United States Department of Agriculture
Forest Service

Range Report

Colville National Forest Plan Revision

Draft Environmental Impact Statement

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Introduction

This report evaluates and discloses the potential environmental consequences on the range resource that may result with the adoption of a revised land management plan. It examines, in detail, six different alternatives for revising the 1988 Colville National Forest Land and Resource Management plan.

Revision Topics Addressed in this Analysis

The indicators listed for each revision topic are to be used to evaluate each management issue and to display the variations between the alternatives.

Table 1. Evaluation criteria and key indicators for Livestock Grazing

Issue	Evaluation Criteria	Key Indicator
Old Forest Management	Timber harvest in most cases can provide increased forage, which can be available for livestock	*Amount of timber harvest (acres) in each alternative*
Motorized Recreation Trails	Ability of grazing permit holder to access the allotment using motorized trails	*Percent of total forest acreage allocated to Backcountry Non-motorized management area by alternative*
Road Access	Ability of grazing permit holder to access the allotment using USFS system roads	*Desired road density or road miles for each alternative*
Recommended Wilderness	Ability of grazing permit holder to access the allotment	*Percent of total forest acreage in recommended wilderness management areas*
Wildlife	Whether wildlife plan direction or habitat guidelines constrain livestock grazing	*Proposed plan components by alternative for specific wildlife habitat needs*
Riparian and Aquatic Resource Management	Riparian plan direction may constrain livestock grazing through setting management direction applicable to livestock grazing within Riparian Management Areas	*Proposed plan components for livestock grazing within Riparian Management Areas by alternative*

Relevant Laws, Regulations and Policy that Apply

Where consistent with other multiple use goals and objectives, there is Congressional intent to allow livestock grazing on suitable lands. Authority to protect, manage, and administer the

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National Forest System, and other lands under Forest Service administration for range management purposes, emanates from the following acts:

1. Organic Administration Act of June 4, 1897 (Ch. 2, 30 Stat. 34, as amended; 16 U.S.C. 551).

2. Bankhead-Jones Farm Tenant Act, Title III, of July 22, 1937, Sections 31-33 (Ch. 517, 50 Stat. 525, as amended; 7 U.S.C. 1010-1012).

3. Granger-Thye Act of April 24, 1950, Sections 1, 5, 7, 11, 12, 18, 19, (Ch. 97, 64 Stat. 82; 16 U.S.C. 571c; 16 U.S.C. 572; 16 U.S.C. 580d; 16 U.S.C. 580g; 580h; 16 U.S.C. 580k; 16 U.S.C. 580).

4. Multiple Use-Sustained Yield Act of June 12, 1960 (P.L. 86-517, 74 Stat. 215, 16 U.S.C. 528-531).

5. Wilderness Act of September 3, 1964, Section 4 (P.L. 88-577, 78 Stat. 890; 16 U.S.C. 1133).

6. National Environmental Policy Act of January 1, 1970 (P.L. 91-190, 83 Stat. 852; 42 U.S.C. 4321 (note), 4321, 4331-4335, 4341-4347).

7. Wild Horses and Burros Protection Act of December 15, 1971 (P.L. 92-195, 85 Stat. 649, as amended; 16 U.S.C. 1331-1340).

8. Forest and Rangeland Renewable Resources Planning Act of August 17, 1974 (P.L. 93-378, 88 Stat. 476, as amended; 16 U.S.C. 1601 (note), 1600-1614).

9. National Forest Management Act of October 22, 1976 (P.L. 94-588, 90 Stat. 2949, as amended; 16 U.S.C. 472a, 476, 500, 513-516, 518, 521b, 528 (note), 576b, 594-2 (note), 1600 (note), 1601 (note), 1600-1602, 1604, 1606, 1608-1614).

10. Federal Land Policy and Management Act of October 21, 1976, Sections 206, 310, 401, 402, 403, 404, (P.L. 94-579, 90 Stat. 2743, as amended; 43 U.S.C. 1716; 43 U.S.C. 1740; 43 U.S.C. 1751; 43 U.S.C. 1752; 43 U.S.C. 1753).

11. Public Rangelands Improvement Act of October 25, 1978 (92 Stat. 1803, 43 U.S.C. 1752-1753, 1901-1908).

It is Forest Service policy to make forage available to qualified livestock operators from lands suitable for grazing consistent with land management plans. This is discussed in Forest Service Manual (FSM) 2203.1, based on 36 Code of Federal Regulations (CFR) 222 (c).

It is Forest Service policy to continue contributions to the economic and social well-being of the American people by providing opportunities for economic diversity and by promoting stability for communities that depend on range resources for their livelihood, as discussed in FSM 2202.1.

It is Forest Service policy that decisions on management of individual grazing allotments be made after project-level environmental analysis for the particular allotment as described in Forest Service Handbook (FSH) 2209.13 91. Management on specific livestock grazing allotments must comply with the provisions of the forest land and resource management plan and

applicable standards and guidelines must be included in the term grazing permit, as described in FSH 2209.13 91.1 and 91.2 .

Affected Environment

Background: The rangelands of the planning area and many of the major perennial grasses (such as bluebunch wheatgrass and Idaho fescue) did not evolve with substantial ungulate grazing (Daubenmire 1970). Year-long open-range grazing in the late 1800s and into the early 1900s was of such magnitude and had such devastating legacy results, that grazing laws were developed for public lands by 1910. In the planning area, season-long sheep and cattle grazing without rotation or rest was prevalent in the first half of the twentieth century and caused degraded conditions in many grasslands and meadows (Franklin and Dyrness 1988, Alverson and Arnett 1986). The effects of past management are apparent in the high amount of non-native grasses like Kentucky bluegrass (*Poa pratensis)*, reed canarygrass (*Phalaris arundinacea)* and redtop *(Agrostis alba)* in low elevation meadows (Kovalchik and Clausnitzer 2004). Disturbed steppe and shrub-steppe communities that were once characterized by perennial bunchgrasses now have a strong forb component or are dominated by introduced species (Clausnitzer et al. 2006). Overgrazing of green fescue (*Festuca viridula)*, an important dominant bunchgrass of montane and subalpine herbaceous vegetation types, has caused soil erosion and increases in unpalatable forb and dwarf-shrub species in some areas that have persisted into presence (Clausnitzer et al. 2006, Shiflet ed. 1974). The recovery rates of bunchgrass communities are slow and may never reach their former status after severe overgrazing (Franklin and Dyrness 1988).

Potential Natural Vegetation: Grazing allotments on the Colville National Forest cover about 745,000 acres (68%) of administered forest lands. At the landscape scale, the potential natural vegetation within grazing allotments consists predominantly of forested communities. Douglas fir forests are the potential natural vegetation for 50% of the landscape within range allotments, 28% of the allotments are characterized by western hemlock communities, and 20% are occupied by subalpine forest communities. The remaining area within the allotments are mapped as dry ponderosa pine forests (1%) and grass- and shrublands (1%). At a finer scale, the predominantly forested landscape includes many montane and subalpine meadows, wetlands, and riparian communities as described by Clausnitzer et al. (2006). Many of these non-forest and deciduous forest communities are small sized or linear features along lake margins and riparian communities, therefore they are treated as inclusions in the landscape scale potential natural vegetation model for the Colville National Forest.

Current condition: Much of the forested landscape consists of dense conifer stands with canopy covers > 60%. Gradient Nearest Neighbor analysis (Ohmann and Gregory 2002) shows that 57% of the allotment area has canopy covers > 60%, 25% has canopy covers of 40-60% and only 19% have canopy covers < 40%. Sites with canopy covers >60% would likely provide little to no forage, sites with canopy covers of 40-60% would provide some forage and sites with canopy cover < 40% would provide most forage. Western Hemlock forests do not tend to produce significant livestock forage even at early seral stages and are therefore not considered suitable rangelands. Other forest communities should be considered transitory range but are currently highly stocked with limited forage production. Future desired conditions for dry conifer communities would favor open canopies, compared to current conditions, and potentially improve forage availability in these stands.

During the homestead era from the 1890s to the 1930s, approximately 4,000 acres of “homestead meadows” were created across the Colville National Forest. These areas are

primarily upland sites that were historically cleared of timber and cultivated to grow crops. Today, these meadows are considered forest system lands managed by the Forest Service. They are dominated by non-native vegetation that provides valuable forage for livestock and wild ungulates. These areas are considered highly departed from their site potential with species such as Kentucky bluegrass (*Poa pratensis)*, orchard grass (*Dactylus glomerata)* and common timothy (*Phleum pratense) as* dominant vegetation mixed with native forbs. These sites are susceptible to invasive plant establishment and spread and require treatments to control invasive species.

Few condition and trend monitoring data are available for the Colville National Forest. Fifteen historic rangeland condition and trend plots, established in the early 1960's and late 1970's, were relocated and inventoried in 2002 and 2005. Vegetation at inventoried sites consists of seeded redtop clearings or meadows (4), Idaho fescue grasslands (2), Sandberg bluegrass grassland (1), subalpine grasslands with green fescue (3), snowberry shrubland (1), forested communities with ponderosa pine (2) or Douglas fir (1), and a lodgepole pine site with spotted knapweed (1). The 2002/2005 forage condition ratings from the Parker-3-Step inventory was good for 7 sites, fair for 4 sites and poor for the remaining 4 sites. The trend after 30-50 years is up for 2 sites, down for 4 sites and static for the remainder.

Livestock grazing on lands of the Colville National Forest has changed dramatically over the past century. Prior to the Forest's establishment, grazing was largely unregulated with mostly cattle and sheep grazing the rangelands. The Colville National Forest was created as a National Forest Reserve in 1907 and records indicate that the first grazing permit was issued in 1911. Relatively large numbers of sheep and cattle grazed the Colville National Forest during the 1920s, 1930s and 1940s with cattle utilizing the lower elevations and sheep grazing the higher elevations, especially in the Kettle Crest mountain range. During the 1950s, the majority of sheep grazing ceased on the Forest, and today almost all permitted grazing is for cattle with only one sheep allotment (currently vacant) remaining.

Livestock grazing on the Colville National Forest is an important use to the local ranching industry and local communities. Grazing on public lands contributes directly to livestock forage needs. The total contribution of national forest land grazing is understated. Forest Service allotments are valuable grazing areas that not only provide foraging opportunities within permitted seasons, but they also afford permit holders the opportunity to grow forage on other private ranch lands that are needed to sustain livestock during periods when they are not on the National Forest. Permitted livestock grazing on the Colville National Forest helps to maintain the social customs and traditions of ranching and agriculture and provides social and economic contributions at a local, regional and national level.

Ecological conditions and trends in forage areas have been evaluated annually (utilization and actual use) and extensively (long-term monitoring sites) during the allotment NEPA process for each allotment. The majority of long-term monitoring sites show an improvement in condition and trend. The exception to this is where tree density has increased, which has resulted in a reduction in forage production.

Livestock are attracted to areas with high amounts of forage and water. Wetlands, springs, and streams on the Forest can be negatively affected by this use. Recent range NEPA analyses have addressed issues in these areas, and the Forest would continue to evaluate livestock effects in these areas.

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Range Allotments and Permitted Livestock

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Over the life of the existing 1988 Forest Plan, permitted Animal Unit Months (AUMs) have declined from a 1988 average of 35,000 per year to a current average of approximately 29,500 per year. Today, there are a total of 58 grazing allotments where 42 currently have permitted use and 16 are in a vacant status. Most vacant allotments cannot be permitted at this time due to there being no current NEPA document which assesses the effects of grazing and no current allotment management plan (AMP). Vacant allotments would be assessed at the project level to determine the appropriateness of future grazing use.

Thirty-eight of the total 58 active and vacant grazing allotments have been assessed under regional protocols for resource conditions, and environmentally analyzed under the provisions of the National Environmental Policy Act of 1969 (NEPA) and the Rescission Act of 1995. This process still needs to occur for the remaining allotments. An adaptive management strategy analyzed through the NEPA process is commonly used to provide livestock management flexibility to allow for changing resource conditions. Implementation of an adaptive management framework is dependent upon appropriate NEPA analysis of potential management strategies and/or practices that may be implemented due to changing resource conditions as well as regulatory or policy changes. Monitoring is also a key component in successfully implementing an adaptive management framework.

Livestock grazing is authorized through the NEPA planning process that allocates forage for grazing, and a permit system administers the authorized grazing within individual allotments. Allotment management plans (AMPs), also developed from the NEPA planning process, provide site-specific details for management of the resource and identify mitigation measures needed to reduce identified potential grazing impacts in order to meet or move toward management objectives, as well as any required monitoring. A variety of range and livestock management tools such as herding, rotational grazing, off-site water development and fencing can be implemented on grazing allotments in order to facilitate improved allotment management, livestock management and natural resource protection.

Riparian Areas

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Livestock are attracted to areas with water and available forage. Cattle, if not actively managed, tend to stay in and graze gentle-gradient riparian areas to an extent that can interfere with attaining the desired vegetation and soil resource conditions for these areas. Adaptive management practices commonly utilized on the Colville National Forest to reduce impacts from grazing on riparian areas include;

- Creation of pastures and development of grazing strategies that provide for deferment, rest and/or vegetative recovery
- Off-stream/off-site water development and trough placement
- Salting livestock in upland areas
- Fencing and/or brush barriers
- Armored stream crossings

Current allotment management focuses on strategies to move livestock enough to distribute their use and impacts throughout pastures and prevent concentration in the riparian areas. Monitoring and identifying appropriate "thresholds and trigger points" is a key component in successfully implementing an adaptive management practice.

Rangeland Resources

Rangelands provide for a wide variety of tangible products which include forage for grazing and browsing animals, wildlife habitat, water, minerals, recreation, and wood products. Rangelands also produce intangible products such as natural beauty and scenery. The ability of these lands to support the needs of grazing and browsing animals is a result of their capacity to produce rangeland vegetation and forage.

As a result of development and sub-division of private property, which has reduced the amount of private grazing lands, demand for public land grazing on the Colville National Forest is experienced to be constant or increasing. Currently the demand for Forest Service permitted grazing is higher than our ability to supply suitable areas.

Climate Change

Climate change may have the potential to affect grazing capacity in both the short-term and long-term. Changes in forage production may result from predicted shifts in precipitation patterns and increased temperatures.

"Uncertainty about climate projections are much greater at the local and regional scales important to land managers because uncertainties amplify as data and model outputs are downscaled. Ecological response to climate related changes is highly likely to be more difficult than climate to model accurately at local scales. Though there is uncertainty based on modeling, it does not imply a complete lack of understanding regarding climate change and grazing lands. Managing in the face of uncertainty will best involve a suite of approaches, including planning analyses that incorporate modeling with uncertainty, and short-term and long-term strategies that focus on enhancing ecosystem resistance and resilience, as well as actions taken that help ecosystems and resources move in synchrony with the ongoing changes that result as climates and environments vary. Flexibility to address the inherent uncertainty about local effects of climate change could be achieved through enhancing the resiliency of forests. Efforts to address existing stressors would address current management needs, and potentially reduce the future

interactions of these stressors with climate change." (U.S. Climate Change Science Program, 2008)

Although we know an ecosystem's sensitivity to grazing pressure and threshold for degradation changes with bioclimatic setting, resulting in lower sustainability in very dry and very humid ecosystems (Asner et.al. 2004), the future bioclimatic setting within the project area is highly uncertain. It is very likely that as future average temperatures increase, snow pack would be reduced and snow melt, run-off and peak flows would occur earlier in the year (USDA 2008). In addition, with increased atmospheric carbon, primary production is expected to increase particularly on semi-arid rangelands (Derner et.al. 2005). It has been hypothesized that grazed areas resulting in a lower soil water holding capacity and lower temperature sensitivity of soil respiration might release less CO_2 to the atmosphere through soil respiration under future precipitation and temperature scenarios (Chen et.al. 2008).

Need for Change

Desired Conditions for Livestock Grazing for Alternatives

- There are opportunities to engage in ranching activities and graze livestock on NFS lands. These activities contribute to the stability and social, economic, and cultural aspects of rural communities.
- The desired structure and diversity of native herbaceous plant communities (including highly palatable forage species) are maintained or enhanced through proper livestock management principles. Rangelands consisting of native plant communities such as open conifer forests, low elevation grasslands, shrub-steppe plant communities and meadows have few to no invasive plant species, have stable or improving ecological conditions, and are resilient to disturbance events. Rangelands with significant non-native plant components (seeded meadows or historically overgrazed sites) have stable or improving soil stability.
- Rangelands and forestlands provide forage for use by both livestock and wildlife. Grazing continues to be a viable use of vegetation on the Forest. Availability of lands identified as suited for this use contributes to providing animal products, economic diversity, open space, and promotes cultural values and a traditional local life style. Allotments are generally grazed on an annual basis.
- Consistent with sustaining other resource desired conditions, a viable level of forage is available for use under a grazing permit system where use generally occurs on an annual basis generally between June and October. Riparian and upland areas within allotments reflect ecological conditions supporting the desired conditions, including those described in the Wildlife, Aquatic and Riparian, Soil, and Vegetation Desired Conditions.

Guidelines for Livestock Grazing for Alternatives

- Current livestock management practices should be compatible for the maintenance and, where necessary, improvement of native plant communities.
- New construction and reconstruction of fences and water developments would follow Forest Service specifications.
- Annual operating instructions for livestock grazing permittees should ensure livestock numbers are balanced with capacity and address any relevant resource concerns (e.g., forage production, wildlife, weeds, soils, etc.).

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- Post-fire grazing should not be authorized until Forest Service range staff confirms range readiness.
- Livestock use in and around wetlands should be evaluated on an allotment specific basis.

Old Forest Management and Timber Production

In the revision of the Forest Plan, three broad-scale concerns drove the need to consider how we address old forest management, especially the current reserve system approach at the landscape scale. These are:

- The recent history of uncharacteristic levels of disturbances resulting from fire and insect and disease activity that would likely continue into the future.
- The interaction between disturbances and climate change that elevates the importance of restoring landscape resiliency.
- Uncertainty about the recovery and viability of old forest-dependent species given the increased risk of uncharacteristically severe disturbances that is likely to be exacerbated by climate change impacts.

Motorized Recreation Trails

The current land management plans provide direction for summer and winter motorized uses, including identifying areas where such use may not be authorized or is limited, mainly for protection of aquatic, plant, and wildlife habitats.

The goal for recreation settings and experiences would include providing a spectrum of high quality, nature-based outdoor recreational settings where visitors access the Forest, including access to the biological, geological, scenic, cultural, and experiential resources of the Forest. Where the visitor's outdoor recreational experience involves few conflicts with other users, access is available for a broad range of dispersed recreation activities such as dispersed camping, rock climbing, boating, mushroom and berry picking, hunting, and fishing and these experiences are offered in an environmentally sound manner, are within budget limits, and contribute to the local economy.

Access

Three broad concerns drove the need to address road density:

1) The Forest can no longer afford to properly maintain the road system at current operational maintenance levels,

2) The current road system is not aligned with current and future resource management objectives, and

3) The existing road management direction is confusing and difficult to follow because it is scattered throughout the current Forest Plan (Colville National Forest Land and Resource Management Plan), Forest Plan amendments (East-side Screens, Interim Inland Native Fish Strategy for the Intermountain, Northern, and Pacific Northwest Regions [INFISH, USDA Forest Service 1994 and 1995]), national-level decisions (the Roadless Rule), and interim policy (e.g., Grizzly Bear No-Net-Loss, Lynx Agreement, the Interior Columbia Basin Strategy).

