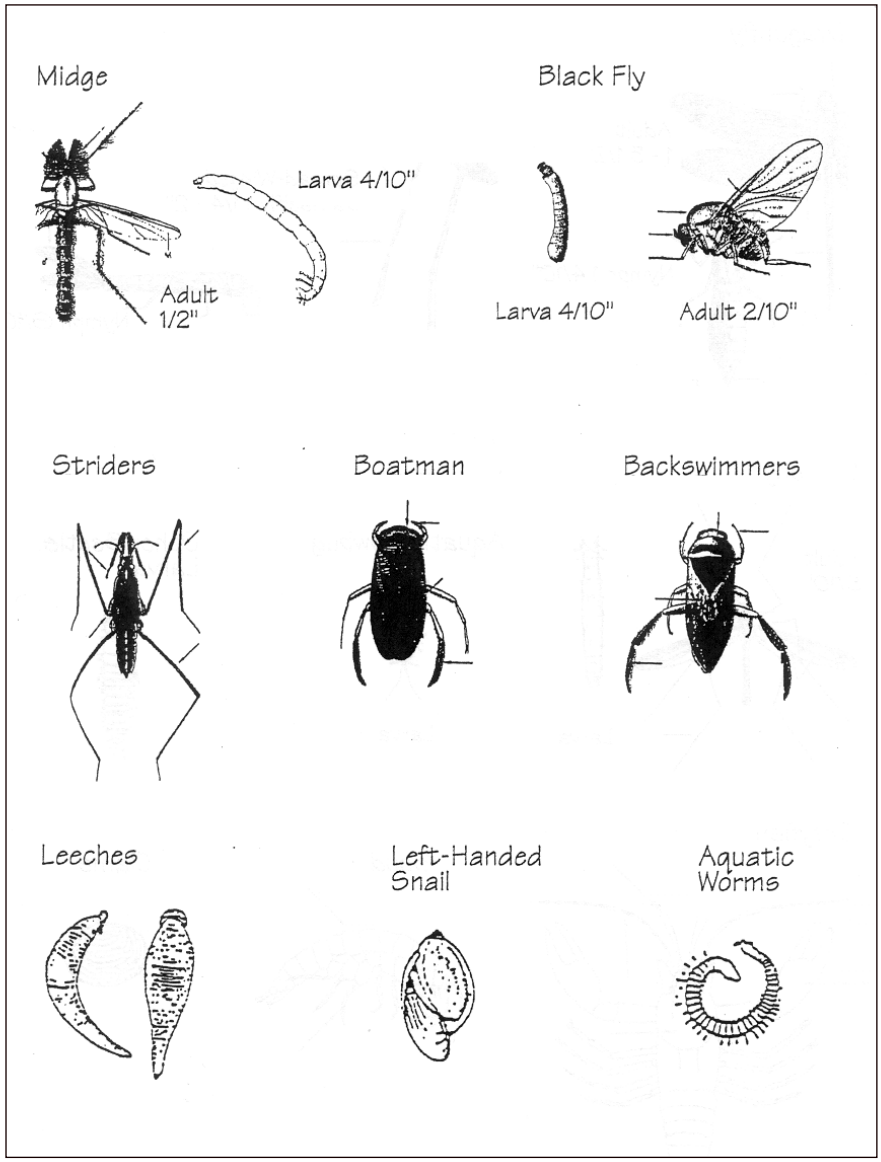
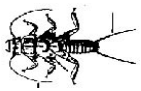
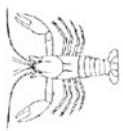


Table A4.1 Summary of macroinvertebrate data

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things To Look For
Stonefly Nymph 	2 tails, 2 sets wing pads, (wing pads not always noticeable)	Cold running water	Through body surface; some small gills; does "pushups" to increase oxygen flow	Predator or herbivore	Streamlined body for crawling on rocks; requires high oxygen levels
Mayfly Nymph 	3 tails (sometimes 2); 1 set wing pads	Cool or cold running water	Through gills along abdomen; may wave gills in water to increase oxygen flow	Herbivore or scavenger	Requires high to medium oxygen levels
Caddisfly Larva 	Most species build cases or nets; soft body, some free living	Cool or cold running water; ponds	Through body surface; some fingerlike gills	Filter feeder, herbivore, predator	Builds cases of heavy material (rocks) to avoid being swept away by fast-flowing streams; uses grass and plants to make cases as well
Water Penny Larva 	Round, flat, segmented, disklike body	Cold running water	Usually through gills on underside	Herbivore—grazes on algae	Flattened body resists pull of current
Predaceous Diving Beetle Larva 	Up to 6 cm long; robust jaws	Most still and moving water habitats	Through body surface	Voracious predator	Special channels in jaws to suck body fluids of prey

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things To Look For
Whirligig Beetle 	Black; congregates in schools	Surface of quiet water	From atmosphere	Predator or scavenger	Has two pairs of eyes to see above and below water's surface; has type of "radar" to locate object in water; secretes white odorous substance to deter predators
Black Fly Larva 	Small body; small hooks at end of abdomen attach to rocks	Cold running water	Through body surface; small gills	Filter feeder	Anchors to rocks with silk; only needs medium to high oxygen levels
Dragonfly Nymph 	Stout body; arm-like grabbing mouthpart	Cool still water	Dissolved oxygen, through gills in internal body chamber	Active predator	Clings to vegetation or hides in clumps of dead leaves or sediment
Damselfly Nymph 	3 leaf-like gills at end; arm-like grabbing mouthpart	Cool still water	Through gills at end of abdomen	Active predator	Clings to vegetation or hides in clumps of dead leaves or sediment
Hellgrammite (Dobsonfly, Alderfly, or fishfly Larva 	Up to 9 cm long	Cool or cold, slow to fast moving water	Through gills along side of abdomen; some fish flies have breathing tubes	Active predator	Can swallow prey without chewing