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Recommended Wilderness Areas

By law, all National Forest System lands must be evaluated for possible wilderness recommendation during the plan revision process. The result of that evaluation shows whether a need exists for additional wilderness and what trade-offs may exist if the area is eventually designated part of the National Wilderness Preservation System.

Currently, the Salmo-Priest Wilderness covers about 3 percent of the Colville National Forest and evaluation showed a need for additional wilderness opportunities on the Forest. A review of possible areas showed some are available to fill this need.

Wildlife

The current Forest Plan provides limited protection for habitat connectivity, providing wildlife and aquatic crossing structures, and managing activities adjacent to the structures so they are used by wildlife.

Riparian and Aquatic Resource Management

The current Forest Plan includes riparian management direction from the Inland Native Fish Strategy (INFISH, USDA Forest Service 1994 and 1995). This approach appears to have either maintained or improved riparian and aquatic habitat conditions at the watershed and larger scales.

Objectives for Riparian Management Areas would give emphasis to maintaining or restoring the riparian and aquatic structure and function of intermittent and perennial streams, confer benefits to riparian-dependent plant and animal species, enhance habitat conservation for organisms that are dependent on the transition zone between upslope and riparian areas, contribute to improved water quality and flows, and contribute to a greater connectivity of the watershed for both riparian and upland species.

Desired conditions for Riparian Management Areas within any given watershed are to have compositions of native flora and fauna and a distribution of physical, chemical, and biological conditions commensurate with natural processes.

Environmental Consequences

Methodology

Assumptions

- This programmatic analysis does not analyze changes that may occur to livestock management at an allotment level. Instead, project level analysis would be completed independent of this planning effort at the allotment level to determine the appropriate intensity, timing and duration of livestock use.
- The proposed plan allows for site-specific determinations relating to allotment management, such as the proper grazing systems and range improvements needed to meet desired conditions.

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- The proposed plan sets objectives for vegetation treatment and manipulation practices that contribute to the amount and condition of rangeland vegetation.(1982 Rule Sec. 219.20 (a)).
- Conflict or beneficial interactions among livestock and wild animal populations are managed at the allotment level throught adaptive management and appropriate mitigation measures(1982 Rule Sec. 219.20 (b)).
- The proposed plan, through desired conditions and objectives for each management area, provides direction to move rangelands in unsatisfactory condition toward desired conditions. Implementation occurs at the allotment level (1982 Rule Sec. 219.20 (b)).
- Under all alternatives, project level analysis, including season of use, permitted livestock numbers, and forage use levels occur at the allotment-level. Livestock grazing under all alternatives would be managed with adaptive management to match livestock numbers with annual forage production and resource needs based upon assessment and monitoring data.
- Climate change may affect forage conditions on the forests. Under all alternatives, adaptive management used in allotment management planning allows for adjustments in the number of livestock and season of pasture use so that livestock use matches forage production for every grazing season.
- Rangeland capability does not change across alternatives.

Methods of analysis

Constraints to livestock grazing were identified and include availability of forage, impacts to rangeland vegetation, access for administration of grazing allotments, and modification of allotment management resulting from wildlife and riparian management concerns. Level of risk is assessed using percent of forest allocated to a management area that is associated with the risk, either increasing or decreasing the risk; or risks are assessed by looking at changes in plan components by alternative.

This report describes the capability and suitability of National Forest System (NFS) lands for producing forage for grazing animals and for providing habitat for wildlife. It also describes the potential environmental consequences of vegetation treatments (mechanical and fire) on the rangeland resource.

An Animal Unit Month (AUM) is the amount of dry forage consumed by one animal unit over 30 days. An Animal Unit is one 1000 pound cow with or without a calf under six months, or five sheep

The methods for determining acres of land capable and suitable for livestock grazing are described in detail in Appendix A and Appendix B to this report. The boundary for the suitability analysis contains all Forest System Lands within the boundaries of the Colville National Forest.

Incomplete and Unavailable Information

There is no incomplete or unavailable information regarding this report or analysis.

Spatial and Temporal Context for Effects Analysis

The spatial affected environment for direct and indirect effects is the lands administered by the Colville National Forest. Effects are analyzed over the life of the forest plan, which is 15-20 years.

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Past, Present, and Foreseeable Activities Relevant to Cumulative Effects Analysis

- Sub-division of private lands and development.
- Grazing on adjacent federal, state and private lands.
- Wildfire.

Summary of Effects Common to All Alternatives

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Because the land management plan does not authorize or mandate any site-specific projects or activities there can be no direct effects. However, there may be implications, or longer term environmental consequences, of managing the forest under this programmatic framework.

All alternatives provide similar guidance for managing livestock grazing. The management focus is to balance livestock grazing with available forage and other resource needs. This would be accomplished at the allotment level.

Lands Capable and Suitable for Livestock Grazing

A rangeland capability and suitability analysis has been completed for this Forest Plan Revision effort. Capability was assessed for cattle and sheep grazing separately. Total capable rangeland acres on the Colville National Forest are seen in Table 2 of this report.

Provisions of the 1982 planning rule require that the capability and suitability for producing forage for grazing animals on NFS lands be determined. Capability refers to the potential of an area of land to produce resources, supply goods and services, and allow resource uses under an assumed set of management practices and at a given level of management intensity. Capability depends upon current resource conditions and site conditions, such as climate, slope, landform, soils, and geology, as well as the application of management practices.

Table 2. Colville National Forest Capable Rangelands

Description	Acreage
Forest Service Administered Lands	1,103,000
Capable for Cattle Grazing	**690,311**
Capable for Sheep Grazing	**881,287**

Rangeland capability does not vary by alternative and is therefore only determined once through the land management planning process.

This current assessment improves on the prior assessment done during the development of the 1988 Land and Resource management Plan because it accounts for changes in suitability that have occurred since the original decisions were issued, and also because it employs current GIS mapping technologies that were unavailable during previous planning efforts.

Suitability refers to the appropriateness of applying certain resource management practices to a particular area of land, as determined by an analysis of the economic and environmental

consequences and the alternative uses forgone. A unit of land may be suitable for a variety of individual or combined management practices.

The criteria for suitability for livestock grazing are the same in the action alternatives. This is very similar to the existing direction under the No Action alternative.

Table 3. Suitability of livestock grazing on the Colville National Forest

Management Area	Livestock Grazing	
	Suitable	Not Suitable
Wood/Forage	X	
Scenic Timber	X	
Old Growth Dependent Species Habitat/Late Forest Structure	X	
Caribou Habitat		X
Winter Range	X	
Scenic/Winter Range	X	
Focused Restoration	X	
General Restoration	X	
Active Management/Responsible Management Areas	X	
Restoration Zone	X	
Backcountry	X	
Backcountry Motorized	X	
Wilderness – Designated	X	
Salmo-Priest Wilderness		X
Recommended Wilderness	X	
Research Natural Areas	X	X
Scenic Byway Corridor	X	

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Management Area	Livestock Grazing	
	Suitable	Not Suitable
Kettle Crest Special Interest Area	X	

Range Suitability Determination

Table 4. Colville National Forest Suitable Rangelands

Alternative	Acres of Suitable Rangeland
No Action	Cattle – 363,845 Sheep – 448,160
Proposed Action	Cattle – 363,217 Sheep – 447,532
Alternative R	Cattle – 363,217 Sheep – 447,532
Alternative P	Cattle – 363,217 Sheep – 447,532
Alternative B	Cattle – 363,217 Sheep – 447,532
Alternative O	Cattle – 363,217 Sheep – 447,532

Even though the amount of land suitable for livestock grazing varies slightly by alternative, there would be no anticipated impact on permitted animal unit months (AUMs) in all alternatives based on their suitability alone. The alternatives would continue to provide some level of forage for domestic livestock and opportunities for ranching lifestyles consistent with the other desired conditions.

Old Forest Management and Timber Production

Addressing forest health issues through vegetation management and fuels reduction would likely produce positive outcomes in the amount and abundance of understory vegetation which permitted livestock and wildlife use as forage. Griffis et.al. found that the abundance of native grass production increased significantly with treatment intensity through thinned timber stands which also had prescribed fire to reduce surface fuels (Griffis et.al., 2001). Additional research has revealed that as stand density index decreases, forage production has been shown to increase (Moore and Deiter, 1992).

Permitted grazing would benefit from timber production through increased forage abundance. This increased forage production may not result in changes to permitted stocking levels since it would need to be determined at the project level if there would be a net increase in forage production and how other resources may be affected by potential changes.

Access

Access is assessed for the various alternatives in this report by looking at the combined total of the percentages found for "Backcountry" and Recommended Wilderness Management Areas combined with proposed road density limits. The greater the total number for these two management areas equates to more acres where future access, relative to roads or motorized trails, would be reduced.

Table 5. Colville National Forest Restricted Access Management Areas by Alternative

Management Area	Percent of Forest by Alternative					
	No Action	Proposed Action	Alt. R	Alt. P	Alt. B	Alt. O
Backcountry	8	8	2	11	0	16
Recommended Wilderness	0	9	19	6	20	1
Total	**8**	**17**	**21**	**17**	**20**	**17**

A constraint to livestock grazing from all motorized access is mainly limited to the grazing permit holder's ability to access the allotment. Motorized access (including Off-Highway Vehicles) into non-motorized management areas within allotments can be authorized by line officers on a case-by-case basis for allotment administration. Motorized access needs include transportation of fence and/or water development materials, control of invasive plants, maintaining range improvement projects, checking livestock, locating livestock and distributing salt. Permit holders for allotments with less motorized access may take more time and labor to observe stock, check fences and water developments, and distribute salt than allotments with motorized off-highway vehicle access.

To assess the total effects of changes in access, proposed road density limits also need to be considered. Table 6 displays the road density limits for each of the alternatives analyzed in the Forest Plan Revision.

Table 6. Upper limit of desired road density by alternative

Alternative					
No Action	**Proposed Action**	**R**	**P**	**B**	**O**
80% of the Forest is suitable for roads. About 4,000 miles of roads on the Forest. Upper limits vary from 0.4 to no limit.	2 miles per square mile in Focused Restoration MAs and 3 miles per square mile in General Restoration MAs.	1 miles per square mile in Focused Restoration MAs and 2 miles per square mile in General Restoration MAs.	1 miles per square mile in Focused Restoration MAs and 2 miles per square mile in General Restoration MAs.	Cap USFS road miles at current level. Applicable forest-wide.	Cap USFS road miles at current level. Applicable forest wide.

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Climate Change

Climate change scenarios predict more, larger uncharacteristic wildfires. Wildfires can burn fences and water developments within allotments. Pastures may have to rest from grazing until recovery objectives are met following a wildfire. These short-term effects of wildfire are minor compared to the long-term effects of increased forage from large wildfires (over 100 acres burned) which can last for decades. Over the last 15 years total acres burned by wildfire on the Forest has exceeded 1000 acres in three years – 1994, 2001, and 2003. The trend in size and number of larger wildfires is expected to increase over the life of the plan, resulting in an increase in forage.

"Grazing lands are estimated to contain 10 to 30 % of the world's soil organic carbon" (Schuman, Janzen and Herrick 2002). While some studies have found limited to large reductions in soil carbon and increases in CO_2 flux associated with grazing (Haferkamp and Macneil 2004)(Welker et.al. 2004), studies involving modeling and remotely sensed data indicate that proper grazing can improve ecosystem production as measured by soil carbon storage (Li, Liu and Tan 2007)(Steinfeld and Wassenaar 2007)(Reeder et.al. 2004)(Schuman, Janzen and Herrick 2002). Additional studies similarly conclude that certain levels of grazing may even increase carbon sequestration (Hellquist et.al. 2007) (Derner, Boutton and Briske 2006) (Derner et.al. 2005)(LeCain et.al. 2001)(Ganjegunte et.al. 2005)(Manley et.al. 1995) (Reeder et.al. 2004) (Schuman, Janzen and Herrick 2002). Complementing these findings, several studies indicate that light to moderate levels of grazing have no overall effect on total carbon sequestration (Hellquist et.al. 2007)(XiuZhi et.al. 2005)(Ingram et.al. 2008)(Derner, Boutton and Briske 2006) (Stavi et.al. 2008)(Owensby, Ham and Auen 2006)(Shrestha and Stahl 2008)(Ingram et.al. 2008). In fact, intensive rotational grazing appears to be a viable option for greenhouse gas reduction and carbon sequestration credits (Bosch, Stephenson, Groover and Hutchins 2008) (Steiguer, Brown and Thorpe 2008)(NRCS 2006)(Li, Liu and Tan 2007)(Ingram et.al. 2008)(Conant and Paustian 2000)(Steiguer, Brown and Thorpe 2008)(Streater 2009)(Sharrow 2008).

It can safely be asserted that there is tremendous variability in carbon storage and its response to grazing across different land types (Derner, Boutton and Briske 2006)(Henderson, Ellert and Naeth 2004). The Northern Great Plains appears to have small potential as a carbon sink (Haferkamp and MacNeil 2004). Alternately local research indicates that ungrazed sagebrush steppe sites were CO_2 sinks during the period they were measured (Svejcar et.al.2008). Management practices which maintain or move plant associations to "good" condition appear to be consistent with maintaining the soil organic pool. (Henderson, Ellert and Naeth 2004)(Brown and Thorpe 2008) (Sharrow 2008).

Grazing results in redistribution of carbon on the landscape (Stavi et.al. 2008). It has been noted that livestock waste management represents a potential long-term soil carbon gain (Fellman et.al. 2008). Free ranging livestock deposit manure across the landscape resulting in aerobic decomposition. Aerobic decomposition of manure generates considerably less methane than does decomposition associated with stockpiling strategies used in more concentrated livestock production strategies (Alberta Agriculture and Food Ag-Info Center)(EPA 2005) . This "in-effect" land application of manure also results in a buildup of soil carbon that decomposes much more slowly than occurs when composting (NRCS 2007).

All alternatives would use adaptive management to address climate change. Climate change is expected to affect forage conditions on the Forest. The adaptive management used in allotment management planning, which is outside of this planning effort related to the Forest Plan

Revision, allows for adjustments in the number of livestock and season of pasture use so that livestock use matches forage production for every grazing season.

Wilderness and Recommended Wilderness

Wilderness designation by congressional action does not affect allotment boundaries or suitability for grazing. The existing wilderness area, Salmo-Priest, does not have any range allotments within its boundary, therefore permitted livestock grazing would not occur in the future. There should be no effects to livestock grazing from designated wilderness management, though new requirements concerning the types of materials that could be utilized for range improvement projects may be a future constraint should any Recommended Wilderness be designated as wilderness in the future.

The amount of Recommended Wilderness existing within grazing allotments has the potential to constrain a grazing permittee's motorized access into the various Potential Wilderness Areas where motorized trails exist. The degree to which Recommended Wilderness exists within allotments by alternative is displayed in Figure 1.

Should recommended wilderness become designated wilderness, the potential for livestock grazing would likely cease on the portions of vacant allotments within wilderness area boundaries. Grazing of allotments with active permits could continue with the designation of Wilderness.

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Figure 1. Percent of allotment acres in Recommended Wilderness

No Action Alternative

This is the current Colville Forest Plan as amended. No action means the current management direction would continue.

Summary of Effects

Access for allotment management by motorized trail or roads is likely to remain unchanged from that experienced under the 1988 plan.

Any new sheep grazing permits would be managed to reduce risks of disease transmission to bighorn sheep herds. Effects from domestic sheep grazing on bighorn sheep would be analyzed at the allotment level and a “Risk of Contact” analysis would be completed.

Impacts to permittee’s time, labor and costs would continue to be affected by riparian area direction.

Old Forest Management and Timber Production

This report focuses on livestock grazing activities and operations.

Timber harvest can have a favorable effect on forage production by creating areas of forage through removing overstory. The quality of the forage created depends on the vegetation type and individual site characteristics. The expected timber harvest acreage would continue, so there is no increase in forage from increased acres of timber harvest.

Prescribed fire can also create areas of forage depending on the vegetation types burned. Under this alternative, the amount of prescribed fire is unlikely to markedly increase in the short term. Forage created by prescribed fire would not increase.

Motorized Recreation Trails

Total miles of motorized trails on the forest are expected to remain the same in the short-term. Motorized trail access for permittees would remain the same in the short-term.

Access

Today there are about 4,000 miles of National Forest System roads and about 80 percent of the forest is suitable for road construction. The current forest plan includes standards and guidelines that limit road densities to between 0.4 to 2 miles per square mile in deer and elk winter range; grizzly bear habitat areas; and lynx habitat. Outside of these habitats, the forest plan does not set an upper limit on road density. Today the average National Forest System road densities in 12th field watersheds range from a low of 0.33 to a high of 4.45 miles per square mile on National Forest System lands. The total miles of National Forest System roads are expected to remain the same or decrease slightly over the next 10 years.

Current forest plan constraints on access may result in increased time, labor, and capital investments for the permit holder. Permit holders of allotments with less road access may take more time and labor to observe stock, check fences and water developments, and distribute salt than allotments with higher road densities.

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Low maintenance native surface roads serve as routes for easily moving livestock on, off of and around pastures, and some routes may be lost as roads are decommissioned. Cut and fill slopes along with the native surface of low maintenance roads is a location providing foraging areas for livestock, therefore lower road densities may have a small effect on availability of forage.

A positive effect of lower road density and miles is that cattle and range improvements would generally receive less disturbance and vandalism. Public use of roads in allotments with intensive grazing systems disturbs livestock, increases the risk of gates being left open, and tends to disrupt the proper use of forage by moving livestock along roadways.

Road densities and total miles of road on the forest are expected to remain the same in the short-term and likely to decrease in the long-term due to budget trends. Motorized vehicle access for permittees would remain the same in the short-term and may decline slightly in the long-term.

Recommended Wilderness Areas

Currently there are no recommended wilderness areas on the Forest.

Wildlife

Sheep

The Forest currently supports two bighorn sheep herds and has no active sheep allotments. It is unknown if or when a sheep allotment may become active. Risk of contact concerning disease transmission from domestic sheep to bighorn sheep exists which can be fatal for bighorn sheep. The current forest plan is silent on disease transmission risks. It is assumed that any permit for sheep grazing would take steps to reduce or eliminate the risk of contact. The Forest Service would continue to address risks through allotment management planning, which may reduce future permitting of domestic sheep in allotments proximate to bighorn sheep herds. A risk of contact analysis would be conducted at the allotment level before domestic sheep are considered for authorized back onto the forest.

Wildlife management

The eastern portion of the Forest is within the Selkirk and Cabinet-Yaak Grizzly Bear Recovery Zone that extends east into Idaho and Montana. The current forest plan is silent on grizzly bear depredation, other than to state that grizzly bear habitat is managed in accordance with the Interagency Bear Guidelines, Colville National Forest Guidelines for Management in Occupied Grizzly Bear Habitat (Appendix H, FEIS), national policy, and the Grizzly Bear Recovery Plan. Following direction to avoid depredation may result in changes in timing or location of livestock movement within an allotment. If this occurs, the permittee may need to spend more time and labor to implement these changes.

Riparian and Aquatic Resource Management

Forest plan direction that protects riparian areas have an effect on grazing operations through the need for the permit holder to spend time, labor, and make capital investments to limit potential livestock grazing effects to riparian areas. Currently there are riparian management areas which are called Riparian Habitat Conservation Areas (RHCAs) established by the INFISH and Eastside Screens amendments, and management direction from the INFISH amendment that

address livestock grazing in Riparian Management Areas. This direction would continue and permittee's time, labor and capital investments would continue at the same levels, assuming allotment management is in compliance with the allotment management plan.

Proposed Action Alternative

This is the June 30, 2012, proposed action released to the public with the Lewisia draft plan revision document providing supporting information.

Summary of Effects

Old Forest Management: The Proposed Action alternative is likely to increase forage for livestock and wildlife by creating large openings. Due to climate change the trend in size and number of larger wildfires is expected to increase over the life of the plan, also resulting in an increase in forage.

Access: The total effect to access comes from looking at percentage of Forest acres in "Backcountry" and "Recommended Wilderness" combined and proposed road density limits. Compared to the No Action alternative, access opportunities could be slightly reduced through an increase in the "Backcountry" and "Recommended Wilderness" acres, but a reduction in access is not likely to be related to road density limits. Limited access could equate to additional time and labor costs for permittees.

Riparian and Aquatic Resources: Riparian area widths would increase compared to the No Action alternative and that experienced under the 1988 Forest Plan. The "guidelines" directing management for grazing practices in the Aquatic Riparian Conservation Strategy (ARCS) are unlikely to have a substantial effect on allotment management. The ARCS "standard" requiring new livestock handling, management or watering facilities to be located outside of Riparian Management Areas (RMAs) could act to constrain future options while seeking to improve riparian areas and water quality.

Old Forest Management and Timber Production

Timber harvest can have a favorable effect on forage production by creating transitory rangelands that exist for a period of time following treatment. The expected timber harvest remains the same across all alternatives due to budget trends, so there is likely to be no increase in forage from increased acres of timber harvest. However, the Proposed Action and Alternative P include desired conditions for creating gaps and patches of vegetation ranging up to 40 acres. More and larger gaps in vegetation would create more foraging areas, so the Proposed Action and Alternative P are likely to increase forage for livestock and wildlife. Timber harvest and follow up fuels treatments result in increased forage standing crop due to the relationship between forage production and overstory being curvilinear with forage production being negatively related to density of overstory vegetation (Masters et.al., 1993). More forage would reduce forage competition with big game and may improve livestock distribution over the allotments.

Prescribed fire can also create desirable foraging areas depending on the vegetation types burned. Due to budget trends the amount of prescribed fire is likely to remain the same across all alternatives and is unlikely to markedly increase in the short term.

The Proposed Action and Alternative P are expected to result in forests that are more resilient and have fewer large and uncharacteristic wildfires in the long term. The trend in size and number of larger wildfires is expected to increase over the life of the plan as a result of anticipated climate change, resulting in an increase in forage in the short term, while in the long-term wildfire created forage would decrease.

Motorized Recreation Trails

The combined total for Management Areas that would restrict motorized access would total 17.2% of the Forest under the Proposed Action Alternative. This means that there would be 9.4% fewer acres under the Proposed Action alternative where motorized access would be allowed compared to the 1988 Forest Plan. Limited access could equate to an increase in time and labor costs for permittees.

The analysis assumes that permit holders may not have motorized off-highway vehicle access to parts of their allotment within a backcountry non-motorized management area.

Access

The Proposed Action Alternative's recommended road density limits of 2 miles/square mile for Focused Restoration Management Areas and 3 miles/square mile for General Restoration Management Areas are unlikely to result in a noticeable change in grazing permittee's ability to access their allotments. Some watersheds would see reductions in the amount of roads present, but this is unlikely to have an impact on allotment management because of a lack in infrastructure, grazable areas and/or allotments within the affected watersheds.

Recommended Wilderness Areas

Concerning Recommended Wilderness, the Proposed Action, Alternative P and Alternative O would allow existing motorized uses to continue until Congress makes a decision on the Forest Service's recommendation. None of the Recommended Wilderness areas currently have National Forest System roads, or motorized trails. Alternatives with a high percentage of allotment acres in Recommended Wilderness would have the highest effect to permit holder's use of mechanized equipment in these areas. This would result in the permit holder having to spend more time and labor to manage the allotment.

Wildlife

There is nothing specifically in the Proposed Action Alternative for wildlife that would affect livestock or allotment management.

Riparian and Aquatic Resource Management

The "guidelines" directing management for grazing practices in the Aquatic Riparian Conservation Strategy (ARCS) are unlikely to have a substantial effect on allotment management. The ARCS "standard" requiring new livestock handling, management or watering facilities to be located outside of Riparian Management Areas (RMAs) could act to limit future management options, such as water development and re-development, while seeking to improve riparian areas and water quality. Additional standards or changing a guideline to a standard is an added constraint that may challenge grazing permittees to comply with their allotment management plan(s).

Riparian Management Area widths vary by alternative. Riparian area widths for the Proposed Action would increase compared to the No Action alternative and that experienced under the 1988 Forest Plan. This alternative increases riparian management area widths for lakes and natural ponds from 150 feet to 300 feet, which could potentially further constrain a permittee's ability to fully utilize management options within these areas.

Alternative R

Alternative R responds to public comments that support old forest protection through static late forest structure reserve land allocations and a 21-inch upper diameter limit on cutting trees. It also addresses comments advocating for increased wilderness, fewer miles of motorized trail, and additional protections for wildlife. Likewise, Alternative R responds to public concerns that the proposed action may not provide watershed and aquatic resource protection as effective as the current forest plan amendment (INFISH) and that the proposed action may not adequately manage the potential for detrimental effects of activities within riparian areas. This alternative is based on a management option developed by a coalition of conservation groups.

Alternative R recommends 19% of the Forest for wilderness designation. Alternative R has the lowest level of Backcountry Motorized management area (.006% of the Forest) and the lowest road density desired conditions for Late Forest Structure and General Restoration areas. The plan components for motorized use and road density directly address public issues concerning potential impacts that road access and summer motorized trail use may have on aquatic, riparian, and wildlife habitats.

Summary of Effects

Access: The total effect to access comes from looking at the percentage of Forest acres in "Backcountry" and "Recommended Wilderness" combined and proposed road density limits. Compared to the No Action alternative, access opportunities would be reduced through an increase in the "Backcountry" and "Recommended Wilderness" acres and the identified road densities for Focused and General Restoration Management Areas. Alternative R is the most restrictive of the alternatives in regards to restricting access through the amount of land contained within Focused Restoration, Backcountry and Recommended Wilderness Management Areas. Limited access would equate to an increase in time and labor costs for permittees.

Riparian and Aquatic Resources: Riparian area widths would increase compared to the No Action alternative, and that experienced under the 1988 Forest Plan. The "guidelines" and "standards" directing management for grazing practices in the Aquatic Riparian Conservation Strategy Modified (ARCSMod) is likely to have an effect on allotment management and could act to limit future options and reduce the length of permitted grazing seasons. Grazing permittees could realize additional constraints based on minimum stubble height requirements of ARCSMod. The ARCSMod "standards" could act to limit future options while seeking to improve riparian areas and water quality.

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Old Forest Management and Timber Production

Timber harvest can have a favorable effect on forage production by creating transitory rangelands that exist for a period of time following treatment. The expected timber harvest remains the same across all alternatives due to budget trends, so there is no increase in forage from increased acres of timber harvest.

Prescribed fire can also create desirable foraging areas depending on the vegetation types burned. Due to budget trends the amount of prescribed fire is likely to remain the same across all alternatives and is unlikely to markedly increase in the short term.

Motorized Recreation Trails

The combined total for Management Areas that would restrict motorized access would total 21% of the Forest under Alternative R. This means that there would be 13.2% fewer acres under Alternative R where motorized access would be allowed compared to the 1988 Forest Plan. Limited access would increase time and labor costs for permittees.

The analysis assumes that permit holders may not have motorized off-highway vehicle access to parts of their allotment within a backcountry non-motorized management area.

Access

Alternative R's recommended road density limits of 1 mile/square mile for Focused Restoration Management Areas and 2 miles/square mile for General Restoration Management Areas, combined with this alternative having the largest percentage of Forest acres being in a Focused Restoration Management Area are likely to result in a noticeable change in a grazing permittee's ability to access their allotments. Many watersheds would likely see reductions in the amount of roads present, and this reduction in access could result in grazing permit holders having to spend more time and labor to manage the allotment.

Low maintenance native surface roads serve as routes for easily moving livestock on, off of and around pastures, and some routes may be lost as roads are decommissioned. Cut and fill slopes and the native surface of low maintenance roads is another source of forage, so lower road densities may have an effect on availability of forage for livestock grazing.

A positive effect of lower road density and miles is that cattle and range improvements would generally receive less disturbance and vandalism. Public use of roads in allotments with intensive grazing systems disturbs livestock, increases the risk of gates being left open, and tends to disrupt the proper utilization of forage by moving livestock along roadways. Alternative R would have the most allotment acreage in the management area "Focused Restoration" with the lowest road density.

Recommended Wilderness Areas

In the short-term the effect of recommended wilderness to livestock grazing is to limit motorized trail access for the permit holder in the R and B alternatives, where a standard doesn't allow motorized uses within Recommended Wilderness.

Alternatives R and B would recommend the largest amount of Recommended Wilderness to congress for potential designation and these alternatives would have the most substantial effect on range management through limiting access, restricting tools and increasing the time required

to complete management activities. None of the Recommended Wilderness areas currently have National Forest System roads, but the Owl Mountain, Jackknife, Twin Sisters and South Huckleberry PWAs all have motorized trails that are used for livestock and allotment management. Since all of these PWAs become Recommended Wilderness in Alternative R, a permittee's ability to complete allotment and livestock management activities would be further constrained. In the long-term, if Congress decides to designate the Recommended Wilderness areas as wilderness, motorized and mechanized activities may not be authorized. This would result in the permit holder having to spend more time and labor to manage the allotment.

Wildlife

There is nothing specifically in Alternative R for wildlife that would affect livestock or allotment management.

Riparian and Aquatic Resource Management

Forest plan direction contained within Alternative R to protect riparian areas would constrain grazing and would likely require the permit holder to spend additional time, labor, and make capital investments to limit potential livestock grazing effects on riparian areas. Alternatives R and P have the most constrained plan components for riparian areas that would affect permitted livestock grazing. For example, alternatives R and P have an added standard to restrict livestock access to fish redds of federally listed threatened and endangered fish. Additional standards or changing a guideline to a standard may put the permittee at a higher risk of being in non-compliance with the allotment management plan.

Riparian Management Area widths for Alternative R would increase compared to current direction in the 1988 Plan and INFISH. Alternatives with wider riparian area widths are the Proposed Action, R, P, and O. These alternatives increase riparian area widths, and therefore protections, for lakes and natural ponds from 150 feet to 300 feet.

Alternatives R and P have additional standards, and standards that in other alternatives are guidelines, addressing livestock grazing and rangeland infrastructure in riparian areas. More constraining plan standards, and increased riparian area widths in may increase time, labor and capital expenditures by the permittee to manage allotments.

Standard 21 of ARCSMod, which pertains to livestock handling, management and water facilities, could limit the implementation of future management options to improve riparian areas and water quality. Specifically, given the constraining RMA widths and the terrain and types of stream channels experienced on the Colville, it would be extremely difficult to re-locate new water troughs outside the RMA. In fact, of the many hundred water developments currently on the Colville National Forest, none are located outside of the RMA and they have been shown to provide off-site watering opportunities for livestock that in turn result in improved water quality and riparian conditions. Requiring water troughs to be placed at least 300 feet from fish-bearing streams would likely require at least 2,000 feet of pipe to convey water to the trough and return the overflow back to the stream. These long pipelines, which are low gradient, low pressure, gravity fed systems, have been found to be extremely temperamental and inconsistent in delivering water to their intended location. When livestock troughs do not consistently have water in them, livestock would revert to drinking from streams and therefore impede riparian recovery and could result in exceeding identified guidelines for forage/browse utilization and bank alteration.

Guideline 22 of ARCS-Mod pertaining to green-line vegetation areas is more restrictive in regard to minimum stubble height amounts and would potentially double the amount of required residual stubble height left in riparian areas compared to the existing condition. It is recognized that riparian and stream conditions are improving on the Colville National Forest with current management which requires a minimum of 4 inches of herbaceous stubble in riparian zones. This ARCS-Mod guideline, which would require a minimum of 6-8 inches of herbaceous stubble in riparian zones, could constrain permitted grazing and could result in shortened grazing seasons for permittees. Science suggests that 4 inches (10cm) of residual stubble height is recommended as a starting point for improved riparian management as this amount is near optimal when considering riparian issues such as maintaining forage vigor, entrapping and stabilizing sediment under inundated flow, trampling of streambanks and diversion of willow browsing (Clary and Leininger, 2000). In some situations, 2.75 inches (7cm) may provide for adequate riparian ecosystem function while others may require 6-8 inches (15 to 20 cm) (Clary and Leininger, 2000). Having conservative/restrictive guidelines identified in ARCS-Mod, such as a minimum stubble height requirement of 6-8 inches, is likely to ensure riparian health, but presents additional constraints for livestock operators who could experience shorter grazing seasons in order to comply with an 6-8 inch minimum stubble height requirement. Based upon vegetation monitoring in upland and riparian areas and a knowledge of the permitted grazing occurring on the Colville National Forest, it is estimated that maintaining at least 6-8 inches of residual stubble height could equate to a 10-50% reduction in AUMs as a result of shortened grazing seasons that would be required to attain the specified minimum stubble height values in the ARCS-Mod Guideline 22. This estimation is at the Forest-wide scale and the reality experienced on a given allotment could vary depending on the condition of and setting along streams and riparian areas, how livestock utilize the pastures, amounts of suitable rangelands within pastures, the amount and location of developed water sources and the number of pastures that exist within the allotment. The reality of reduced AUMs authorized through permitted grazing as a result of restrictive riparian guidelines and standards has been realized elsewhere on public lands in the western United States. Following implementation of similar riparian standards and guidelines in California (Region 5), authorized grazing use has been reduced 27% from 2000 to 2014 (Tate, 2015). Dr. Tate also noted that on California public rangelands, many of the drier and higher elevation rangelands are unable to produce 8 inches of riparian herbaceous vegetation in the absence of grazing and this is equally true for many of the riparian areas on the Colville National Forest.

Standard 23 of ARCS-Mod pertaining to allotment management planning and livestock handling facilities could result in difficulty gathering and removing livestock from the allotment at the end of the permitted use season. Livestock handling facilities are strategically placed within allotments in order to maximize their effectiveness and function. These facilities need to be strategically placed in order to be effective and are usually near water, but away from the source and associated riparian vegetation on a relatively flat landscape. Should these facilities be required to be moved farther away from water because of the arbitrary 300 foot distance from the stream, it could compromise a permittee's ability to successfully gather livestock from the allotment and potentially result in extended livestock use in the riparian areas thereby reducing the recovery period for vegetation and increasing impacts to streams and streambanks.

Standard 24 of ARCS-Mod pertaining to fish redds would require that livestock would not be able to access federally-listed threatened or endangered fish redds. Depending on the method to accomplish this, allotment management could be complicated which could result in increased time, effort, and cost to grazing permittees. Riparian exclosure fencing is one way to accomplish

this standard and this method could make pasture moves more difficult if trailing routes are compromised as a result of additional fencing.

Implementation of ARCS-Mod guidelines and standards do not account for the variability that occurs over the 1.1 million acres of the Colville National Forest. Therefore, these constraints applied across the entire Forest could dampen economic contributions to local economies if standards or guidelines are at risk of being exceeded and livestock have to be removed sooner than authorized.

Alternative P

Many public comments expressed concern that wilderness designation may result in lower revenue to local economies due to reduced recreational opportunities. This alternative utilizes many plan components from the Proposed Action while also addressing economic concerns associated with wilderness. Alternative P proposes a lower amount of recommended wilderness than the proposed action (6% of the landscape). In addition, Alternative P proposes a moderate level of non-motorized backcountry use (11%). To assure adequate protection for terrestrial and aquatic habitats from roads and motorized trails, desired road density conditions are the same as Alternative R. Riparian widths are the same as in the proposed action.

Summary of Effects

Old Forest Management: Alternative P is likely to increase forage for livestock and wildlife by creating large openings. Due to climate change the trend in size and number of larger wildfires is expected to increase over the life of the plan, also resulting in an increase in forage.

Access: The total effect to access comes from looking at percentage of Forest acres in “Backcountry” and “Recommended Wilderness” combined and proposed road density limits. Compared to the No Action alternative, access opportunities would be reduced through an increase in the “Backcountry” and “Recommended Wilderness” acres and the identified road densities for Focused and General Restoration Management Areas. Limited access could equate to an increase in time and labor costs for permittees.

Riparian and Aquatic Resources: Riparian area widths would increase compared to the No Action alternative and that experienced under the 1988 Forest Plan. The “guidelines” and “standards” directing management for grazing practices in the Aquatic Riparian Conservation Strategy Modified (ARCSMod) is likely to have an effect on allotment management and could act to limit future options and reduce the length of permitted grazing seasons. Grazing permittees could realize additional constraints based on minimum stubble height requirements of ARCSMod. These guidelines and standards would also constrain grazing beyond what has been identified as optimal to protect stream and riparian values in most areas (Clary and Leininger, 2000).

Old Forest Management and Timber Production

Timber harvest can have a favorable effect on forage production by creating transitory rangelands that exist for a period of time following treatment. The expected timber harvest remains the same across all alternatives due to budget trends, so there is no increase in forage from increased acres of timber harvest. However, the Proposed Action and Alternative P include desired conditions for creating gaps and patches of vegetation ranging up to 40 acres. More and

larger gaps in vegetation would create more foraging areas, so the Proposed Action and Alternative P are likely to increase forage for livestock and wildlife. Timber harvest and follow up fuels treatments result in increased forage standing crop due to the relationship between forage production and overstory being curvilinear with forage production being negatively related to density of overstory vegetation (Masters et.al., 1993). Additional forage would reduce forage competition with big game and may improve livestock distribution over the allotments.

Prescribed fire can also create desirable foraging areas depending on the vegetation types burned. Due to budget trends the amount of prescribed fire is likely to remain the same across all alternatives and is unlikely to markedly increase in the short term.

The Proposed Action and Alternative P are expected to result in forests that are more resilient and have fewer large and uncharacteristic wildfires in the long term. The trend in size and number of larger wildfires is expected to increase over the life of the plan due to anticipated climate change, resulting in an increase in forage in the short term, while in the long-term wildfire created forage would decrease. However, the Proposed Action and Alternative P would continue to provide increased forage because of the desired condition for large size gaps and patches.

Motorized Recreation Trails

The combined total for Management Areas that would restrict motorized access would total 17% of the Forest under the Alternative P. This means that there would be 9.2% fewer acres under Alternative P where motorized access would be allowed compared to the 1988 Forest Plan. Limited access could equate to an increase in time and labor costs for permittees.

The analysis assumes that permit holders may not have motorized off-highway vehicle access to parts of their allotment within a backcountry non-motorized management area.

Access

Alternative P's recommended road density limits of 1 mile/square mile for Focused Restoration Management Areas and 2 miles/square mile for General Restoration Management Areas is likely to result in a noticeable change in a grazing permittee's ability to access their allotments. Many watersheds would likely see reductions in the amount of roads present, and this reduction in access would result in grazing permit holders having to spend more time and labor to manage the allotment.

Low maintenance native surface roads serve as routes for easily moving livestock on, off of and around pastures, and some routes may be lost as roads are decommissioned. Cut and fill slopes and the native surface of low maintenance roads is another source of forage, so lower road densities may have an effect on availability of forage for livestock grazing.