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things To Look For
Water Strider Adult 	Skates on water's surface	Ponds or still pools of stream	From atmosphere	Active predator	Can stay on water's surface because feet have small surface area and are water-repellent
Water Boatman Adult 	Long swimming hairs on legs	Ponds or still pools of stream	From atmosphere, by carrying air bubble from water's surface on body	Omnivore, herbivore, or scavenger	Has swimming hairs on legs that act as oars
Backswimmer Adult 	Light-coloured underside; swims on back	Ponds or still pools of streams	From atmosphere, by carrying air bubble from water's surface on body	Predator	Swims on back, sleek body shape
Cranefly Larva 	Cylindrical body; often has lobes at hind end, may have small soft legs	Bottoms of streams and ponds in sediment and algae	From atmosphere through spiracles (openings) at hind end	Active predator, herbivore, or omnivore	Species that eat woody decaying matter have gut bacteria to digest cellulose
Mosquito Larva 	Small body; floats at surface	Cool to warm still water	From atmosphere through breathing tube, on hind end as a larva and front end as pupa	Scavenger—feeds on micro-organisms	Swims or dives when disturbed

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things To Look For
Aquatic Sowbug 	Flattened body, top to bottom; 7 pairs legs	Shallow freshwater, among rocks and dead leaves	Through body surface on legs	Scavenger—eats decaying matter, or omnivore	Male clasps female under it during mating; female then sheds half of exoskeleton, which becomes case into which fertilized eggs are placed
Crayfish 	5 pairs legs, first pair often robust; looks like small lobster	Under rocks or in burrows in shallow freshwater	Through gills under body	Scavenger or omnivore	Crawls backwards when disturbed; males display some courtship behaviour to reduce female aggressiveness
Scud 	Flattened body, side to side; swims on side	Bottom of lakes, streams, or ponds	Through gills under body	Scavenger or omnivore	Male carries female on its back during mating; female then sheds half of exoskeleton, which becomes case into which fertilized eggs are placed
Midge Larva 	Small thin body with a hard head and small legs on the hind end	Most still and moving water habitats	Through body surface, small gills	Predator, herbivore, or omnivore	Extremely common; sometimes red because they have hemoglobin in their blood to help transport oxygen; wiggle actively
Rat-Tailed Maggot Larva 	Cylindrical body; tail-like breathing tube	Cool to warm water with low oxygen levels	From atmosphere through breathing tube	Scavenger—eats decaying matter and sewage	Can survive low oxygen levels fatal to most invertebrates

Appendix 5 Picture-key to Grasses

Picture-key to Common Grass Tribes

1. Inflorescence a spike (spikelets without stalks).....*Hordeae*
(Barley tribe)

1. Inflorescence a panicle (spikelets with stalks).....

2. Each spikelet with 1 flower; glumes small .....*Agrostideae*
(Timothy tribe)

2. Each spikelet with 2 to many flowers (florets).....

3. Glumes shorter than first floret (lowest enclosed lemma); lemmas awnless, or awned from near the tip.....*Festuceae*
(Fescue tribe)

3. Glumes equal to, or longer than first floret (lowest enclosed lemma).....

4. Glumes narrow; lemmas awned from the back, or awnless .....*Aveneae*
(Oat tribe)

4. Glumes broad, boat-shaped; lemmas awned from a notched apex, or awnless.....*Phalarideae*
(Canarygrass tribe)

Picture-key to Grass Genera

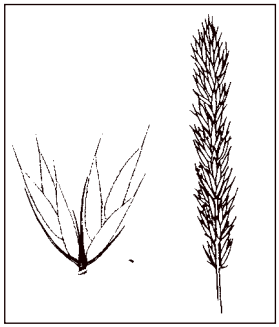
Hordeae (Barley tribe)

Inflorescence a spike

spikelets solitary at each node

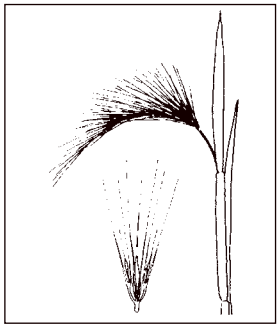
Agropyron (wheatgrass)

spikelets two at each node, alike



Elymus (wildrye)

spikelets three at each node, lateral pair reduced to awns

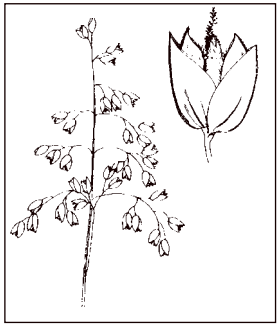


Hordeum (barley)

Phalarideae (Canarygrass tribe)

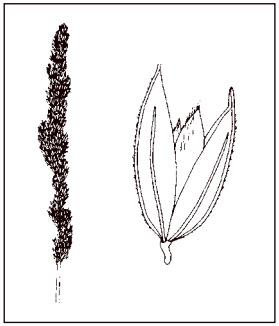
Spikelets 3-flowered; glumes broad, boat-shaped

panicle open or tufted



Hierochloe (sweetgrass)

panicle compact; spikelets crowded, all turned in same direction



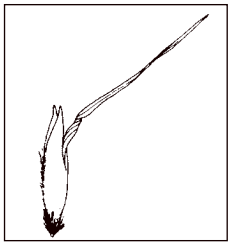
Phalaris (canarygrass)

Picture-key to Grass Genera

Aveneae (Oat tribe)