A positive effect of lower road density and miles is that cattle and range improvements would generally receive less disturbance and vandalism. Public use of roads in allotments with intensive grazing systems disturbs livestock, increases the risk of gates being left open, and tends to disrupt the proper utilization of forage by moving livestock along roadways.

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Recommended Wilderness Areas

Concerning Recommended Wilderness, the Proposed Action, Alternative P and Alternative O would allow existing motorized uses to continue until Congress makes a decision on the Forest Service's recommendation. None of the Recommended Wilderness areas currently have USFS system roads, or motorized trails. Alternatives with a high percentage of allotment acres in Recommended Wilderness would have the highest effect to permit holder's use of mechanized equipment in these areas. This would result in the permit holder having to spend more time and labor to manage the allotment.

Wildlife

There is nothing specifically in Alternative P for wildlife that would affect livestock or allotment management.

Riparian and Aquatic Resource Management

Forest plan direction contained within Alternative P to protect riparian areas would constrain grazing and would likely require the permit holder to spend additional time, labor, and make capital investments to limit potential livestock grazing effects on riparian areas. Alternatives R and P have the most constrained plan components for riparian areas that would affect permitted livestock grazing. For example, alternatives R and P have an added standard to restrict livestock access to fish redds of federally listed threatened and endangered fish. Additional standards or changing a guideline to a standard may put the permittee at a higher risk of being in non-compliance with the allotment management plan.

Riparian Management Area widths for Alternative P would increase compared to current direction in the 1988 Plan and INFISH. Alternatives with wider riparian area widths are the Proposed Action, R, P, and O. These alternatives increase riparian area widths, and therefore protections, for lakes and natural ponds from 150 feet to 300 feet.

Alternatives R, P and O have additional standards, and standards that in other alternatives are guidelines, addressing livestock grazing and rangeland infrastructure in riparian areas. More constraining plan standards, and increased riparian area widths may increase time, labor and capital expenditures by the permittee to manage allotments.

Standard 21 of ARCS-Mod, which pertains to livestock handling, management and water facilities could limit the implementation of future management options to improve riparian areas and water quality. Specifically, given the constraining RMA widths and the terrain and types of stream channels experienced on the Colville, it would be extremely difficult to re-locate new water troughs outside the RMA. In fact, of the many hundred water developments currently in existence on the Colville National Forest, none are located outside of the RMA and they have been shown to provide off-site watering opportunities for livestock that in turn result in improved water quality and riparian conditions. Requiring water troughs to be placed at least 300 feet from fish-bearing streams would likely require at least 2,000 feet of pipe to convey water to the trough and return the overflow back to the stream. These long pipelines, which are low gradient, low pressure, gravity fed systems, have been found to be extremely temperamental and inconsistent in delivering water to its intended location. When livestock troughs do not consistently have water in them, livestock would revert to drinking from streams and therefore impede riparian recovery and could result in exceeding identified guidelines for forage/browse utilization and bank alteration.

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Guideline 22 of ARCS-Mod pertaining to green-line vegetation areas is more restrictive in regard to minimum stubble height amounts and would potentially double the amount of required residual stubble height left in riparian areas compared to the existing condition. It is recognized that riparian and stream conditions are improving on the Colville National Forest with current management which requires a minimum of 4 inches of herbaceous stubble in riparian zones. This ARCS-Mod guideline, which would require a minimum of 6-8 inches of herbaceous stubble in riparian zones, could constrain permitted grazing and could result in shortened grazing seasons for permittees. Science suggests that 4 inches (10cm) of residual stubble height is recommended as a starting point for improved riparian management as this amount is near optimal when considering riparian issues such as maintaining forage vigor, entrapping and stabilizing sediment under inundated flow, trampling of streambanks and diversion of willow browsing (Clary and Leininger, 2000). In some situations 2.75 inches (7cm) may provide for adequate riparian ecosystem function while others may require 6-8 inches (15 to 20 cm) (Clary and Leininger, 2000). Having conservative/restrictive guidelines identified in ARCS-Mod, such as a minimum stubble height requirement of 6-8 inches, is likely to ensure riparian health, but presents additional constraints for livestock operators who could experience shorter grazing seasons in order to comply with an 6-8 inch minimum stubble height requirement. Based upon vegetation monitoring in upland and riparian areas and a knowledge of the permitted grazing occurring on the Colville National Forest, it is estimated that maintaining at least 6-8 inches of residual stubble height could equate to a 10-50% reduction in AUMs as a result of shortened grazing seasons that would be required to attain the specified minimum stubble height values in the ARCS-Mod Guideline 22. This estimation is at the Forest-wide scale and the reality experienced on a given allotment could vary depending on the condition of and setting along streams and riparian areas, how livestock utilize the pastures, amounts of suitable rangelands within pastures, the amount and location of developed water sources and the number of pastures that exist within the allotment. The reality of reduced AUMs authorized through permitted grazing as a result of restrictive riparian guidelines and standards has been realized elsewhere on public lands in the western United States. Following implementation of similar riparian standards and guidelines in California (Region 5), authorized grazing use has been reduced 27% from 2000 to 2014 (Tate, 2015). Dr. Tate also noted that on California public rangelands, many of the drier and higher elevation rangelands are unable to produce 8 inches of riparian herbaceous vegetation in the absence of grazing and this is equally true for many of the riparian areas on the Colville National Forest.

Standard 23 of ARCS-Mod pertaining to allotment management planning and livestock handling facilities could result in difficulty gathering and removing livestock from the allotment at the end of the permitted use season. Livestock handling facilities are strategically placed within allotments in order to maximize their effectiveness and function. These facilities need to be strategically placed in order to be effective and are usually near water, but away from the source and associated riparian vegetation on a relatively flat landscape. Should these facilities be required to be moved further away from water because of the arbitrary 300 foot distance from the stream, it could compromise a permittee's ability to successfully gather livestock off of the allotment and could potentially result in extended livestock use in the riparian areas thereby reducing the recovery period for vegetation and increasing impacts to streams and streambanks.

Standard 24 of ARCS-Mod pertaining to fish redds would require that livestock would not be able to access federally-listed threatened or endangered fish redds. Depending on the method to accomplish this, allotment management could be complicated which could result in increased time, effort and cost to grazing permittees. Riparian exclosure fencing is one way to accomplish

this standard and this method could make pasture moves more difficult if trailing routes are compromised as a result of additional fencing.

Implementation of ARCS-Mod guidelines and standards do not account for the variability that occurs over the 1.1 million acres of the Colville National Forest. Therefore, these constraints applied across the entire Forest could dampen economic contributions to local economies if standards or guidelines are at risk of being exceeded and livestock have to be removed sooner than authorized.

Kettle Crest Special Interest Area (SIA)

Alternative P and O proposes the creation of a Special Interest Area in the Kettle Crest range to account for the special characteristics seen in and unique values recognized for this area. The Proposed Kettle Crest SIA is suitable for livestock grazing and no effects are anticipated from its existence.

Alternative B

This alternative combines feedback from diverse interest groups and incorporates management strategies supported by the Northeast Washington Forestry Coalition. Alternative B addresses the concerns of multiple constituencies in one alternative by designating restoration and timber management zones, recommending the highest level of wilderness designation and the least amount of area for backcountry management and backcountry motorized use.

Alternative B emphasizes two management areas that focus on forest vegetation: the Restoration Zone management area, which emphasizes late forest structure on 31% of the landscape, and the Active Management area, which emphasizes timber production on 43% of the Forest. The Restoration Zone and the Active Management area are similar to the Focused and General Restoration areas in the Proposed Action and other alternatives. Like the No Action alternative, Eastside Screens are retained. Unlike the other alternatives, one management zone (Active Management) emphasizes even-aged management (clear-cuts) for timber production.

Alternative B provides for the highest acreage of Recommended Wilderness across all alternatives, 20.1% of the landscape, and the least amount of Backcountry and Backcountry motorized recreation opportunities. Unlike any of the other alternatives, Alternative B responds to concerns related to the impact of the road system on terrestrial and aquatic habitats by limiting the total miles of Forest Service roads to no more than the current level.

Any objectives or goals not specifically changed by the public entities that developed this alternative incorporate existing (1988) Forest Plan direction for the affected resource areas.

Summary of Effects

Access: The total effect to motorized trail access comes from looking at percentage of allotment acres in “Backcountry” and “Recommended Wilderness” combined. The highest percentage of allotment acres in Recommended Wilderness and Backcountry are in R and B, which would limit motorized trail access and increase time and labor for permittees the most among the alternatives.

Riparian and Aquatic Resources: Of the action alternatives, riparian area widths are the smallest in the B alternative, which would have the least effect on the permittee’s management of the

allotment. Alternative B recommends riparian and aquatic resources be guided by requirements of INFISH, which is the same as is followed in the 1988 Plan.

Old Forest Management and Timber Production

Timber harvest can have a favorable effect on forage production by creating forage areas through removing overstory. The expected timber harvest remains the same across all alternatives due to budget trends, so there is no increase in forage from increased acres of timber harvest. Alternatives B and O limit gap size to three acres. More and larger gaps in vegetation would create more forage areas, so Alternative B is not likely to increase forage for livestock and wildlife very much.

Prescribed fire can also create desirable foraging areas depending on the vegetation types burned. Due to budget trends the amount of prescribed fire would remain the same across all alternatives and is unlikely to markedly increase in the short term.

Motorized Recreation Trails

The combined total for Management Areas that would restrict motorized access would total 20.1% of the Forest under the Alternative B. This means that there would be 12.3% fewer acres under Alternative B where motorized access would be allowed compared to the 1988 Forest Plan. Limited access could equate to an increase in time and labor costs for permittees.

The analysis assumes that permit holders may not have motorized off-highway vehicle access to parts of their allotment within a backcountry non-motorized management area.

Access

Today there are about 4,000 miles of National Forest System roads and about 80 percent of the forest is suitable for road construction. Alternative B would cap the number of road miles at the current level so that should any new road be proposed, an equal amount of road would have to be decommissioned.

Road densities and total miles of road on the forest are expected to remain the same in the short-term and likely to decrease in the long-term due to budget trends. Motorized vehicle access for permittees would remain the same in the short-term and may decline slightly in the long-term.

Low maintenance native surface roads serve as routes for easily moving livestock on, off of and around pastures, and some routes may be lost as roads are decommissioned. Cut and fill slopes along with the native surface of low maintenance roads is a location providing foraging areas for livestock, therefore lower road densities may have a small effect on availability of forage for livestock grazing.

Recommended Wilderness Areas

In the short-term the effects of recommended wilderness to livestock grazing is to limit motorized trail access for the permit holder in the R and B alternatives, where a standard allows no motorized uses within Recommended Wilderness.

Alternatives R and B would recommend the largest amount of Recommended Wilderness to congress for potential designation and these alternatives would have the most substantial effect

on range management through limiting access, restricting tools and increasing the time required to complete management activities. None of the Recommended Wilderness areas currently have USFS system roads, but the Owl Mountain, Jackknife, Twin Sisters and South Huckleberry PWAs all have motorized trails that are used for livestock and allotment management. Since all of these PWAs become Recommended Wilderness in Alternative B, a permittee's ability to complete allotment and livestock management activities would be constrained. In the long-term, if Congress decides to designate the Recommended Wilderness areas as wilderness, motorized and mechanized activities may not be authorized. This would result in the permit holder having to spend more time and labor to manage the allotment.

Wildlife

There is nothing specifically in Alternative B for wildlife that would affect livestock or allotment management.

Riparian and Aquatic Resource Management

Existing Forest Plan direction concerning riparian and aquatic resource management would be continued in Alternative B. Forest plan direction that protects riparian areas have an effect on grazing operations through the need for the permit holder to spend time, labor, and make capital investments to limit livestock grazing effects to riparian areas. Currently there are riparian management areas which are called Riparian Habitat Conservation Areas (RHCAs) established by the INFISH and Eastside Screens amendments, and management direction from the INFISH amendment that address livestock grazing in Riparian Management Areas. This direction would continue and permittee's time, labor and capital investments would continue at the same levels, assuming allotment management is in compliance with the allotment management plan.

Alternative O

This alternative comes from a series of public, collaborative meetings run by the Forest Service that focused on motorized recreation, wilderness recommendations, and vegetation management and reflects areas of general agreement among participants in those meetings. The Forest Service fully developed this alternative using the proposed action to fill in the gaps not addressed in the collaborative process.

Alternative O emphasizes summer and winter non-motorized opportunities in a backcountry, un-roaded setting and minimizes recommended wilderness. In addition, the Kettle Crest Special Interest Area is proposed to provide outstanding recreational values in a semi-primitive setting while allowing other uses, to address public disagreement about recommending this area for wilderness. Backcountry motorized (BCM) areas are also emphasized.

Alternative O manages late forest structures using a fixed reserve system and utilizes the Eastside Screens. This alternative proposes two management areas to address vegetation management: the Restoration Zone management area to restore the historic range of variation, and the Responsible management area that emphasizes timber production. The management zones are very similar to those proposed in Alternative B, the other alternative informed by collaborative processes. The total percentage of the Forest allocated to vegetation management (72 percent) is similar to Alternative B (73 percent) though Alternative O has a greater percentage in the Restoration Zone management area than Alternative B.

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Summary of Effects

Access: The total effect to access comes from looking at percentage of Forest acres in "Backcountry" and "Recommended Wilderness" combined and proposed road density limits. Compared to the No Action alternative, access opportunities could be slightly reduced through an increase in the "Backcountry" acres, but a reduction in access is not likely to be related to road density limits. Limited access could equate to an increase in time and labor costs for permittees.

Riparian and Aquatic Resources: Riparian area widths would increase compared to the No Action alternative and that experienced under the 1988 Forest Plan. The "guidelines" directing management for grazing practices in the Aquatic Riparian Conservation Strategy (ARCS) are unlikely to have a substantial effect on allotment management. The ARCS "standard" requiring new livestock handling, management or watering facilities to be located outside of Riparian Management Areas (RMAs) could further constrain future management options in developing livestock management activities that may improve riparian vegetation and water quality.

Old Forest Management and Timber Production

Timber harvest can have a favorable effect on forage production by creating forage areas through removing overstory. The expected timber harvest remains the same across all alternatives due to budget trends, so there is no increase in forage from increased acres of timber harvest. Alternatives B and O limit gap size to three acres. More and larger gaps in vegetation would create more forage areas, so Alternative O is not likely to increase forage for livestock and wildlife very much.

Prescribed fire can also create desirable foraging areas depending on the vegetation types burned. Due to budget trends the amount of prescribed fire would remain the same across all alternatives and is unlikely to markedly increase in the short term.

Motorized Recreation Trails

The combined total for Management Areas that would restrict motorized access would total 17.5% of the Forest under Alternative O. This means that there would be 9.7% fewer acres under Alternative O where motorized access would be allowed compared to the 1988 Forest Plan. Limited access could equate to an increase in time and labor costs for permittees.

The analysis assumes that permit holders may not have motorized off-highway vehicle access to parts of their allotment within a backcountry non-motorized management area.

Access

Today there are about 4,000 miles of USFS system roads and about 80 percent of the forest is suitable for road construction. Alternative O would cap the number of road miles at the current level so that should any new road be proposed, an equal amount of road would have to be decommissioned.

Road densities and total miles of road on the forest are expected to remain the same in the short-term and likely to decrease in the long-term due to budget trends. Motorized vehicle access for permittees would remain the same in the short-term and may decline slightly in the long-term.

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Low maintenance native surface roads serve as routes for easily moving livestock on, off of and around pastures, and some routes may be lost as roads are decommissioned. Cut and fill slopes along with the native surface of low maintenance roads is a location providing foraging areas for livestock, therefore lower road densities may have a small effect on availability of forage for livestock grazing.

Recommended Wilderness Areas

Concerning Recommended Wilderness, the Proposed Action, Alternative P and Alternative O would allow existing motorized uses to continue until Congress makes a decision on the Forest Service's recommendation. None of the Recommended Wilderness areas recommended in Alternative O currently have USFS system roads, or motorized trails.

The only PWA recommended as Recommended Wilderness in Alternative O is the Salmo-Priest Adjacent of which is not contained within a grazing allotment. No permitted grazing exists in this PWA and therefore there would be no effect to grazing by this recommendation.

Wildlife

There is nothing specifically in Alternative O for wildlife that would affect livestock or allotment management.

Riparian and Aquatic Resource Management

The "guidelines" directing management for grazing practices in the Aquatic Riparian Conservation Strategy (ARCS) are unlikely to have a substantial effect on allotment management. The ARCS "standard" requiring new livestock handling, management or watering facilities to be located outside of Riparian Management Areas (RMAs) could further constrain future management options in developing livestock management activities that may improve riparian vegetation and water quality. Additional standards or changing a guideline to a standard may put permittees at a higher risk of being in non-compliance with the allotment management plan.

Riparian Management Area widths vary by alternative. Riparian area widths for Alternative O would increase compared to the No Action alternative and that experienced under the 1988 Forest Plan. This alternative increases riparian area widths for lakes and natural ponds from 150 feet to 300 feet.

Kettle Crest Special Interest Area (SIA)

Alternatives P and O propose the creation of a Special Interest Area in the Kettle Crest range to account for the special characteristics seen in and unique values recognized for this area. The Proposed Kettle Crest SIA is suitable for livestock grazing and no effects are anticipated from its existence.

Cumulative Effects – Common to All Alternatives

The cumulative environmental consequences for a programmatic Forest Plan also considers lands managed by other entities in the area and describes the relative contribution of the Forest Plan decision when considering surrounding landscape with other similarly scaled planning efforts and opportunities

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The area for this cumulative effects analysis includes adjacent National Forests, Bureau of Land Management, State, tribal, and private land.

Vegetative treatments are expected to occur on these adjacent lands at a similar level and intensity. These types of treatments would increase forage for livestock and improve rangeland condition.

Cattle grazing effects on Forest allotments and other allotments and/or pastures within these watershed areas affect vegetation by reducing plant height, canopy cover, and ground cover. The time frame for these combined effects is 30 years, 15 years in the past and 15 years in the future because changes in condition and trend in the vegetation depend on the presence of favorable growing conditions after cattle leave the pasture. If growing conditions are favorable, plant height and canopy cover would completely recover within one year. If growing conditions are not favorable, plant recovery would occur more slowly (up to two to three years). Vegetation recovery from the other activities and natural events may take this long depending on climate.

The cumulative effect of adjacent federal lands management would not change any of the direct and indirect effects. Grazing, where allowed on adjacent federal lands, is intensively managed to accommodate other public land uses and to protect resource values. The effects to permit holders on other federal lands are much the same as Forest Service permit holders on the Colville NF. There have been no significant changes in the management plans for adjacent federal lands relative to grazing that would be considered a cumulative effect.

Livestock production costs would likely increase due to increase input costs and the availability of grazing lands decrease due to residential and agricultural development of private lands.

An effect associated with mechanical treatments and livestock grazing is the potential to spread invasive species from adjacent lands. New weed populations could occur from vehicle-transported seeds, disturbed soils and increased light availability following mechanical treatments or creation of seedbeds by livestock use. Livestock and wildlife can spread weed seeds, but livestock and wildlife use results in fewer new weed populations than those established along roads and trails by seeds spread from vehicle tires, equipment tracks, and/or attached soil (Tyser and Worley, 1992; Tyser and Key, 1988; Gelbard and Harrison, 2003). This circumstance is attributed to the higher amount of biotic and below ground biotic resistance experienced in areas other than roads and trails (Gelbard and Harrison, 2003). All alternatives would contribute similarly to the control, treatment, and eradication of invasive plant species introduced from outside the forests.

Fires from adjacent lands can escape and spread onto the Colville National Forest. If they do, it could lead to temporary grazing exclusions and impact ranching operations by requiring the permittee to find new forage or sell all or part of the livestock.

Monitoring Recommendations

There are no monitoring recommendations related to range management at the Forest Plan level and all monitoring would be identified and implemented at the allotment or project level.

Other Agencies and Individuals Consulted

Tom Hilken, USFS Region 6 Range Program Manager

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Acronyms

ARCS – Aquatic Riparian Conservation Strategy

AUM – Animal Unit Month

FEIS – Final Environmental Impact Statement

FSH – Forest Service Handbook

FSM – Forest Service Manual

GIS – Geographic Information System

NFS – National Forest System

PIBO – PACFISH INFISH Biological Opinion

PWA – Potential Wilderness Area

RHCA – Riparian Habitat Conservation Area

RMA – Riparian Management Area

SIA – Special Interest Area

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Appendix A - Methodology and Analysis Process to Determine Rangeland Suitability and Capability for Colville National Forest Plan Revision

1. Introduction

Provisions of the 1982 planning rule require that the capability and suitability for producing forage for grazing animals on NFS lands be determined. Further requirements can be found in the National Forest Management Act at 16 U.S.C. 1604(g)(2)(A) and in 36 CFR 219.20. The analysis process and results are discussed in the following sections.

This current assessment improves on the prior assessment done during the development of the 1988 Land and Resource management Plan because it accounts for changes in suitability that have occurred since the original decisions were issued, and also because it employs current GIS mapping technologies that were unavailable during previous planning efforts.

To perform this assessment, the document titled *Rangeland Suitability for Livestock Grazing at the Forest Plan Level and Standards for NEPA Display* (Rev. 3/6/03) was used as a template. While completing this analysis, it is required to first determine what lands under national forest administration are capable of providing adequate forage for grazing animals, and then the capable lands are assessed for suitability based on specific identified resource management practices. Finally a suitability determination, based on the capability and suitability analysis of the planning area is produced.

2. Definitions of Capability and Suitability

Capability

As defined in 36 CFR 219.3, capability refers to the potential of an area of land to produce resources, supply goods and services, and allow resource uses under an assumed set of management practices and at a given level of management intensity. Capability depends upon current resource conditions and site conditions, such as climate, slope, landform, soils, and geology, as well as the application of management practices, such as silviculture or protection from fire, insects, and disease.

Rangeland capability does not vary by alternative and is therefore only determined once through the land management planning process.

Suitability

Suitability refers to the appropriateness of applying certain resource management practices to a particular area of land, as determined by an analysis of the economic and environmental consequences and the alternative uses forgone. A unit of land may be suitable for a variety of individual or combined management practices.

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Rangeland suitability may vary by alternative being considered in the Land Management Planning process, and for this reason, suitability is determined by alternative or grouping of similar alternatives.

Capability & Suitability Determination

The overlay of the capable acres with the suitable acres yields the Capable and Suitable Acres. This analysis is done separately for cattle and for sheep as they utilize the landscape differently. It would also vary for differing alternatives as suitability may change based on alternative components. For the Forest Plan Revision, cattle and sheep are the only kinds of livestock being considered since it is anticipated that no other kinds of livestock would be permitted to graze on the Colville National Forest during the life of this plan. If other kinds of livestock use are considered at a later time, a capability and suitability analysis at the project level could be done to make determinations of capability and suitability for those species.

The capability and suitability analysis and determination is not a decision to graze livestock on any specific area of land. Nor is it a decision about, or estimate of, livestock grazing capacity. The capability/suitability analysis and determination may or may not provide supporting information for a decision to graze livestock on a specific area, though this would be accomplished at the project (allotment) scale.

Grazing allotments would contain areas that are capable and/or suitable as well as areas that are modeled as being not capable and/or not suitable. Since the evaluation is based on a modeling process and is dealing with a variety of complex landscapes, it is inevitable that this intermingling would occur on a land base of any significant size. Therefore, these capability/suitability determinations are not intended to imply that livestock would be precluded from occasionally being found on lands that may be modeled as non-capable or non-suitable.

Together, the capability and suitability analyses can provide information for Forest Plan level analysis as well as project level analysis and subsequent NEPA decisions.

At the Forest Plan level, capability and suitability analysis provides basic information regarding the potential of the land to produce resources and supply goods and services in a sustainable manner, as well as the appropriateness of using that land in a given manner. This information assists the interdisciplinary team and the line officer in evaluating alternatives and arriving at Forest landscape level decisions. It also helps in an analysis of alternative uses foregone.

At the project level, rangeland capability and suitability may be reviewed, updated, or made more site-specific, if it is an issue for that project or provides information useful to the decisions being made. For instance, rangelands identified as capable and suitable for domestic livestock grazing in the land and resource management plan may include areas that are not appropriate for domestic livestock grazing when analyzed at the site-specific level (i.e., some wetlands or some campgrounds). A more site-specific analysis at the allotment (or multi-allotment) scale may provide information useful in planning management of the given allotment(s).

The process utilized in completing this analysis, as well as future project level analysis, can be found in Appendix A of this document.

3. Determining Capability

All lands administered by the Colville National Forest were considered when being assessed for capability. Cattle and sheep grazing were considered separately because of distinct differences in the ways in which these animals forage and utilize the landscape. No other livestock species were considered since other domestic livestock species are not currently authorized to graze, or anticipated to graze on the Colville National Forest during the life of the plan.

From the total acres, lands considered rock outcrops, very wet and rubble-land were subtracted. This category includes lands classified as rock outcrop, rubble-land, lithic, serpenitic, river-wash, very wet or badlands in the soil resource coverages for the National Forest.

Range capability guidance suggests that lands incapable of producing 200 lbs/acre/year of forage be removed next. Because much of the potential forage resource occurs on transitory range in holes in the forest canopy, the team believed that this standard was inappropriately high. In such situations, levels of forage production are unlikely to reach the specified level on an acreage basis because, due to dense tree cover, up to 75 percent of an acre may produce little forage. A threshold of 50 lbs/acre/year is used instead. Within the soil resource coverages for the Forest, lands classified as shallow soils were removed from consideration at this stage because of inherent productivity limitations.

Next, water bodies were removed from the capable land base. Existing coverages of the Forest's lakes, rivers and streams were used as the source for these adjustments. No minimum size of water body was selected for this exercise. A width of 6 feet was used as the average width for perennial streams for this analysis.

Next, the surfaces of levels 2 through 5 roads were removed from the capable land base as well as county roads and state highways. Level 1 roads were found to be capable rangelands for the Colville National Forest because they are almost always found in a fully vegetated state and they do currently support livestock grazing. The transportation coverage for the Forest was used as the data source. An average width of 16 feet is assumed on all roads that occur within the Forest.

Since slope limits the accessibility of livestock to potential forage, steep slopes need to be withdrawn from the capable land base. Consistent with the recommendations found in the *Rangeland Suitability for Livestock Grazing at the Forest Plan Level and Standards for NEPA Display* document, a 40 percent slope was determined to be a reasonable threshold for cattle and a 60 percent slope threshold was considered appropriate for sheep on the Forest (USDA Forest Service, 2003). Lands steeper than these thresholds were removed from the land base. The Forest's digital elevation model was used to accomplish these withdrawals.

The template provides for the optional removal of additional lands because of distance from a water source. A determination was made that no such removal was necessary because water sources are relatively common on the Forest and this is not a limiting factor related to rangeland Capability.

The acreages that remained are considered to be the acreages of Capable Rangelands on the Colville National Forest.

4. Determining Suitability

The process of completing an analysis of rangeland suitability begins with the total acres that have been found to be capable rangelands, through the process identified above. In assessing suitability, the first reduction in the capable land base involves removing areas with high percentage tree canopy coverage. When canopy cover is 70 percent or greater, little forage is produced on these lands and they would be considered unsuitable.

Transitory rangelands that are producing adequate forage because of canopy cover reduction due to wildfire or silvicultural activity would be considered suitable if canopy cover is less than 60 percent. The expectation is that without further disturbance, a stand with 60 percent canopy cover would become 70 percent closed by the end of the revised Forest Plan's life (USDA Forest Service, 2003). The source of the canopy cover information is the current vegetation map developed from satellite imagery for the Forest Plan revision.

In considering vegetation types that may be handled differently, it was concluded through an interdisciplinary discussion that all Western hemlock plant associations would be classified as unsuitable because, even after disturbance, the shrub types likely to dominate are unpalatable to livestock. Aspen stands would not be excluded from the suitable base because they tend to be small and not suitable for mapping. The source for the deletions based on plant associations are forest potential vegetation coverages.

Next, management areas or habitats which prohibit, or propose to prohibit, livestock grazing were removed.

The following areas are removed from the suitable area:

Table 1—Colville National Forest unsuitable management areas/locations

Area	Alternative(s)
Caribou Habitat	All
Research Natural Areas (RNAs)	All
Salmo-Priest Wilderness	All
Proposed Hall Ponds RNA	All except Existing Condition

The sources for these boundaries are Forest management area coverages.

Wilderness legislation in 1964 allowed grazing on allotments that already existed in affected lands at the time the wilderness area is designated. Forest Service Manual 2320 and the Congressional Grazing Guidelines found in Forest Service Manual 2323.22 give further direction on grazing allotments in wilderness. Since the Salmo-Priest Wilderness on the Colville National Forest has never included a grazing allotment, the lands contained within its boundaries are considered unsuitable. The data source for this deduction is the management area coverage for the Forest.

Fenced recreation areas, administrative sites and permanent exclosures are considered unsuitable.

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Since there are no fenced roads or railroads within the Forest, no reductions are being made based on road or railroad buffers.

Large wildfire areas are not removed from the suitable land base. Burned area rehabilitation teams generally advise restricting grazing for a period of one to three years following the fire, but since this is a small percentage of the time considered in the Revision, no reductions were considered.

With these subtractions completed, the tentatively determined suitable land base is defined for the Colville National Forest. Further reductions may be made by the revision team during the revision process based on economics or other resource incompatibilities. Such deductions are likely to vary by alternative being considered and would be analyzed during alternative development.4.1. Range Capability and Suitability Determination

Table 2—Colville National Forest Capable Rangelands

Description	Acreage
Forest Service Administered Lands	1,103,000
Capable for Cattle Grazing	**690,311**
Capable for Sheep Grazing	**881,287**

Table 3—Colville National Forest Suitable Rangelands

Alternative	Acres of Suitable Rangeland
No Action	Cattle – 363,845 Sheep – 448,160
Proposed Action	Cattle – 363,217 Sheep – 447,532
Alternative R	Cattle – 363,217 Sheep – 447,532
Alternative P	Cattle – 363,217 Sheep – 447,532
Alternaive B	Cattle – 363,217 Sheep – 447,532
Alternative O	Cattle – 363,217 Sheep – 447,532

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Appendix B - Processes Used for Determinations of Rangeland Capability and Suitability

Capability

Use GIS to identify areas that meet the following criteria (it is not expected that all National Forest System units would have all of the following data sets available in the near future. Use the best available data in making the determination and document what data sets are not available and what steps were taken to provide similar data). If local changes are made to the values to be applied, document the rationale behind the changes:

1. Begin with all lands within the project area that are National Forest System (NFS) lands.

2. Subtract soil types that are dominated by a large percentage of rock outcrop and rubbleland, loose granitic or highly erosive soils, or very wet and boggy soils. Optional - to identify erosive areas, a geologic layer to identify active landslides, slumps, etc. may be used.

3. Subtract soil types that are not inherently capable of producing more than 200 pounds of forage/acre within their Potential Natural Community (such as badland outcrops or alkali salt flats).

4. Subtract areas that consist of lakes, reservoirs, or ponds, e.g. the area covered by water at the high water mark (from polygon water layer from CFFs).

5. Buffer major rivers (Colorado or North Platte, for example) by the actual width (averaged for individual reaches if need be) and subtract.

6. Buffer perennial streams by the actual width of the water surface at the mean high water mark, or use an average width of 3 feet on either side of center line and subtract. The 6-foot width for perennial streams represents an average width for a stream's water surface and can be used as a Unit-wide average for purposes of modeling.

7. Buffer Forest development roads by 8 feet on either side of center line and subtract. The 16-foot width for roads represents an average width for a road's surface and can be used as a Unit-wide average for purposes of modeling. The road surface is non-capable unless the road surface has been obliterated and revegetated in which case, the road surface would remain within the capable land base.

8. Subtract slopes meeting the following criteria:

    a. Subtract slopes greater than 60% (not capable for either sheep or cattle). Keep track of capable acres for cattle and sheep separately (may also need to track separately for other kinds and classes of livestock such as bison as the need presents).

    b. From the above (a) capability calculations, subtract slopes greater than 40% (slopes of 41-60% are capable for sheep but not normally for cattle). This figure

can be modified for each specific Forest or Geographic area to fit with local situations (with documented rationale).

9. Optional: Subtract areas that lack available water, or lack the potential to develop water, within approximately 3 miles of the center of the polygon for Grasslands or one mile in mountainous rangelands. This figure can be modified for each specific Forest or Geographic area to fit with local situations (with documented rationale).

10. The remaining area is **Capable Rangeland**. The capable rangeland would normally be displayed as two separate map displays/acreage tables: one map/acreage table set displays capable polygons/acreage for cattle; and, a second set displays capable polygons/acreage for sheep. Other displays may be used for other kinds of animals as needed.

Suitability

To determine rangeland suitability (36 CFR 219.3, definition of suitability); perform the following as a separate GIS analysis for each alternative or group of similar alternatives:

1. Subtract areas determined to be other than capable as determined in the capability evaluation above.

2. Subtract areas that currently have an overstory of tree canopy cover and/or unpalatable shrub canopy cover greater than 70%.

    a) Transitory range would be considered as a special short-term instance where suitability occurs because of the removal of the overstory vegetation (as by fire or harvest). However, since the long term site potential is normally a moderate to dense canopy with little understory production, and since these areas are normally dedicated to timber (and other resource) production, these areas are generally considered to be suitable for grazing only for the lifespan of the time that it takes for the canopy to once again close back to 70% or greater, and only if the costs or viability of adequately mitigating effects relative to livestock grazing on forest vegetation regeneration are acceptable.

    b) Use harvest maps and records to determine if specific areas currently meet the suitable criteria and if they are expected to remain within that criteria for the life of the plan. If so, they are determined to be suitable. If the transitory site would become non-suitable during the life of the plan, either portray it as non- suitable, or show it as being suitable only for the estimated time that it would continue to meet suitability definitions.

    c) Optional: Certain vegetative types (such as some Aspen communities) may be suitable for a given type of livestock in certain geographic areas and not in other areas. If appropriate, these vegetative communities may be subtracted out of the suitable acres as needed. Document the rationale for the decision.

3. Subtract areas that have a proposed management area prescription allocation that does not allow for livestock grazing (e.g., certain Research Natural Areas, Caribou Habitat, etc.). Subtract only management area prescriptions that have proposed standards & guidelines

that do not allow for livestock grazing management, or where decisions have previously been reached that livestock grazing is incompatible with the planned land management prescription and the proposed alternative would continue that incompatibility finding.

4. Subtract fenced recreation areas, developed recreation sites, administrative sites (except administrative pack and saddle stock pastures), minerals production sites, fenced cultural resource sites, permanent exclosures, and appropriate special use sites, where livestock use has been determined to be incompatible with the primary land use and/or where the alternative proposes to exclude livestock use.

5. Buffer primary roads (from CFFs or Infra Travel Routes; Primary roads are defined by the actual fenced area, or where a fence is known or proposed to exist but the exact location is unknown, buffer by 100 feet on either side of the center line and subtract.

6. Buffer secondary/county roads by the actual fenced area, or where a fence is known or proposed to exist but the exact location is unknown by 33 feet on either side of the center line and subtract to account for the area that is fenced along secondary/county roads. Only use when the road (or road segment) is fully excluded from livestock grazing on NFS lands. The road surface itself is non-capable. The fenced area alongside the road is capable of growing harvestable forage, but is unsuitable for livestock grazing if decisions have or would be made that livestock grazing is incompatible with other objectives associated with the ROW/easement. Road surfaces are taken out at the capability analysis level and fenced areas along roads are taken out at the suitability analysis level.

7. Buffer railroads by 100 feet on either side of centerline or by the actual fenced area, or where a fence is known or proposed to exist but the exact location is unknown, and subtract.

8. Subtract areas that are not currently within any range allotment or are closed to grazing. The reason for past or proposed closure or current lack of livestock grazing activity needs to be explained (e.g., lack of access, conflicts with wildlife, conflicts with recreation, etc.).

9. Subtract areas where decisions have been made that specific TES habitats need to be excluded from livestock grazing.

10. Have IDT specialists on the planning team identify any additional areas where conflicts occur between livestock grazing and other resources to the extent that the conflicts cannot be resolved or satisfactorily mitigated, and where the other resource values are proposed in the alternative to take precedence over livestock use. If the planning recommendation is that livestock use in these areas is incompatible, or the conflicts are incapable of being resolved in a satisfactory manner, these lands would be designated as non-suitable for the specific alternative for this planning cycle. Document the reason for the non-suitable determination.

11. The remaining area is **Suitable Rangeland.** The suitable rangeland would normally be displayed as multiple map displays and acreage tables with one map/acreage table display for each alternative.

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Appendix C - Non-Forest, Deciduous Forest, and Riparian/Wetland Communities of Northeastern Washington

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Non-Forest , Deciduous Forest, and Riparian/Wetland Communities of Northeastern Washington

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Unpublished report to support forest plan revision
on the Colville, Okanogan, and Wenatchee National Forests

Rod Clausnitzer, Terry Lillibridge and Katie Phillips

1/13/2006

NON-FOREST, DECIDUOUS FOREST, AND RIPARIAN/WETLAND COMMUNITIES

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Introduction

The purpose of this document is to describe the ecological character and geographic extent of non-forest, deciduous forest, and riparian/wetland vegetation of northeastern Washington. Nine vegetation groups are described based upon broad physiognomic and environmental factors related to dominant vegetation lifeform and elevational gradients. This classification would serve as a framework for vegetation analyses that support forest plan revision on the Colville, Okanogan, and Wenatchee National Forests (Planning Area 2). Area 2 ecologists Katie Phillips, Rod Clausnitzer, and Terry Lillybridge have contributed to the following descriptions.

Alpine and Subalpine Vegetation

Definition

The alpine and subalpine vegetation group is comprised of grasslands, forblands and shrublands including meadows, talus areas, and snowbed communities. These high elevation areas are simple in structure, typically supporting a single physiognomic layer. Where shrubs occur, they are often no larger than the accompanying forbs and grasses. Low-statured vegetation is a product of the harsh conditions where this group occurs. Snow pack is retained for much of the year, the growing season is short, and degree days (days warm enough for root or shoot growth) are relatively few. Exposure is extreme with high solar insolation and severe desiccating winds. Temperature fluctuations from day to night are large, and the average daily minimum temperatures very low. Low temperatures mean slow organic decomposition, so nutrients tend to be locked up in organic matter for relatively long periods of time. Due to these harsh conditions, trees, if they occur, exhibit krummholz or dwarfed stature, or if erect, have flagged tops. The alpine and subalpine vegetation group includes a variety of plants including the following genera: *Carex*, *Festuca*, *Stipa*, *Saxifraga*, *Xerophyllum*, *Artemisia*, *Phyllodoce*, *Vaccinium*, *Dryas*, Salix, Cassiope, and *Lupinus*.