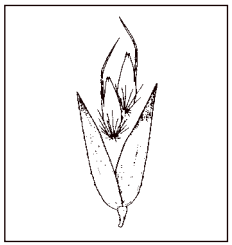
Spikelets 2 to many 6-flowered; glumes equal to or longer than first floret

- lemmas with conspicuous awn
  - awn flattened and twisted, arising from between teeth at tip



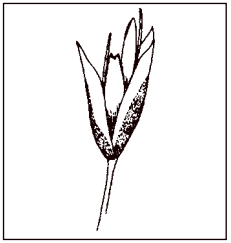
Danthonia (oatgrass)

  - awn round, arising from the back
    - lemmas 3–4 toothed at tip, awned from below middle
      - leaves flat, leaves > 3 mm wide; spikelets purplish



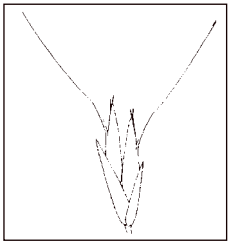
Vahlodea (mountain hairgrass)

      - leaves < 3 mm wide; spikelets greenish or tawny



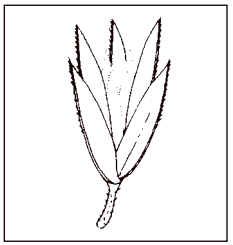
Deschampsia (hairgrass)

    - lemmas keeled, 2-toothed, awned from above middle



Trisetum (trisetum)

- lemmas awnless

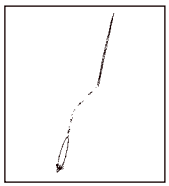
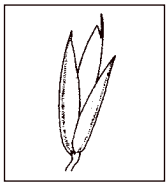
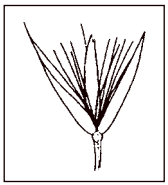
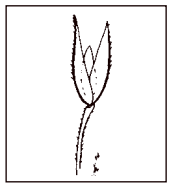
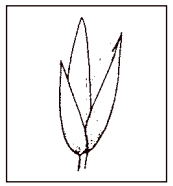
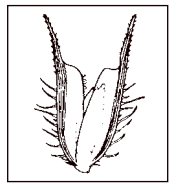


Koeleria (junegrass)

Picture-key to Grass Genera

Agrostideae (Timothy tribe)

Spikelets 1-flowered

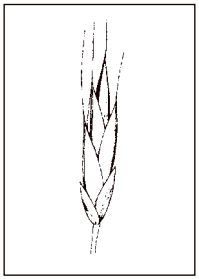
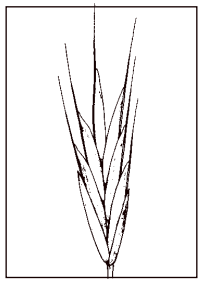
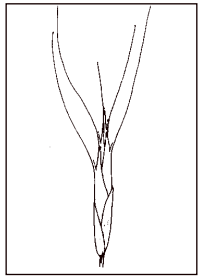
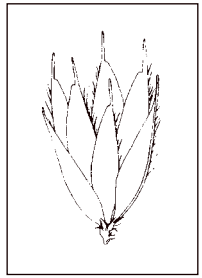
- inflorescence not spike-like
  - lemmas hard, with long awn
    - awn not twisted
      - 
      - *Oryzopsis* (ricegrass)
    - awn twisted and bent
      - 
      - *Stipa* (needlegrass)
  - lemmas not hard, awn short
    - panicle drooping
      - 
      - *Cinna* (wood-reed)
    - panicle not drooping
      - lemmas with tuft of stiff hairs at base
        - 
        - *Calamagrostis* (reedgrass)
      - lemmas lacking tuft of hair at base
        - glumes longer than lemma
          - 
          - *Agrostis* (bentgrass)
        - glumes shorter than lemma
          - 
          - *Arctagrostis* (polargrass)
- inflorescence cylindrical, spike-like
  - glumes awnless
    - 
    - *Alopecurus* (little meadow-foxtail)
  - glumes awned
    - 
    - *Phleum* (timothy)

Picture-key to Grass Genera

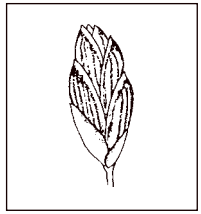
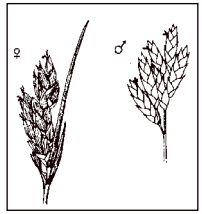
Festuceae (Fescue tribe)

Spikelets 2 to many-flowered

lemmas with awns

spikelets small; leaves narrow	spikelets large; leaves flat, broad	spikelets long, slender; glumes purplish	spikelet short and borad; lemmas bristly
			
Festuca (fescue)	*Bromus* (brome)	*Schizachne* (false melic)	*Dactylis* (orchardgrass)

Lemmas without awns

spikelets small; leaf tip boat shaped	spikelets long; lemmas striated	spikelets long; lemmas not striated	low plants; male and female heads separate
			
Poa (bluegrass)	*Glyceria* (mannagrass)	*Puccinellia* (alkaligrass)	*Distichlis* (saltgrass)

Appendix 6 Stream, Wetland, and Lake Classification

Stream Classification

Riparian class	Riparian management area (m) (reserve)	Width Qualifiers
S1-A or B	100 (0)/70(50)	>20 m
S2	50 (30)	5–20 m
S3	40 (20)	1.5–5 m
S4	30 (0)	<1.5 m
S5*	30 (0)	>3 m
S6*	20 (0)	<3 m

* non–fish-bearing, non-CWS

Wetland Classification (<2 m depth)