Distribution

Alpine and subalpine herbaceous vegetation occupy the highest elevation vegetated areas of the planning area. They are found along the crest of the Cascade Mountain range in the Kettle Mountains of the Okanogan Highlands, and in the Selkirk Mountains, a northern extension of the Rocky Mountains. The upper and lower elevation limits of the alpine and subalpine zones vary with aspect, soil type, latitude and longitude. This zone occurs at higher elevations in the eastern portion of the planning area than in the west, due to more favorable soils and earlier snow melt in these areas influenced by the continental climate regime (Franklin and Dyrness 1988). The lower limit of the subalpine vegetation zone was found at 6,330 feet (1,930 meters) on the northeast side of Mount Rainier (Hamman 1972). The lower limit can be found at around 5,700 feet (1,738 meters) on Callispell Mountain on the Colville National Forest (Colville National Forest unpublished ecology data 2004). At lower elevations this zone grades into cool forest types with continuous tree cover dominated by subalpine fir *(Abies lasiocarpa)*, mountain hemlock *(Tsuga mertensiana)*, lodgepole pine *(Pinus contorta)*, Pacific silver fir *(Abies amabilis)*, and Engelmann spruce *(Picea engelmannii)*. Kovalchik and Clausnitzer (2004, page 245) found that high elevation meadow types “may extend into moderate elevations in cold air drainages or extreme maritime areas where the timber line environment is lowered owing to extreme snowpacks and short growing season.” The upper limit of the vegetation zone was found to be around 8,528 feet

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(2,600 meters) in Washington's northern Cascades (Douglass and Bliss 1977). On the northeast side of Mount Rainier, the upper limit extended to as much as 8,610 feet (2,625 meters) (Hamann 1972) while the zone extends to 7,900 feet (2,409 meters) on Bald Mountain in the Pasayten Wilderness (Clausnitzer pers. comm. 2004). Above this, snow fields, glaciers, and rock dominate.

Classification

The most current and comprehensive vegetation classification that includes alpine and subalpine non-forest vegetation is the recently completed Kovalchik and Clausnitzer (2004) aquatic/wetland/riparian classification. Limited to wetland, riparian, and aquatic types, this classification covers national forest lands within the planning area. Additionally, there are several local classifications that provide valuable information. Douglas and Bliss (1977) and Douglas (1972) are surveys of alpine and high subalpine vegetation types in the northern Cascades; Hamann (1972) is similar work from the northeast side of Mount Rainier; and Taylor and Douglas (1978) is from the Chowder Ridge Research Natural Area on the north side of Mount Baker. From the central Cascade portion of the planning area, del Moral (1977) is a classification from the Enchantment Lakes area, and Alverson and Arnett (1986) is a botanical reconnaissance of the Lake Chelan, Sawtooth Ridge area. No local classifications specific to the subalpine and alpine non-forested vegetation are available from the Okanogan Highlands or Kettle Range. Layser (1980) compiled a flora of Pend Oreille County that includes brief descriptions of higher elevation vegetation types, but no attempt was made to classify the vegetation. Daubenmire (1981) looked at subalpine parks in the Selkirk and Rocky Mountains, but described the vegetation in general terms.

Douglas and Bliss (1977) divided the alpine and high subalpine vegetation types into habitat and physiognomic groupings that serve as umbrellas under which the finer classifications were grouped (see Tables 1 and 2). Snowbed communities were described as occurring where snow remains late into the late season months of July to August, and possibly September in high snowfall years, even September. Mesic herb communities were characterized by dense cover of herbs and usually a lack of cryptogamic stratum. Dwarf shrub communities occur in a variety of habitats, but generally all are dominated by low-stature shrubs. Dry graminoid community types dominated by sedges or grasses were characterized by a high total plant cover and were found to be floristically rich. Other types include herb field, fell field, boulder fields, and vegetation stripe communities. These types essentially remain snow free all winter, have low total plant cover, and exhibit extreme influences of frost. Other authors have grouped vegetation types similarly, though meadows and cushion plant types may be added to the previous list (Hamann 1972).

Douglas and Bliss (1977) and del Moral (1977) found that the strongest environmental factors driving the ordination of types within the groupings were time of snowmelt, degree of summer drought, soil depth, and disturbance. Del Moral termed these attributes "vegetation stress" and assigned vegetation types along a gradient of stress and soil disturbance. An example of this was described by Daubenmire (1981) in the green fescue *(Festuca viridula)* balds found in the northern Rocky Mountains and Selkirk range. Daubenmire found that south facing slopes near ridgetops were subject to high winds that essentially pushed snow to the leeward side of the ridge during the winter. Plants in these areas without snow pack were unprotected from storms and driven snow, and were denied an important annual source of precipitation. The harsh conditions and severe summer drought, in part, prevented tree establishment.

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Disturbance

High elevation environments are believed to be vulnerable to global climate change. Modeling of global warming scenarios predict that alpine and subalpine vegetation types would see great declines, largely due to the climate becoming more favorable for tree establishment (Bachelet et al. 2000; Henderson 2003). Areas where this vegetation zone occurs only in tenuous patches at the tops of mountains could see local extinctions of this vegetation zone if global temperatures increase along with increases in precipitation.

Little information is available about historic fire regimes in the non-forest areas above timberline. Shrub and herbaceous communities do not support vegetation that can be readily inspected for fire occurrences (Agee 1994). Lightning strikes are undoubtedly common, but these ecosystems probably do not ignite or carry fire readily. Conditions that would allow a fire to spread are likely rare and topography often highly dissected with rock or wet areas, limiting spread if a fire occurs. The Forest Service classifies alpine meadows and barrens as fire regime group IV, with a fire return interval (periods between fires) of 35-100 or more years with high fire severity because more than 75 percent of the upper vegetation layer is replaced (USDA Forest Service 2004).

Long fire return intervals in this group mean that fire suppression activities have had little effect on alpine and subalpine areas. Agee (1994) proposes that at the landscape scale there may be a slight shift toward late seral communities and away from early seral communities. Others have proposed that fire suppression has allowed for the broad-scale invasion of trees into *Festuca viridula* and *Phyllodoce-Vaccinium* communities (Ratliff 1985). However, invasion of grasslands and meadows by trees can also be explained by periods of low rainfall and warm summers (Franklin and Dyrness 1977) or management such as grazing (Agee 1994).

Distribution of high elevation herbaceous vegetation types is thought to be determined by timing of snow melt, solar insolation, soil depth and drainage, and degree of summer drought (Douglas and Bliss 1977, Franklin and Dyrness 1988). The zonal soils in the northern Cascade Range are generally poorly developed with the least developed soils, Entisols, associated with unstable snowbed sites or high windswept ridges and plateaus (Douglas and Bliss 1977). Inceptisols (more soil development) typically occur under herbaceous dominated communities including poorly drained snowbed types to the well-drained dry grass and dry sedge communities. Spodosols are associated with both forest patches and shrublands.

The Okanogan Highland subalpine ecosystems exhibit better developed soils due to their more gentle terrain and deep glacial deposits. In these areas, windswept south facing balds are likely subject to severe summer droughts that preclude forestation (Daubenmire 1980, Daubenmire 1981, Daubenmire 1984).

Historically, sheep used alpine and subalpine areas during summer months, and impacts of this use can still be found in some portions of the planning area. Today these high elevation areas are popular destinations for recreation enthusiasts. Studies have looked at two aspects of the effects of recreation on high elevation vegetation; trampling, and pack stock grazing. Cole (1995) looked at various plant communities and individual species to determine their resistance and resilience (ability to recover from damage) to trampling damage by hikers. Cole determined that plant morphology of species within a community explained the greatest amount of variation in resistance to trampling and resilience after trampling. He found that the most resistant plants were *caespitose* (growing in dense low tufts) or matted graminoids like *Carex* species, and the least resistant plants were erect forbs like *Thermopsis* and *Dryopteris*. The species that recovered the most poorly after trampling (least resilient) were generally shrubby species with perennating buds

located above the ground surface (*chamaephytes*) like *Vaccinium scoparium*, *Pachistima myrsinites* and *Phyllodoce empetriformis*. Erect forb species had high recovery rates after trampling (Cole 1995).

Use of packhorses in alpine and subalpine meadows is another disturbance agent associated with recreation. Olson-Rutz et al. (1996) looked at effects of picketing horses on high elevation plant communities and found that areas grazed by picketed horses for an eight-hour period, or multiple periods adding to eight hours, had more bare ground and less litter in the following year. The numbers of stems from herbaceous plants were also reduced in subsequent years. However, short periods of grazing, up to four hours, had no measurable effects (Olson-Rutz et al. 1996). No attempt was made to differentiate between plant species in this study.

TABLE 1. ALPINE AND SUBALPINE VEGETATION TYPES

Citation	Vegetation type	Type code	Physiognomy
Alverson and Arnett 1986	Alpine fellfield and herbfield		
Douglas and Bliss 1977; Henderson 1973; Hamann 1972	*Antennaria lanata*	ANLA3	Herbaceous
Van Ryswyk 1969	*Antennaria lanata-Vaccinium scoparium*	ANLA3-VASC	Herbaceous
Amerman 1996	*Arctostaphylos uva-ursi/ Penstemon procerus-Festuca viridula*	ARUV/PEPR2-FEVI	Shrub
Douglas and Bliss 1977	*Arctostaphylos uva-ursi*	ARUV	Shrub
Hamann 1972	*Arctostaphylos uva-ursi/ Solidago spathulata*	ARUV/SOSP	Shrub
del Moral 1977	*Arenaria obtusiloba-Lupinus lepidus*	AROB3-LULE2	Shrub
Hamann 1972	*Arenaria obtusiloba-Lupinus lepidus*	AROB3-LULE2	Shrub
McLean 1970	*Artemisia tridentata ssp.vaseyana/ Calamagrostis rubescens*	ARTRV/CARU	Shrub
Layser 1980	*Artemisia tridentate ssp. Vaseyana/Festuca viridula*	ARTRV/FEVI	Shrub
Douglas and Bliss 1977	*Calamagrostis purpurascens*	CAPU	Herbaceous
Douglas and Bliss 1977	*Carex breweri*	CABR12	Herbaceous
Douglas and Bliss 1977	*Carex nardina*	CANA2	Herbaceous
Douglas and Bliss 1977	*Carex phaeocephala*	CAPH2	Herbaceous
Douglas and Bliss 1977	*Carex pseudoscirpoidea*	CAPS2	Herbaceous
Douglas 1972; Franklin and Dyrness 1988	*Carex spectabilis*	CASP5	Herbaceous
del Moral 1977	*Carex spectabilis-Juncus parryi-Luzula*	CASP5-JUPA-LUHI4-CANA2	Herbaceous

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Citation	Vegetation type	Type code	Physiognomy
	hitchcockii-Carex nardina		
del Moral 1977	*Carex spectabilis-Lupinus lepidus-Antennaria alpina*	CASP5-LULE2-ANAL4	Herbaceous
del Moral 1977	*Carex spectabilis-Lupinus lepidus-Erigeron aureus*	CASP5-LULE2-ERAU	Herbaceous
Van Ryswyk 1969	closed tundra or turf dominated by *carices*	CAREX (?)	Herbaceous
Douglas and Bliss 1977	*Cassiope mertensiana*	CAME7	Shrub
Hamann 1972	*Cassiope mertensiana-Phyllodoce empetriformis*	CAME7-PHEM	Shrub
del Moral 1977	*Cassiope mertensiana-Phyllodoce glanduliflora*	CAME7-PHGL6	Shrub
Douglas and Bliss 1977	*Danthonia intermedia*	DAIN	Herbaceous
Douglas and Bliss 1977	*Dryas octopetala*	DROC	Shrub
Alverson and Arnett 1986	*Dwarf Shrub Communities*	Dwarf Shrub	Shrub
Douglas and Bliss 1977	*Empetrum nigrum*	EMNI	Shrub
Hamann 1972	*Empetrum nigrum/Lupinus lepidus*	EMNI/LULE2	Shrub
Hamann 1972	*Erigeron aureus/Lupinus lepidus*	ERAU/LULE2	Shrub
Douglas and Bliss 1977	*Eriogonum pyrolafolium-Luzula piperi*	ERPY2-LUPI2	Herbaceous
Layser 1980	*Eriogonum umbellatum/ Hieracium cynoglossoides-Arenaria capillaris*	ERUM/HICY-ARCA7	Shrub
Kovalchik and Clausnitzer 2004	Heath Series	HEATH	Shrub
Hamann 1972	*Ivesia tweedy-Astragalus alpinus*	IVTW-ASAL7	Herbaceous
Douglas and Bliss 1977	*Kobresia myosuriodes*	KOMY	Herbaceous
Hamann 1972	*Luetkea pectinata*	LUPE	Herbaceous
Douglas and Bliss 1977	*Lupinus latifolius*	LULA4	Herbaceous
del Moral 1977	*Lupinus lepidus-Carex proposita-Penstemon davidsonii*	LULE2-CAPR10-PEDA2	Herbaceous
del Moral 1977	*Lupinus lepidus-Carex spectabilis-Artemisia*	LULE2-CASP5-ARTR3	Herbaceous

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Citation	Vegetation type	Type code	Physiognomy
	trifurcata		
Hamann 1972	*Phlox diffusa-Arenaria capillaris*	PHDI3-ARCA7	Shrub
del Moral 1977	*Phlox diffusa-Eriogonum pyrolifolium*	PHDI3-ERPY2	Shrub
Hamann 1972	*Phyllodoce empetriformis-Cassiope mertensiana*	PHEM-CAME7	Shrub
Douglas and Bliss 1977	*Phyllodoce empetriformis*	PHEM	Shrub
Henderson 1973	*Phyllodoce empetriformis/ Lupinus latifolius*	PHEM/LULA4	Shrub
del Moral 1977	*Phyllodoce empetriformis/ Juncus parryi*	PHEM/JUPA	Shrub
Franklin and Dyrness 1988	*Phyllodoce empetriformis-Vaccinium deliciosum*	PHEM-VADE	Shrub
Douglas and Bliss 1977	*Phyllodoce glanduliflora*	PHGL6	Shrub
Hamann 1972	*Phyllodoce glanduliflora/ Aster alpigenus*	PHGL6/ASAL2	Shrub
Hamann 1972	*Polygonum newberryi*	PONE5	Shrub
Douglas and Bliss 1977	*Salix cascadensis*	SACA6	Shrub
Douglas and Bliss 1977	*Salix nivalis*	SANI8	Shrub
Van Ryswyk 1969	*Salix spp./Carex macrochaeta*	SALIX/CAMA11	Shrub
Hamann 1972	*Saxifraga tolmiei*	SATO2	Herbaceous
Douglas and Bliss 1977	*Saxifraga tolmiei-Luzula piperi*	SATO2-LUPI2	Herbaceous
Alverson and Arnett 1986	Snowbed communities		Herbaceous
Hamann 1972	*Tauschia stricklandii/ Vaccinium deliciosum*	TAST/VADE	Shrub
Franklin and Dyrness 1988, Hamann 1972	*Vaccinium deliciosum*	VADE	Shrub

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Low Elevation Herbaceous Vegetation

Definition

The low elevation herbaceous vegetation type is a physiognomic group characterized by a single herbaceous layer that occurs below the lower elevational extent of contiguous natural forest. Vegetation types within this group vary along a moisture gradient from steppe (dry grasslands) to moist meadows. Saline-alkaline sites dominated by salt-tolerant herbaceous species are also included in this group. Steppe vegetation is by far the largest proportion within the low elevation herbaceous type. Climax steppe communities are typically dominated by one or more perennial bunchgrasses (such as *Agropyron spicatum*, *Festuca idahoensis*, *Poa secunda*) but may contain a strong forb component on more mesic sites. Cheatgrass (*Bromus tectorum*) can be a dominant in disturbed communities within this steppe vegetation. Giant wildrye (*Elymus cinereus)* and alkali saltgrass (*Distichlis stricta)* typically dominate saline-alkaline sites within this zone.

Across much of its distribution, steppe vegetation occurs in a mosaic with shrub-steppe. Shrub-steppe has been described as a physiognomic subgroup within the true steppe supporting a conspicuous, but discontinuous, layer of shrubs (Daubenmire 1970). Where soils are not a limiting factor, conditions in the steppe vegetation types are considered slightly more mesic than those that occur in the shrub-steppe (Daubenmire 1970, USDA Forest Service 1997). Shrub-steppe is discussed in detail in the next paragraph. Pockets of quaking aspen (*Populus tremuloides*) and black cottonwood (*Populus trichocarpa*) forest also occur within the area. Quaking aspen are primarily found in moist depressions, whereas black cottonwoods are found along major rivers. These species are discussed in the Riparian and Deciduous section.

Steppe vegetation is generally restricted to upland locations where perennial water is unavailable and flooding is rare. However, the low elevation herbaceous group includes a small component of meadow vegetation. The common site attributes for meadow ecosystems are listed in (Kovalchik and Clausnitzer 2004, page 247) as "(1) the vegetation is dominated by graminoids, (2) the sites have measurably high water tables for much of the growing season, and (3) the sites are too wet for trees and shrubs." Low elevation meadows are often highly disturbed and dominated by non-native species like Kentucky bluegrass (*Poa pratensis*), reed canarygrass (*Phalaris arundinacea*), and redtop (*Agrostis alba*). Where relatively undisturbed, low elevation meadow areas can include the following genera: sedges (*Carex*), mannagrass (*Glyceria*) and bulrushes (*Scirpus*) (Kovalchik and Clausnitzer 2004). Moist meadows supporting reed canarygrass and tufted hairgrass (*Deschampsia caespitosa*) were found in the Turnbull National Wildlife Refuge in Spokane County (Hall 1972). Refuge potholes with standing water in the growing season were dominated by bulrushes (*Scirpus spp*.) (Hall 1972).

Distribution

Distribution of this vegetation type is largely the product of low precipitation caused by the rain shadow of the Cascades Mountains, though timing of precipitation and soil characteristics are also important drivers (Daubenmire 1970, Driscoll 1964). Climatically, this vegetation zone is arid to semi-arid with warm to hot dry summers and relatively cold winters (Franklin and Dyrness 1988). Maritime influences are still felt in this zone, but continental-type climatic conditions prevail (Franklin and Dyrness 1988). Because much of the moisture in this zone falls in the winter when plants are dormant, many of the low elevation herbaceous species take advantage of fall moisture and either germinate or regrow in the fall (Shiflet 1997).

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Before the arrival of non-indigenous persons, the steppe and shrub-steppe vegetation groups formed a contiguous non-forested landscape stretching across the Columbia Basin from the eastern foothills of the Cascade Range to the Idaho border, and extending up the Okanogan River valley. Elevations range from several hundred feet along the Columbia River to several thousand feet at the lower forest boundary, though fingers of this vegetation type extends up into warm, dry, forested communities on south facing slopes and rock outcrops. Broad valley bottoms and ponds or lakes typify the locations of meadows at low elevations, though disturbance related species such as canarygrass and Kentucky bluegrass are more common on alluvial bars and toe slopes, respectively (Kovalchik and Clausnitzer 2004). Soils vary widely, with mollisols and inceptisols typical in the drier steppe areas. Calcium carbonate and salt accumulations are not uncommon (Daubenmire 1970). Many of these soils are suitable for agriculture and approximately 56 percent of the low elevation herbaceous zone has been converted to agriculture or urban use (Quigley and Arbelbide tech. eds. 1997).