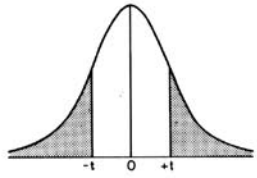
Riparian class	Criterion	Ecosystem
W1	>5 ha	Any
W2	1–5 ha	BG, PP, IDF dry, CDF, dry CWH
W3	1–5 ha	Other
W4	0.25–1 ha	BG, PP, IDF dry
	0.5–1 ha	Coastal dry
W5	complex	

Lake Classification

Riparian class	Criterion	Ecosystem
L1-A	>1000 ha	Anywhere
L1-B	5–1000 ha	Anywhere
L2	1–5 ha	BG, PP, IDF dry, CDF, dry CWH
L3	1–5 ha	Other
L4	0.25–1 ha	BG, PP, IDF dry
	0.5–1 ha	Coastal dry

Appendix 7 Distribution of Two-tailed Tests

DISTRIBUTION OF t (TWO-TAILED TESTS)



Degrees of Freedom	Probability of a Larger Value, Sign Ignored								
	0.500	0.400	0.200	0.100	0.050	0.025	0.010	0.005	0.001
1	1.000	1.376	3.078	6.314	12.706	25.452	63.657		
2	0.816	1.061	1.886	2.920	4.303	6.205	9.925	14.089	31.598
3	.765	0.978	1.638	2.353	3.182	4.176	5.841	7.453	12.941
4	.741	.941	1.533	2.132	2.776	3.495	4.604	5.598	8.610
5	.727	.920	1.476	2.015	2.571	3.163	4.032	4.773	6.859
6	.718	.906	1.440	1.943	2.447	2.969	3.707	4.317	5.959
7	.711	.896	1.415	1.895	2.365	2.841	3.499	4.029	5.405
8	.706	.889	1.397	1.860	2.306	2.752	3.355	3.832	5.041
9	.703	.883	1.383	1.833	2.262	2.685	3.250	3.690	4.781
10	.700	.879	1.372	1.812	2.228	2.634	3.169	3.581	4.587
11	.697	.876	1.363	1.796	2.201	2.593	3.106	3.497	4.437
12	.695	.873	1.356	1.782	2.179	2.560	3.055	3.428	4.318
13	.694	.870	1.350	1.771	2.160	2.533	3.012	3.372	4.221
14	.692	.868	1.345	1.761	2.145	2.510	2.977	3.326	4.140
15	.691	.866	1.341	1.753	2.131	2.490	2.947	3.286	4.073
16	.690	.865	1.337	1.746	2.120	2.473	2.921	3.252	4.015
17	.689	.863	1.333	1.740	2.110	2.458	2.898	3.222	3.965
18	.688	.862	1.330	1.734	2.101	2,445	2.878	3.197	3.922
19	.688	.861	1.328	1.729	2.093	2.433	2.861	3.174	3.883
20	.687	.860	1.325	1.725	2.086	2.423	2.845	3.153	3.850
21	.686	.859	1.323	1.721	2.080	2.414	2.831	3.135	3.819
22	.686	.858	1.321	1.717	2.074	2.406	2.819	3.119	3.792
23	.685	.858	1.319	1.714	2.069	2.398	2.807	3.104	3.767
24	.685	.857	1.318	1.711	2.064	2.391	2.797	3.090	3.745
25	.684	.856	1.316	1.708	2.060	2.385	2.787	3.078	3.725
26	.684	.856	1.315	1.706	2.056	2.379	2.779	3.067	3.707
27	.684	.855	1.314	1.703	2.052	2.373	2.771	3.056	3.690
28	.683	.855	1.313	1.701	2.048	2.368	2.763	3.047	3.674
29	.683	.854	1.311	1.699	2.045	2.364	2.756	3.038	3.659
30	.683	.854	1.310	1.697	2.042	2.360	2.750	3.030	3.646
35	.682	.852	1.306	1.690	2.030	2.342	2.724	2.996	3.591
40	.681	.851	1.303	1.684	2.021	2.329	2.704	2.971	3.551
45	.680	.850	1.301	1.680	2.014	2.319	2.690	2.952	3.520
50	.680	.849	1.299	1.676	2.008	2.310	2.678	2.937	3.496
55	.679	.849	1.297	1.673	2.004	2.304	2.669	2.925	3.476
60	.679	.848	1.296	1.671	2.000	2.299	2.660	2.915	3.460
70	.678	.847	1.294	1.667	1.994	2.290	2.648	2.899	3.435
80	.678	.847	1.293	1.665	1.989	2.284	2.638	2.887	3.416
90	.678	.846	1.291	1.662	1.986	2.279	2.631	2.878	3.402
100	.677	.846	1.290	1.661	1.982	2.276	2.625	2.871	3.390
120	.677	.845	1.289	1.658	1.980	2.270	2.617	2.860	3.373
∞	.6745	.8416	1.2816	1.6448	1.9600	2.2414	2.5758	2.8070	3.2905

Parts of this table are reprinted by permission from R. A. Fisher's *Statistical Methods for Research Workers*, published by Oliver & Boyd, Edinburgh (1925–1950); from Maxine Merrington's "Table of Percentage Points of the t-Distribution," *Biometrika* 32 (1942):300; and from Bernard Ostle's *Statistics in Research*, Iowa State Univ. Press (1954).

Appendix 8 Determining Sample Size

Whether carrying out vegetation sampling, measuring stubble height, clipping forage production plots, or measuring browse use, you will need to know how many sample measurements are needed to provide a reasonable approximation of the true value.

Say that you are measuring grass stubble heights in a key area and obtain the following 20 readings:

12	8	9	7	10	11	10	9	13	6
8	9	12	10	11	7	10	13	9	6

Now, you want to know if you have enough readings (samples) for an accurate representation of stubble height in the key area.