Classification

Low elevation herbaceous vegetation has been classified by Daubenmire (1970) into three climatic climax types plus three edaphic climax types (Table 3). The climatic climaces are widespread in distribution but form a loose moisture gradient from Sandberg bluegrass and bluebunch wheatgrass dominated types to Idaho fescue dominated types. Daubenmire's edaphic climax types occur where soils are sandy, very shallow, or saline-alkaline in character.

Kovalchik and Clausnitzer (2004) classified 13 major and 11 minor meadow plant associations, only a few of which are likely to occur within the low elevation herbaceous group. Also, because the sampling was limited to Forest Service lands, it is likely that there are unclassified meadow types below the forest boundary and not found in the literature.

Disturbance

A global warming model assessment of the planning area indicates that warmer, more moist conditions would likely result in an expansion of xeric vegetation into marginally forested areas, particularly the lower elevation of the ponderosa pine *(Pinus ponderosa)* and Douglas-fir *(Pseudotsuga menziesii)* forests (Henderson 2003). The model considered steppe and shrub-steppe vegetation together so the extent to which steppe would expand independent of shrub-steppe is unknown. Changes to low elevation meadows are not modeled, though shifts in precipitation would likely affect meadow distribution and abundance.

Grasslands retain little evidence of historic fire regimes. As with the shrub-steppe vegetation group, Native Americans likely played a role in fire occurrence near populated areas, but the evidence is inconclusive regarding their impact on a larger spatial scale. It is likely that fuel conditions and weather were more important drivers of historic fire regimes (Whitlock and Knox 2002). Some areas, like the scablands of the eastern Columbia Basin, have biomass productivity so low that they probably rarely carried fire. Other types, like those dominated by Idaho fescue or bluebunch wheatgrass have enough fuel to burn annually, but probably did not because of low flammability early in the season and lack of fire starts across grasslands late in the season (Agee 1994).

The steppe portion of this vegetation group falls into the historic fire regime group II, of high frequency (0-35 year mean fire return interval), high severity fire (USDA Forest Service Fire Regime Condition Class (FRCC) 2004). It is considered high severity because more than 75

percent of the dominant overstory vegetation, in this case forbs and grasses, would be top-killed in a fire event. Response of the vegetation varies with species composition. Agee (1994) concluded that, in vegetation types dominated by Idaho fescue, the vegetation would typically exhibit an increase in forb cover following a fire. However, vegetation types dominated by bluebunch wheatgrass may experience an increase in grasses as well as forbs. Basal area of grasses in *Agropyron spicatum-Poa secunda* communities were found to be little affected by fire in the Snake River valley (Daubenmire 1975). Fires in the adjacent shrub-steppe communities favor grasses and herbs and frequent fire may result a conversion of shrub-steppe to steppe (shrubland to grassland) (Agee 1994).

Low elevation meadows are believed to have longer fire return intervals than the surrounding uplands because of their low flammability. Kovalchik and Clausnitzer (2004) describe the ability of meadows to burn as dependent on a lack of grazing (which makes fuels available) and drought conditions (which make fuels dry). Fire regime group IV is probably more appropriate for this portion of the low elevation herbaceous group because it consists of high severity fires occurring at moderately long fire return intervals (35 to 100 or more years). Generally, fire removes litter and temporarily increases site productivity. Even though above-ground portions of the meadow plants are removed, the rhizomes are unharmed and readily re-sprout. On rare occasions when conditions are dry enough to burn the organic substrate, rhizomes may be harmed and their competitive edge reduced (Kovalchik and Clausnitzer 2004).

The rangelands of the planning area and many of the major perennial grasses (such as bluebunch wheatgrass and Idaho fescue) did not evolve with substantial ungulate grazing (Daubenmire 1970). Year long open-range grazing in the late 1800s and into the early 1900s was of such magnitude and had such devastating results, that grazing laws were developed for public lands by 1910. In the planning area grazing was likely more prevalent, and overgrazing more of an issue, in the first half of the twentieth century than today (Franklin and Dyrness 1988, Alverson and Arnett 1986). However, the recovery rates of bunchgrass communities are slow and may never reach their former status after severe overgrazing (Franklin and Dyrness 1988).

Grazing and fire suppression are believed to be responsible for the expansion of shrub-steppe, and woodland into steppe communities, particularly along the ecotone where these physiognomic groups meet (Franklin and Dyrness 1988, Quigley and Arbelbide 1997). Grazing removes the dominant grass and reduces the ability of fire to spread, thereby favoring fire intolerant shrubs. Similarly, fire suppression lengthens the fire return interval, allowing shrubs and trees to compete in areas where grasses and herbs once thrived. As shrubs or trees increase, they tie up nitrogen and other trace nutrients causing a decline of site productivity. Subsequently, foliage cover, basal cover and litter from grasses and forbs decline further, causing exposure of the surface soil to erosion. Once the soil surface is eroded and the subsoil exposed, the environment becomes more conducive to the woody species that better compete for subsoil moisture (Quigley and Arbelbide 1997). The Interior Columbia Basin Ecosystem Management Project (ICBEMP) analysis found this to be most prevalent at lower elevations where road density provides ready access for fire suppression (Quigley and Arbelbide 1997).

Grazing and historic management of lower elevation herbaceous vegetation led to the introduction of noxious plants, including cheatgrass, a highly competitive annual species. Cheatgrass germinates in the fall and can use much of the available soil moisture before perennial species initiate new growth in the spring (Agee 1994). Additionally, cheatgrass finishes its life cycle and becomes flammable earlier in the year than the native perennial grasses. This makes the steppe community prone to fire over a longer fire season. Because cheatgrass is favored over the native perennial grasses by fire, it is considered a positive loop; more fire increases cheatgrass,

and cheatgrass increases fire susceptibility (Brooks et al. 2004). Daubenmire (1975) found that in abandoned croplands of the Snake River valley cheatgrass and redstem stork's bill (*Erodium cicutarium*) resisted re-invasion of the natural vegetation even after 52 years of disuse. The ICBEMP analysis found that the low elevation herbaceous group was the most susceptible vegetation group to cheatgrass and other exotic species invasions (Quigley and Arbelbide 1997).

TABLE 2. LOWER ELEVATION HERBACEOUS VEGETATION TYPES

Citation	Vegetation Type	Type code
Daubenmire 1970; Franklin and Dyrness 1988	*Agropyron spicatum-Festuca idahoensis*	AGSP-FEID
Daubenmire 1970; Franklin and Dyrness 1988	*Agropyron spicatum-Poa secunda*	AGSP-POSE
Daubenmire 1970; Franklin and Dyrness 1988	*Agropyron spicatum-Poa secunda - Lithosolic*	AGSP-POSE - Lithosolic
Shiflet ed. 1994	*Bluegrass scabland*	POSE-DAUN
Daubenmire 1970	*Festuca idahoensis-Hieracium cynoglossoides*	FEID-HICY
Kovalchik and Clausnitzer 2004	*Poa pratensis*	POPR
Kovalchik and Clausnitzer 2004	*Scirpus microcarpus*	SCMI
Daubenmire 1970	*Sporobolus cryptandrus-Poa secunda*	SPCR-POSE
Daubenmire 1970; Franklin and Dyrness 1988	*Stipa comata-Poa secunda*	STCO4-POSE

Montane Herbaceous Vegetation

Definition

The montane herbaceous vegetation type is a physiognomic group characterized by a single herbaceous layer occurring as openings in forested communities. Vegetation types within this group vary along a moisture gradient from dry grasslands to meadows. Vegetation types found in the drier portions of this group may overlap with those of the lower elevation herbaceous and include many of the same genera (such as *Festuca*, *Agropyron*, and *Stipa*) (Daubenmire 1981; 1970). These dry sites experience summer drought due to topography or soils that preclude successful tree regeneration (Daubenmire 1970; 1981; McLean 1970).

Montane meadows and moist forblands are widely distributed through the forested zone. Typical genera include *Calamagrostis*, *Danthonia*, *Deschampsia*, *Athyrium*, and *Carex*, though species diversity is generally high.

Some moderate non-forested sites in this montane zone are considered seral to forest. These openings typically result from a disturbance event such as fire and are considered transient in nature. Seral grasslands are not discussed at length in this section, but are discussed as a seral stage in the warm and cool forested vegetation groups.

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Distribution

Montane herbaceous vegetation is found in distinct openings within contiguous forest between subalpine parkland at upper elevations, and the lower elevation herbaceous vegetation at the forest ecotone. Montane herbaceous vegetation is found where tree growth is limited by topographic or edaphic (soil) conditions. For example, dry montane herbaceous types were linked to compacted and bedrock-controlled soils in the Cascade Range of British Columbia (McLean 1970) and in Meeks Table Research Natural Area on the Naches Ranger District (Tiedemann et al. 1972). Daubenmire (1970) described a topographic progression in the Okanogan Highlands of threetip sagebrush (*Artemisia tripartita*) shrublands at the warm forest shrub-steppe interface grading to more or less shrub free openings at higher elevations. Daubenmire associated the trend with decreasing temperatures and longer periods of soil freezing that limited effective precipitation.

At the higher elevations of the montane herbaceous zone, drought has also been linked to the green fescue balds found on south-facing slopes in the cool forests of the Selkirk and Cascade Ranges. Here soils are generally well developed in glacial and ash deposits, but prevailing winds prevent the accumulation of winter snowpack, resulting in summer drought stress. The combination of drought and severe weather prevent tree growth (Daubenmire 1980, Daubenmire 1981, Daubenmire 1984, Johnson 1994). Steep south-facing topography was observed by McLean (1970) to allow dry montane herbaceous types to extend above upper timberline.

Meadows and forblands in the montane zone occur in areas too wet for trees and shrubs. These areas form a relatively narrow ecotone between aquatic and terrestrial ecosystems, comprising only a fraction of the total landscape. Meadows and forblands "occur on a variety of sites, such as floodplains, bogs, marshes, lakeshores, springs, and basins" (Kovalchik and Clausnitzer 2004, page 2). A Sitka valerian-green false hellebore (*Valeriana sitchenses-Veratrum viride*) community is listed in Franklin and Dyrness (1988) as a vegetation type found in avalanche chutes of the eastern Cascades.

Classification

No comprehensive classification of montane openings has been created for the planning area. Daubenmire (1970) included some climatic climax types of the low elevation herbaceous plants that are likely found at higher elevations in the planning area. The Area 2 ecology data indicates that plots similar to Daubenmire's bluebunch wheatgrass-Idaho fescue occur at around 4000 feet on the Colville NF, and at approximately 3000 feet on the Naches Ranger District. Moseley identified a xerophytic park type at around 4,200 feet (1,280 meters) in the Coeur D'Alene River drainage; he called this Idaho fescue-bluebunch wheatgrass. Daubenmire describes an Idaho fescue-parsnipflower buckwheat (*Festuca idahoensis-Eriogonum heracleoides*) habitat-type common to both the steppe (low elevation herbaceous) and montane herbaceous zones. McLean (1970) found a similar association adjacent to the Douglas-fir zone in southern British Columbia, and Layser (1980) describes a similar community occurring in small open areas along moderately high elevation ridges with shallow rocky soils in Pend Oreille County.

High elevation green fescue-dominated vegetation types have been documented from Mount Rainier (Henderson 1973; Hamann 1972), the northern Cascades (Douglas and Bliss 1977; Alverson and Arnett 1986), and the Selkirk Mountains (Daubenmire 1981; Layser 1980). They occupy openings within the forested zone, but also extend into parklands and above timberline. Of the seventy Area 2 Ecology plots sampled in non-forested areas containing high cover values of green fescue all are above 5,000 feet in elevation and most are on southerly aspects. Many of

these are well within the subalpine fir forest zone of the planning area (Lillybridge et al. 1995, Williams et al. 1995).

Green fescue communities vary in associated species across the planning area. Daubenmire found that many of the associates in the Selkirk Mountains were also found in the lower elevation steppe communities to the west. Moseley (1996) did not find the same affinity with lower elevations in his studies from the Coeur D'Alene River drainage, though he did note a higher proportion of beargrass (*Xerophyllum tenax*), a maritime affiliate. Beargrass was also found in green fescue stands of Mount Rainier but is noted as being a fire follower (Hamann 1972) and is considered a seral species in subalpine fir zone in Franklin ad Dyrness (1988). Green fescue stands of the Cascades are noted as having high species diversity relative to other subalpine types.

Meadow and moist forb vegetation types have been classified by Kovalchik and Clausnitzer (2004) into 13 major meadow plant associations, 11 minor meadow plant associations, and 5 forb series (Table 4). Although many of these occur at higher elevations in the alpine zone, they may also be found at moderate elevations in cold air drainages (Kovalchik and Clausnitzer 2004).

Disturbance

Global warming models indicate that warmer and moister conditions would likely see an expansion of xeric vegetation into marginally forested areas, particularly the lower elevation of the ponderosa pine and Douglas-fir forests (Henderson 2003). The models do not consider montane forest openings specifically. During the relatively drier and warmer period of the early Holocene (10,000 to 5,000 years before present), *Artemisia* and grasses found in these openings were prevalent in the Okanogan Highlands (Whitlock 1992). Whatever climate changes may occur, it can be expected that shifts in species ranges and distributions would follow (Millar 2003). Riparian areas and meadows were not included in modeling, though changes to precipitation timing and amounts would affect these systems.

Herbaceous vegetation retains little evidence of historic fire regimes. It is likely that Native Americans played some role in lighting fires in this type, but documentation is poor. Historically, some areas had biomass productivity so low that they probably rarely carried fires. Others, like meadows and forblands, may have had enough fuel to burn, but rarely did because of low flammability (Kovalchik and Clausnitzer 2004).

The dry portion of this vegetation group falls into the fire regime group II, of high frequency (0-35 year mean fire return interval), high severity fire (USDA Forest Service FRCC 2004). It is considered high severity because more than 75 percent of the dominant overstory vegetation, in this case grasses and forbs, would be top-killed in a fire event. Response of the vegetation varies with species composition. Agee (1994) concluded that in vegetation types dominated by Idaho fescue, vegetation would typically exhibit an increase in forb cover following fire. However, vegetation types dominated by bluebunch wheatgrass may experience an increase in grasses as well as forbs. Basal area of grasses in *Agropyron spicatum-Poa secunda* communities were found to be little affected by fire in the Snake River valley (Daubenmire 1975). Fires in the montane shrub communities favor grasses and herbs and frequent fire may result in an increase in seral grasslands (Agee 1994, Quigley and Arbelbide tech eds. 1997).

Montane meadows are believed to have longer fire return intervals than the surrounding uplands because of their low flammability. Their ability to burn is dependent on a lack of grazing (which makes fuels available) and drought conditions (which makes the fuels dry) (Kovalchik and Clausnitzer 2004, Hansen et al. 1995). Fire regime group IV is probably more appropriate for this

portion of the montane herbaceous group because this fire regime group includes high severity fires occurring at moderately long fire return intervals (35 to 100 or more years). The strongly rhizomatous grasses associated with meadows are typically not harmed by fire unless conditions are dry enough to burn the organic substrate. In these cases rhizomes may be harmed and their competitive edge reduced. Generally, fire removes litter and temporarily increases site productivity. Even though above ground portions of the meadow plants are removed, the rhizomes are unharmed and re-sprout readily (Kovalchik and Clausnitzer 2004). Riparian areas and wet meadows were found to play important roles as natural fire breaks in the upper elevations of this zone (Schellhaas et al. 2001).

The herbaceous communities of the planning area and many of the major perennial grasses (such as bluebunch wheatgrass and Idaho fescue) did not evolve with substantial ungulate grazing (Daubenmire 1970). Year long open-range grazing in the late 1800s and into the early 1900s was so widespread and had such devastating results that grazing laws were developed for national forests by 1910. In the planning area, grazing was likely more prevalent, and overgrazing an issue in the first half of the twentieth century than today (Franklin and Dyrness 1988; Alverson and Arnett 1986). However, recovery rates of the bunchgrass communities are slow and they may never reach their former status after severe overgrazing (Franklin and Dyrness 1988). Overgrazing of green fescue balds leads to exposure of bare soil in an otherwise continuous grassy mat. The exposed soil then erodes due to accelerated surface winds and water, and increaser species of forb and dwarf-shrub replace the mat-forming grasses (Shiflet ed. 1994).

Recovery of meadow ecosystems from grazing or recreation use is highly variable (Kovalchik and Clausnitzer 2004). In general, these systems are fairly resistant and resilient to disturbance. However, if soils are churned and compacted and the natural dominant vegetation is replaced with increaser and invader species, long-term damage can take decades to centuries to recover pre-disturbance conditions (Kovalchik and Clausnitzer 2004). Timing and duration of grazing are important management tools for these ecosystems. Where trails and roads are created they can concentrate runoff and drain areas of meadow or cause bank sloughing resulting in significant loss of meadow and riparian vegetation (Kovalchik and Clausnitzer 2004).

Grazing and fire suppression are believed to be responsible for the expansion of shrub-steppe and forests into steppe communities, particularly along the ecotone where these physiognomic groups meet (Franklin and Dyrness 1988; Quigley and Arbelbide tech.eds.1997). Grazing removes the dominant grass; this reduces the ability of fire to spread, thereby favoring fire intolerant shrubs. Similarly, fire suppression lengthens the fire return interval allowing shrubs and trees to compete in areas where grasses and herbs once thrived. As shrubs increase, they tie up nitrogen and other trace nutrients causing a decline of site productivity. Subsequently, foliage cover, basal cover and litter from grasses and forbs decline, causing exposure of the surface soil to erosion. Once the soil surface is eroded and the subsoil exposed, the environment becomes more conducive to the woody species that better compete for subsoil moisture (Quigley and Arbelbide 1997).

TABLE 3. MONTANE HERBACEOUS VEGETATION TYPES

Citation	Vegetation Type	Type code
Daubenmire 1981	*Agropyron spicatum-Festuca viridula*	AGSP-FEVI
Henderson 1973	*Anemone occidentalis-Castilleja parviflora*	ANOC6-CAPA26
Layser 1980	*Eriogonum umbellatum-Hieracium cynoglossoides-Arenaria capillaris*	ERUM-HICY-ARCA7

Citation	Vegetation Type	Type code
Daubenmire 1970	*Festuca idahoensis-Hieracium cynoglossoides*	FEID-HICY
Douglas and Bliss 1977	*Festuca viridula*	FEVI
Franklin and Dyrness 1988	*Festuca viridula*	FEVI
Layser 1980	*Festuca viridula*	FEVI
Hamann 1972	*Festuca viridula-Aster lediphyllus*	FEVI-ASLE3
Hamann 1972	*Festuca viridula-Lupinus latifolius*	FEVI-LULA4
Henderson 1973	*Festuca viridula-Potentilla flabellifolia*	FEVI-POFL3
Franklin and Dyrness 1988	*Valeriana sitchenses-Veratrum viride*	VASI-VEVI
Layser 1980	*Xerophyllum tenax*	XETE

Montane Shrubland Vegetation

Definition

Montane shrublands are comprised of two components differing in their potential to dominate a site: climax and seral shrublands. Climax montane shrublands, like climax montane grasslands, are vegetation types occurring in openings in an otherwise contiguous forest canopy where edaphic or topographic conditions limit tree growth (Daubenmire 1970; Franklin and Dyrness 1988; McLean 1970). Montane shrublands are comprised of an herbaceous layer over topped by a generally even-aged shrub component (Daubenmire 1970). At low elevations this group may share many species with the shrub-steppe (such as bitterbrush *(Purshia tridentata)*, common snowberry (*Symphoricarpos albus*), and Idaho fescue). Climatic conditions are similar to the surrounding forest type, though effective annual precipitation (precipitation that reaches the root zone) is generally less than in the surrounding forested areas due to steep slopes, high solar insolation or prevailing winds preventing snow accumulation.