Calculate the sample mean and sample standard deviation (σ n-1)

Use the following formula

$$\mathbf{n = s^2t^2/d^2}$$

Where:

n = the required number of samples or measurements

s = the sample standard deviation from the mean

t = the t-table value for the appropriate degrees if freedom (no. samples – 1) and the desired level of confidence

d = the difference between the sample mean and the population (actual) mean

The sample mean is 9.5 cm.

The sample standard deviation is 2.115.

You would like the sample mean stubble height to be within +/- 1.5 cm of the actual stubble height 95% of the time. Refer to the standard t-

table for a two-tailed test under 19 degrees of freedom and a 95% confidence level (column 0.050); the value of t = 2.093.

Therefore

$$n = (2.115^2)(2.093^2)/(1.5^2) = 8.7$$

In this case 9 measurements would be sufficient.

Appendix 9 Plant Community Types

Riparian species and plant communities

Non-saline to slightly saline/moist to very moist	Saline/moist to very moist	Non-saline to slightly saline/wet to emergent **	Saline/wet to emergent**
*Agrostis scabra**	*Agropyron trachycaulum*	*Alopecuris aequalis*	*Alopecuris aequalis*
*Agrostis stolonifera**	*Agrohordeum macounii**	*Beckmania syzigachne*	*Eleocharis palustris*
Calamagrostis canadensis	*Carex praegracilis**	*Calamagrostis stricta*	*Scirpus maritimus*
Deschampsia caespitosa†	*Distichilis stricta*	*Carex aquatilis*	
*Eleocharis palustris**	*Elymus cinereus*	*Carex atherodes*	
Glyceria borealis	*Hordeum brachyantherum**	*Carex rostrata (utriculata)*	
Glyceria grandis	*Hordeum jubatum**	*Eleocharis palustris*	
*Juncus balticus**	*Juncus balticus**	*Glyceria borealis*	
Poa palustris	*Muhlenbergia richardsonis*	*Phalaris arundinacea*	
*Poa pratensis**	*Poa juncifolia*	*Scirpus acutus*	
	*Potentilla anserina**	*Scirpus validus*	
	Puccinellia nuttalliana	*Scolochloa festucacea*	
	Salicornia rubra		
	*Scirpus nevadensis**		
	Spartina pectinata		
	Typha latifolia		

** Tolerates saturated soils with anaerobic conditions for at least part of the growing season.

* Increases on this site. In the case of non-native species, consider as invaders.

† Cold sites.

Riparian trees and shrubs

Species	Soil texture	Tolerance of saturation
Alnus spp	Variable	High
Betula spp*	Sandy to silty loam	High
Cornus stolonifera	Sandy loam	Low–moderate
Populus tremuloides	Sandy loam	Low
Populus trichocarpa	Sands and gravels	Moderate
Salix spp.*	Variable texture over cobbles	Moderate. Delineates high water mark.

* Tolerates cold soil temperatures.

Community types

Cold sites

1. *Deschampsia caespitosa-Juncus balticus-Eleocharis palustris* – cold sites, generally fine-textured and poorly drained. Sometimes in association with dry upland meadows of *Danthonia intermedia* or *Festuca altaica*
   a) degrades to *Poa pratensis-Juncus balticus*

Saline sites

2. *Poa juncifolia-Muhlenbergia richardsonis-(Agropyron trachycaulum)* – saline areas, fine-textured soils, often closed basins
   a) degrades to *Hordeum jubatum-Juncus balticus*
   b) further degrades to *Achillea millefolium*, *Grindelia squarrosa,* and *Aster* spp.
3. *Distichilis stricta-Spartina gracilis-Scirpus nevadensis-(Salicornia rubra).* May be on solonetzic soils.
   a) degrades to *Hordeum jubatum-Carex praegracilis,* and *Grindelia squarrosa*

4. *Puccinellia nuttalliana-Hordeum jubatum-Scirpus nevadensis-(Salicornia rubra).* This community is not found on solonetzic soils. *Puccinellia nuttalliana* dominates wetter sites.
   a) degrades to *Hordeum jubatum* if site dries out
   b) further degrades to *Scirpus nevadensis* and *Grindelia squarrosa*

Marsh and Fen sites

5. *Carex rostrata-C. aquatilis-(Glyceria borealis).* Mixed stands. *C. rostrata* dominates sites where flooding is deeper on mineral soils. *C. aquatilis* dominates where more peat deposits and shallower flooding occur.
   a) where sites dry out, *C. candensis* and *C. stricta* become more prevalent
6. *Carex atherodes*. Mainly pure stands.
   a) but may have minor amounts of *C. rostrata*, *Beckmania syzigachne*, *C. stricta*, or *Alopecuris aequalis*

Emergent to open water sites.

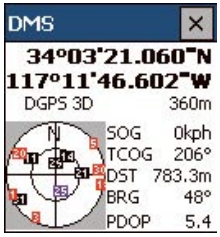
Scirpus acutus is more prevalent in wave-exposed lakes, while *S. validus* is more prevalent in protected wetlands. *Typha* may be absent.

7. *Eleocharis palustris-(Typha latifolia)-Scirpus acutus/validus.* Non-saline to slightly saline sites. *Eleocharis* sites are more shallowly flooded and have better oxygenation than *Typha* sites.
8. *Eleocharis palustris-(Typha latifolia)-Scirpus maritimus*. Saline sites. *Eleocharis* sites are more shallowly flooded and have better oxygenation than *Typha* sites. *Typha* may be absent, as it does not tolerate salinity as well.

Appendix 10 ArcPad Quick Reference*

ESRI® ArcPad™ Quick Reference

GPS POSITION WINDOW



SATELLITE SKYPLOT
Shows the almanac of which satellites should be available.
Black: available and used for calculating the GPS position
Blue: available but not used
Red: unavailable
Tap the Satellite Skyplot to display the Signal Chart

GPS POSITION COORDINATES
Tap and hold the coordinate display to change coordinate system.
Map Projection
DMS (ddd°mm'ss.sss")
DMM (ddd°mm.mmmm')
DD (dd.dddddddddº)
UTM (Universal Transverse Mercator)
WGS84 DMS (ddd°mm'ss.sss")
WGS84 DMM (ddd°mm.mmmm')
WGS84 DD (dd.dddddddddº)
MGRS (Military Grid Reference System)

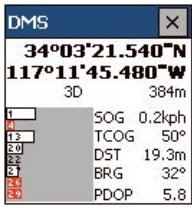
GPS MODE
NOFIX: no position
2D: x,y position
3D: x,y,z position
DGPS 2D/3D: real-time Differential GPS
RTK fix/flt: Real-Time Kinematic fixed or float solution
PPS 2D/3D: Precise Positioning Service

ELEVATION
Tap and hold the elevation display to change units.
Altitude (meters or feet)
Depth (meters or feet)

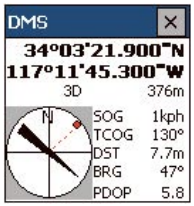
* Function checklists available at the Coastal Management web site at <http://www.crmltd.ca/crm948/>

NAVIGATION INFORMATION
SOG: Speed Over Ground
Tap and hold the COG display to change the reference.
TCOG: True North Course Over Ground
MCOG: Magnetic North Course Over Ground
DST: Distance to destination
BRG: Bearing to destination

POSITION MEASURE OF QUALITY
Tap and hold the display to change the measure.
PDOP: Position Dilution of Precision
HDOP: Horizontal Dilution of Precision
VDOP: Vertical Dilution of Precision
TDOP: Time Dilution of Precision
HPE: Estimated Horizontal Position Error
VPE: Estimated Vertical Position Error
EPE: Estimated Position Error
SATS: Satellites used in solution
DAGE: Differential data age
DSID: Differential reference station ID



SIGNAL CHART
Shows a bar chart of the relative signal strength of the satellites in the almanac. A red bar indicates the satellite is unavailable.
Tap the Signal Chart to display the Compass.



COMPASS
Shows the GPS direction with a black arrow and direction to destination in red.

MAIN TOOLBAR

 **Open Map**	Open an ArcPad map (a file with an .apm extension).
 **Save Map**	Save the current ArcPad map.
 **Add Layer**	Add one or more layers to the current map.
 **Layers**	Open the Layers dialog box.
 **GPS Position Window**	Open or close the GPS Position Window.
 **Tools**	Open the ArcPad Options dialog box.
 **Help**	Open the online help.

OPEN MAP DROPDOWN LIST

 **New Map**	Close the current map and create a new map.
 **New Layer**	Create a new shapefile and load it into the current map.
 **Open Map**	Open an ArcPad map (a file with an .apm extension).
 **Save Map**	Save the current ArcPad map.
 **Save Map As**	Save the current ArcPad map with a new name and/or in a different folder.
 **Map Properties**	Enter the title of the current map.
Recent Maps	Display the nine most recently opened maps.
Recent Layers	Display the nine most recently added layers.
 **Exit**	Close ArcPad.

ADD LAYER DROPDOWN LIST

 **Add Layer**	Add one or more layers to the current map.
 **Add Internet Server**	Add an ArcIMS® image service as a layer to the current map.
 **Geography Network**	Go to the www.geographynetwork.com Web site, using the default Internet browser.

GPS POSITION WINDOW DROPDOWN LIST

 **GPS Position Window**	Open or close the GPS Position Window.
 **GPS Active**	Activate or deactivate the GPS.
 **GPS Tracklog**	Start or stop storing GPS points in the tracklog shapefile.
 **GPS Debug**	Open or close the GPS Debug window.

TOOLS DROPDOWN LIST

 **Options**	Open the ArcPad Options dialog box.
 **Scale Bar**	Display or hide the scale bar.
 **Panning Frame**	Display or hide the map panning frame.
 **Status Bar**	Display or hide the status bar.
Toolbars	Display a submenu containing all the toolbars in ArcPad.

HELP DROPDOWN LIST

 **Help Topics**	Open the online help.
 **About ArcPad**	Open the About ArcPad dialog box.
About Extension	Display a submenu listing all loaded ArcPad extensions.

BROWSE TOOLBAR

 **Zoom In**	Zoom in on the map using the pen.
 **Zoom to Full Extent**	Zoom to the full extent of the map.
 **Go Back to Previous Extent**	Zoom back to the previous extent you were using.
 **Identify**	Activate the Identify tool.
 **Find**	Open the Find tool.
 **Clear Selected**	Unselect the selected feature.
 **Refresh**	Redraw the map.

ZOOM IN DROPDOWN LIST

 **Zoom In**	Zoom in on map using the pen.
 **Zoom Out**	Zoom out on map using the pen.
 **Pan**	Pan the map using the pen.

ZOOM FULL EXTENT DROPDOWN LIST

 **Fixed Zoom In**	Zoom in on the center of the map by 25%.
 **Fixed Zoom Out**	Zoom out on the center of the map by 25%.
 **Zoom to Selected**	Zoom to the extent of the selected feature.
 **Center on GPS**	Center the map on the current GPS position.
 **Zoom to Full Extent**	Zoom to the full extent of the map.
Zoom to Layer	Zoom to the extent of a particular layer in the map.

GO BACK TO PREVIOUS EXTENT DROPDOWN LIST

Go Back to Previous Extent	Zoom back to the previous extent you were using.
Go to Next Extent	Zoom forward to the next extent in the extent history.
Set View Coordinates	Set the map extent or center the map at specified coordinates.
Set Map Scale	Set the map scale.
Create Bookmark	Create a spatial bookmark.
Manage Bookmarks	Edit or delete existing spatial bookmarks.
Zoom to Bookmark	Zoom to an existing spatial bookmark.

IDENTIFY DROPDOWN LIST

Identify	Activate the Identify tool.
Measure	Measure distances in the map view in "point mode".
Radial Measure	Measure radial distances in the map view using the pen.
Freehand Measure	Measure distances in the map view in "freehand mode".
Hyperlink	Activate the Hyperlink tool.
Go To	Activate the Go To tool.
Advanced Select	Activate the Advanced Select tool.

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EDIT/DRAWING TOOLBAR

Select	Activate the Select tool.
Vertex Edit	Activate vertex display and editing for the selected feature.
Point	Activate the point feature type for data capture.
Capture Point Using GPS	Capture a point feature in the editable point layer using the current GPS position.
Add GPS Vertex	Capture a single vertex in the current line or polygon feature using the current GPS position.
Add GPS Vertices Continuously	Continuously capture vertices in the current line or polygon feature using the current GPS position.
Feature Properties	Open the Feature Properties dialog box (or custom edit form) for the selected feature.

SELECT DROPDOWN LIST

Select	Activate the Select tool.
Select at GPS Position	Select the feature at the current GPS position.

POINT DROPDOWN LIST

Point	Activate the point feature type for data capture.
Line	Capture a straight line feature using the pen.
Polyline	Activate the polyline feature type for data capture and start a new line feature.
Freehand Line	Capture a freehand line feature using the pen.

 **Rectangle**	Capture a rectangle polygon feature using the pen.
 **Polygon**	Activate the polygon feature type for data capture and start a new polygon feature.
 **Ellipse**	Capture an ellipse polygon feature using the pen.
 **Circle**	Capture a circle polygon feature using the pen.
 **Freehand Polygon**	Capture a freehand polygon feature using the pen.

FEATURE PROPERTIES DROPDOWN LIST

 **Feature Properties**	Open the Feature Properties dialog box (or custom edit form) for the selected feature.
 **Zoom to Selected Feature**	Zoom to the selected feature.
 **Center on Selected Feature**	Center the map on the selected feature without changing the current map scale.
 **Go to Selected Feature**	Set the selected feature to be the current destination for navigation.
 **Delete Feature**	Delete the selected feature.

ArcPad Resources

Visit **www.esri.com/arcpad** for

- The latest information on ArcPad.
- Updates and downloads.
- Technical Support Knowledge Base.
- ArcPad Discussion Forum.

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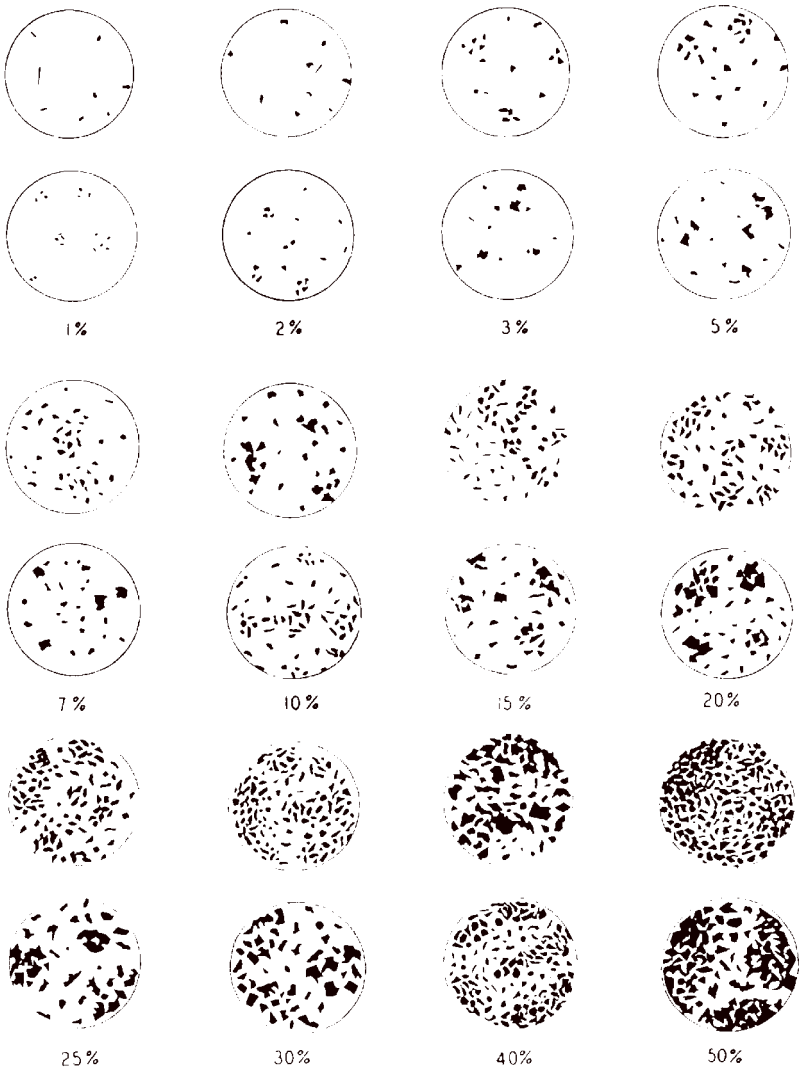
Appendix 11 Comparison Chart for Visual Estimation of Foliage Cover*



* Developed by Richard D. Terry and George V. Chillingar. Published by the Society of Economic Paleontology and Minerology in Journal of Sedimentary Petrology 25(3):229–234, September 1955.

Appendix 12 Generalized Relationships between Grazing System, Stream System Characteristics, and Riparian Vegetation Response*

Grazing system	Steep, low sediment load		Steep, high sediment load		Moderate, low sediment load		Moderate, high sediment load		Flat, low sediment load		Flat, high sediment load	
No grazing	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+
	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+
	Banks	0	Banks	0 to +	Banks	0	Banks	+	Banks	+	Banks	+
Winter or dormant season	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+
	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+
	Banks	0	Banks	0 to +	Banks	+	Banks	+	Banks	+	Banks	+
Early growing season	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+
	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+
	Banks	0	Banks	0 to +	Banks	+	Banks	+	Banks	+	Banks	+
Deferred or late season	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–
	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+
	Banks	0 to –	Banks	0 to –	Banks	0 to –	Banks	+	Banks	+	Banks	+
Three-pasture rest rotation	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–
	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+
	Banks	0 to –	Banks	0 to –	Banks	0 to +	Banks	+	Banks	+	Banks	+
Deferred rotation	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	+
	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+
	Banks	0 to –	Banks	0 to –	Banks	+ to 0	Banks	+	Banks	+	Banks	+
Early rotation	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+	Shrubs	+
	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+
	Banks	0 to –	Banks	0 to +	Banks	+ to 0	Banks	+	Banks	+	Banks	+
Rotation	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–
	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+	Herbs	+
	Banks	0 to –	Banks	0 to –	Banks	0 to +	Banks	+	Banks	+	Banks	+
Season-long	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–
	Herbs	–	Herbs	–	Herbs	–	Herbs	–	Herbs	–	Herbs	–
	Banks	0 to –	Banks	0 to –	Banks	–	Banks	–	Banks	–	Banks	–
Spring and fall	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–
	Herbs	–	Herbs	–	Herbs	–	Herbs	–	Herbs	–	Herbs	–
	Banks	0 to –	Banks	0 to –	Banks	–	Banks	–	Banks	– to 0	Banks	0 to +
Spring and summer	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–	Shrubs	–
	Herbs	–	Herbs	–	Herbs	–	Herbs	–	Herbs	–	Herbs	–
	Banks	0 to –	Banks	0 to –	Banks	–	Banks	– to 0	Banks	– to 0	Banks	0 to +

Note; – = decrease: + = increase; 0 = no change. Stream gradient: 0 to 2% = flat; 2 to 4% = moderate; >4% = steep.

* Adapted from Buckhouse. J.C. and W. Elmore. 1991. Grazing practice relationships: predicting riparian vegetation response from stream systems. *In* Watershed management guide for the interior Northwest. T.E. Bedell (editor). Oregon State University Publication EM 8436.

Glossary

Plant communities:

Current plant community – The plant community currently occupying a site. It is usually described by strata, structure, and species composition.

Desired plant community – The plant community that produces the kind, proportion, and amount of vegetation necessary for meeting or exceeding the objectives set in range use plans and higher-level plans. It must be consistent with site potential.

Potential natural community – The plant community that would establish if all successional sequences were completed without interferences by humans under current environmental conditions. Natural disturbances are inherent in its development, and acclimatized nonnative species may be included.

Riparian area – An area of land adjacent to a stream, river, lake, or wetland containing vegetation that, due to the influence of water, is distinctly different from the vegetation of adjacent upland areas.

Occurrence – There are no hard and fast rules for describing occurrences of individuals or events; however, they can be listed in order of ascendancy as follows:

Uncommon < *Occasional* < *Common* < *Frequent*

Usage of browse species – Use the following general guidelines:

Light – <10% utilization of annual growth. This is incidental use.

Moderate – 10–40% utilization of annual growth.

Heavy – >40% utilization of annual growth. Prolonged heavy use will lead to a change in shrub growth-form.

Stream channel characteristics:

Entrenched – A stream is entrenched when vertically eroded to the point where it no longer has access to its floodplain during a normal flood event. An entrenched stream will have to develop a new floodplain at a lower level.

Non-entrenched – Stream is able to reach its floodplain during a normal flood event.

Floodplain characteristics:

Confined – Floodplain is unable to broaden because of natural topographic features or human-caused changes.

Non-confined – Floodplain is able to broaden without undue restrictions from topography or human-caused changes.

Stream meander patterns:

Straight – Having a stream length to valley length ratio of 1.0.

Sinuous – Having a stream length to valley length ratio of 1.05 to about 1.5.

Meandering – Having a stream length to valley length ratio of 1.5 or greater.

Braided – Having multiple and interconnected channels.

Stream flows:

Perennial – A stream that flows year-round.

Intermittent – A stream that flows only at certain times of the year when it receives water from springs or from some surface sources such as melting snow or a heavy rainfall.

Ephemeral – A stream that flows only in direct response to precipitation, and whose channel is above the watertable.

Continuous – A stream having a surface flow that can be observed along the entire channel.

Interrupted – A stream having a flow that alternates as surface and groundwater flow as it moves down channel.

Wetlands – A wetland is an area of land that is covered by water for part or all of the year. It may be associated with a lake, stream, or coastal habitat. Wetlands may be fresh, saline, or acidic, and range in permanency.

Wetland characteristics:

Permanent – Remain flooded all year during normal moisture conditions. Might dry up during periods of prolonged drought.

Semi-permanent – Generally dry up at some time during a year with normal moisture conditions.

Ephemeral – Flooded for less than 6 weeks in an average year and are recharged by snowmelt or seasonal cloudbursts.