Seral shrublands, on the other hand, are found on sites suitable for tree growth. They are plant communities arising from the removal of overstory vegetation by some disturbance event. These communities represent one stage in a progression of species or communities and structures (the sere) that, in the absence of another catastrophic disturbance, lead to a forested condition. Disturbances that create seral shrublands include fire, avalanche, insects and diseases, windthrow, and timber harvest.

Common shrubfield species include vine maple (*Acer circinatum)*, ninebark *(Physocarpus malvaceus*, Douglas maple *(Acer glabrum var. douglasii)*, Scouler's willow *(Salix scouleriana)*, Oregon boxwood *(Pachistima myrsinites)*, big huckleberry *(Vaccinium membranaceum)*, serviceberry *(Amelanchier alnifolia)*, Sitka alder *(Alnus sinuata)*, snowbrush ceanothus *(Ceanothus velutinus)*, redstem ceanothus *(Ceanothus sanguineus)*, mountain snowberry *(Symphoricaros oreophilus)*, mountain big sagebrush *(Artemisia tridentata ssp. vaseyana*, and threetip sagebrush *(Artemisia tripartita)*. At higher elevations rhizomatous species such as pinegrass *(Calamagrostis rubescens)*, elk sedge *(Carex geyeri)*, northwestern sedge *(Carex concinnoides)*, common snowberry, and shiny-leaf spirea *(Spiraea betulifolia var. lucida)* are also prevalent (Lillybridge et al. 1995). Avalanche chutes in the planning area have been found to

support Sitka alder along creeks, and Scouler's willow and Oregon boxwood in uplands (Kovalchik and Clausnitzer 2004).

Distribution

Climax montane shrublands are found as discrete patches intermixed with contiguous forested vegetation types in areas where tree growth is limited by either topographic or edaphic (soil) conditions. Edaphic limitations include periodic moisture saturation, heavy soils which impede tree root penetration or soil drought during the summer (Hall 1967). Daubenmire (1970) noted montane shrubland climax occurs within the forested zone on shallow soils with bedrock at or near the surface (Lithosols).

Climax montane shrublands reach their highest elevations on southerly facing slopes where snow melt is relatively early (McLean 1970). At lower elevations, this vegetation group may closely resemble the lower elevation shrub-steppe, but it remains physically separated from the expanse of non-forest found in the Columbia Basin (Franklin and Dyrness 1988). It is estimated that 11 percent of the montane climax shrub type has been converted to agriculture and urban use (Quigley and Arbelbide 1997). It was not predicted that conversion would continue to any large extent, in part because much of the climax montane shrub type occurs on public lands.

Seral montane shrublands are found intermixed with all forested zones wherever stand replacing disturbance events occurred. Duration of seral shrub communities is a factor of both environmental conditions (elevation, slope, aspect, soils, and geology) and disturbance type and frequency (Lillybridge et al. 1995). For example, avalanche areas may receive repeated disturbance at a rate too frequent for upright forests to develop. In general, the distribution of seral montane shrublands is dynamic, moving across the landscape on a relatively short time line, whereas the distribution of climax montane shrublands is relatively static.

Classification

No comprehensive classification has been developed for forest openings of the planning area. However, some vegetation types in this group extend from adjacent areas, or are described in local studies. Also, some generalizations are possible from existing Area 2 Ecology plot data. Types from lower elevations draw heavily on Daubenmire's (1970) work in the shrub-steppe in which he indicates that some of the bitterbrush and sagebrush dominated types may extend into forested communities. Corroboration can be found in Southern British Columbia where McLean described Daubenmire's edaphic climax type, threetip sagebrush/bluebunch wheatgrass (*Artemisia tripartita/Agropyron spicatum*), at the lower edge of the Douglas-fir zone at 3,280 to 3,450 feet elevation (1,000 to 1,050 meters). The Area 2 Ecology data includes plots that appear to be Daubenmire's bitterbrush- wheatgrass climatic climax type occurring at 1,480 to 4,800 feet (450 to 1,460 meters). These plots were primarily on the Okanogan National Forest, but extend as far south as the Naches Ranger District. An intermediate bitterbrush-wheatgrass-Idaho fescue type was found in Wolf Creek Research Natural Area as a mosaic with open ponderosa pine and Douglas-fir forests from 2,600 to 3,200 feet (790 to 975 meters) (Hall 1972). Two stiff sagebrush (*Artemisia rigida*) edaphic climax types were classified from basalt flats in the Meeks Table Research Natural Area at over 4,200 feet (1,280 meters) in elevation (Tiedemann 1972). Tiedemann (1972) notes that bitterbrush forms a transitional zone between the stiff sage communities and forests in the RNA.

In some locations more common forest understory species may form climax montane shrub types. For example, Ammerman (1996) identified edaphic climax vegetation types dominated by

boxwood (pachistima) and kinnikinnick (*Arctostaphylos uva-ursi*) on the Lake Wenatchee Ranger District ranging from 4200 to 5740 feet (1.280 to 1,750 meters). Boxwood (pachistima) as a dominant also occurs on the Tonasket Ranger District in an area described as Pachistima-talus in the Area 2 Ecology data.

Mountain big sagebrush dominates higher elevation montane shrub communities that extend downslope into forest openings in the planning area. The Area 2 Ecology data includes mountain big sagebrush with green fescue from plots as high as 6,800 feet (2,073 meters) on the Tonasket and Kettle Falls Ranger Districts and as low as 3,500 feet (1,067 meters) in association with Idaho fescue on the Colville National Forest. McLean identified big mountain sagebrush with pinegrass at about 6,000 feet (1,830 meters) within the subalpine fir zone in southern British Columbia. The Area 2 Ecology data includes similar stands at 5,600 to 6,600 feet (1,700 to 2,012 meters) on the Tonasket, Chelan, and Kettle Falls Ranger Districts. Layser (1980) identified a big mountain sagebrush-green fescue type within parklands on Hall Mountain and Calispell peak in Pend Oreille County. He noted that the type included many lower elevation species in addition to the dominants. For more information regarding green fescue parks see montane grasslands.

Seral shrub communities are not classified in the same way as climax communities because they are a transient in nature and do not exhibit the consistency in attributes that allow ecologists to describe climax vegetation. In Montana, some ecologists have focused on the pathways these communities follow through time as they proceed from one seral community to another during the sere (Arno et al. 1985). These pathways are developed by considering many factors including the potential natural vegetation (climax forest if no catastrophic disturbance occurs), species autecology, disturbance type, site characteristics, and ecological interactions. Others have developed a seral community classification methodology that depicts vegetation along a time gradient rather than the environmental gradient so often used as a climax vegetation classification framework. Seral community classification, identification, and description are provided with this focus on the vegetation. With this approach, pathways "depict the probable course of community development within a framework of defined community types for a disturbance regime" (Clausnitzer 1993, page 3). These latter classifications are developed for grand fir plant associations in northeastern Oregon and southeastern Washington (Clausnitzer 1993) and for some Douglas-fir habitat types in central Idaho (Steele and Geier-Hayes 1989; 1993; 1994).

Disturbance

Global warming models indicate that warmer and moister conditions would likely see an expansion of xeric vegetation into marginally forested areas, particularly the lower elevation of the ponderosa pine and Douglas-fir forests (Henderson 2003). The models do not consider montane forest openings specifically. It has been noted that during the drier and warmer period of the early Holocene (10,000 to 5,000 years before present) species found in forest openings (*Artemisia* and grasses) were prevalent in the Okanogan Highlands (Whitlock 1992). Whatever climate changes may occur, it can be expected that shifts in species ranges and distributions would follow (Millar 2003).

Some models predict that with moderate climate warming and carbon dioxide (CO2) increases, biomass production in forested communities would increase (Bachelet et al. 2004). With an increase in biomass comes an increase in fuel amounts and fuel continuity. Fires that occur under these conditions would be larger and more severe than fires that occur today. This could lead to seral shrub communities comprising a larger portion of the landscape than occurred historically.

Montane shrubland types fall into the fire regime group II, though as elevation increases or conditions become more mesic fire intervals become longer and move toward a fire regime group IV. Fire severity is considered high in both of these classes and typically more than 75 percent of the shrubs are topkilled during a fire event. In these fires, non-sprouting shrubs (shrubs without a fire resistant root crown) like mountain big sagebrush and bitterbrush are generally killed. New shrubs are regenerated from seed present in the soil seedbank or seed transported into the site from unburned plants. The time it takes to regain shrub dominance varies with dominant shrub species, site conditions, fire intensity and season of burn (Johnson 2000, Zlatnik 1999). Mountain big sagebrush was found to take three to five years to produce seed, but at least 10 to 15 years to recover dominance following fire in Idaho (Bunting et al. 1987). Studies of fire recovery of bitterbrush showed variable results ranging from 15 to 20 years for recovery in Oregon (Barrington et al.1988), and up to 30 years in the eastern Cascades (Driver et al. 1980). Where fires occur too frequently for shrubs to produce seed and the shrubs are non-sprouters, climax montane shrublands are replaced by grasslands.

Fire suppression in parts of this zone has allowed trees to invade marginal sites, and shrub densities and fuel loads to reach high levels (Quigley and Arbelbide tech. eds. 1997). Fires in these areas are likely hotter and more severe than occurred historically. High intensity fires under these conditions can reduce the competitive ability of shrubs and perennial species leaving the area vulnerable to invasion by weedy species (Quigley and Arbelbide tech. eds. 1997).

High intensity grazing in the climax montane shrub types has resulted in a replacement of bluebunch wheatgrass and Idaho fescue with Kentucky bluegrass (McLean 1970). Cheatgrass and knapweed have also increased, particularly in areas that were subject to heavy early-season or season-long livestock grazing (Quigley and Arbelbide 1997).

Fire and logging practices may also increase montane shrubland distribution because, following overstory removal, the soil would receive more solar insolation and experience greater summer drought than previously occurred. At the limits of tree establishment, like at lower elevations in the ponderosa pine zone, conversion from forest to shrubland is possible. Tree re-establishment may be extremely slow in these areas (Franklin and Dyrness 1988).

Seral communities dominated by cool shrub types like vine maple and sitka alder, are typified by slow moving and low to moderate intensity fires. However, the historical fire regime of seral communities remains that of the previously existing forest type. The general trend in cool high elevation forests is toward fire regime group IV; fire return intervals greater than 35 years and high fire severity (more than 75 percent replacement) (Agee 1994). Fire regimes of mid-elevation forests are group III; fire return intervals greater than 35 years and mixed fire severity (less than 75 percent replacement). At the lowest elevations, fire regimes may approach group I, frequent fires (less than 35 year fire return intervals) of low to mixed severity (USDA Forest Service Fire Regime Condition Class Handbook 2004). At low elevations, shrub species that sprout would be favored. Nevertheless, weakly sprouting bitterbrush can survive in areas of high fire frequency, but low fire intensity characterized by ponderosa pine forests.

Disturbance type, frequency, timing, duration, intensity, and spatial scale combined with a stochastic element are important modifiers of secondary succession (Clausnitzer 1993; Lillybridge 1995). Additionally, the character of the pre- and post-disturbance vegetation can be the major determinant of subsequent community development – a process termed “initial floristics” (Clausnitzer 1993). For example, fall broadcast burns tend to favor development of redstem and snowbrush ceanothus because they meet the heat scarification and cold wet stratification needs for maximum germination of the seed, but spring burns do not meet both of

these needs. Because the seeds of redstem ceanothus are viable in the seed bank for many years, if the shrub was common on the site before burning or was historically on the site, it would readily germinate (if the fire return interval is shorter than the maximum duration of seed viability). Spring burns tend to favor species that resprout from root crowns like common snowberry and Sitka alder.

Many shrub species increase in cover as tree cover decreases. Logging of cool forest stands can produce conditions that allow shrub species to dominate a stand to the exclusion of tree regeneration. This condition can persist for many years or even decades in some cases. Lillybridge et al. (1995) goes on to say that although shrub fields may initially appear deleterious to conifer establishment and early growth, the ecological role of the shrub-dominated state of succession is not well understood. Functionally, shrubs may act as a nutrient sink, capturing nutrients following a disturbance event and releasing nutrients slowly to the ecosystem as trees colonize and re-establish dominance on a site. In some cases shrubs provide shade for young conifers, add organic matter to the soil, and fix nitrogen (species such as ceanothus, alders, and russet buffaloberry). Further, many shrubs provide important forage and cover for insectivorous wildlife, which also influence stand health and vigor.

TABLE 4. MONTANE SHRUBLAND VEGETATION TYPES

Citation	Vegetation Type	Type code
Alverson and Arnett 1986	*Purshia tridentata/Agropyron spicatum*	PUTR2/AGSP
Amerman 1996	*Arctostaphylos uva-ursi/ Penstemon procerus-Festuca viridula*	ARUV/PEPR2-FEVI
Amerman 1996	*Pachistima myrsinities/Lomatium brandegeei*	PAMY/LOBR2
Amerman 1996	*Pachistima myrsinites/Sedum divergens*	PAMY/SEDI
Amerman 1996	*Pachistima myrsinites-Vaccinium myrtillus/Carex geyeri*	PAMY-VAMY2/CAGE2
Annable and Peterson Date?	*Artemisia tridentata/Festuca idahoensis-Pseudoroegneria spicata*	ARTR2/FEID-PSSP6
Daubenmire 1970	*Artemisia rigida/Poa sandbergii (P.secunda)*	ARRI2/POSE
Daubenmire 1970	*Artemisia tripartita/Festuca idahoensis*	ARTR4/FEID
Daubenmire 1970	*Purshia tridentata/Festuca idahoensis*	PUTR2/FEID
Daubenmire 1970; McLean 1970	*Artemisia tridentata/Festuca idahoensis*	ARTR2/FEID
Daubenmire 1970; McLean 1970	*Artemisia tripartita/Agropyron spicatum*	ARTR4/AGSP
Douglas and Bliss 1977	*Arctostaphylos uva-ursi*	ARUV
Hall 1972	*Purshia tridentata/Agropyron inerme-Festuca idahoensis*	PUTR2/AGIN5-FEID
Franklin and Dyrness 1988	*Artemisia tripartita/Stipa comata*	ARTR4/STCO4
Layser 1980	*Artemisia tridentata ssp. vaseyana/ Festuca viridula*	ARTRV/FEVI
McLean 1970	*Artemisia tridentata ssp. vaseyana/ Calamagrostis rubescens*	ARTRV/CARU

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Citation	Vegetation Type	Type code
McLean 1970; Daubenmire 1970	*Festuca idahoensis-Eriogonum heracleoides*	FEID-ERHE
Tiedemann et al. 1972	*Stipa columbiana-Phlox diffusa/ Artemisia rigida*	STCO3-PHDI3/ARRI2
Tiedemann et al. 1972	*Poa sandbergii (P. secunda)-Eriogonum douglasii/Artemisia rigida*	POSE-ERDO/ARRI2
Daubenmire 1970	*Eriogonum compositum/Poa secunda*	ERCO12/POSE
Daubenmire 1970	*Eriogonum thymoides/Poa secunda*	ERTH4/POSE

Oregon White Oak Vegetation

Description

Oregon white oak (*Quercus garryana*) woodlands are a unique vegetation type covering a relatively small portion of the planning area. It is considered a transitional vegetation type between the ponderosa pine/Douglas-fir and shrub-steppe types and includes understory shrub species from both vegetation types (sagebrush, bitterbrush, serviceberry, shiny-leaf spirea, California hazelnut *(Corylus cornuta)*, and common snowberry) (Lillybridge et al. 1995). Herbaceous species including bluebunch wheatgrass, Sandberg bluegrass, yarrow *(Achillea millefolium)*, and balsamroot *(Balsamorhiza sagittata)* are common species in drier areas whereas pinegrass, Kentucky bluegrass and elk sedge are common in more mesic locations. This type occurs on upland sites as well as riparian situations where river terraces occur in gently sloping valleys of the eastern Columbia Basin. Where it occurs marks the lower boundary of the forest physiognomic group (Lillybridge et al. 1995). Partially due to its massive root system, Oregon white oak is the most drought tolerant tree species in the planning area, and yet is considered flood tolerant. The overstory canopy is generally open and shrub cover typically low except when this type occurs on more favorable deep alluvial soils where snowberry and associate shrubs can become a continuous understory layer.

Distribution

Oregon white oak is widely distributed on the west side of the Cascades, but is limited on the east side to relatively small areas north and south of the Columbia River. Within the planning area, Oregon white oak occurs in the lower reaches of the Naches and Tieton Rivers watersheds (Lillybridge et al. 1995). Most stands on the Wenatchee National Forest occur below 3,100 feet elevation on steep, lower and mid-slope positions, or along arid country river and stream terraces (Lillybridge 1995). Ponderosa pine and Douglas-fir regeneration occurs in more mesic locations within the woodland's distribution, but establishment rates are slow. Historically, frequent fires probably slowed conifer establishment and in some areas this type is considered a fire climax.

Classification

Oregon white oak stands have been classified into three types ranging along a moisture gradient. The driest type supports a bluebunch wheatgrass understory and occurs on steeper slopes. Relatively moderate sites include pinegrass and elk sedge in the understory (Lillybridge et al. 1995). The most mesic type occurs on river terraces and supports a complex understory

component typified by California hazelnut and, or common snowberry (Lillybridge et al. 1995; Kovalchik and Clausnitzer 2004). Oregon white oak types classified by Thilenius (1964) in the Willamette valley lists California hazelnut and common snowberry as associated species, though the types are clearly more maritime in nature including swordfern (*Polystichum munitum*) and poison oak (*Rhus diversiloba*) as associates.

Disturbance

Global warming models predict a loss of Oregon white oak from the Wenatchee National Forest (Henderson 2003). Because this species is limited by temperature in our area, this loss is likely due to an increase in precipitation favoring conifers in that portion of the Cascade foothills.

Oregon white oak is within fire regime group I; fires are frequent (0-35 year intervals) and intensities low to mixed. Fire helps maintain the open woodland structure of these stands and the composition and dominance of shrubs (Lillybridge 1995). Fire has also been shown to increase success of acorn regeneration (Arno et al. 1977). Adult trees are very fire tolerant. Their foliage is relatively non-flammable and they resprout from roots, root crowns and boles should the above-ground stem be killed or damaged. Fire suppression and cattle grazing have allowed shrub dominance to increase, creating fuel ladders and increasing the potential for crown fires in many areas (Quigley and Arbelbide 1997).

In the Interior Columbia Basin Ecosystem Management Project (ICBEMP) analysis woodland as a whole was found to have not changed much in distribution (Quigley and Arbelbide 1997). The analysis concluded that today there is a lack of both early and late seral stages and a dominance of mid seral conditions for woodlands in general. Oregon white oak woodlands made up only a small portion of this type which included limber pine and mountain mahogany stands. They suspect that old oak trees had come under increased competitive pressure from the increase in woody vegetation associated with fire suppression. This condition made these oaks more susceptible to insects and diseases. Additionally, the portions of this type that occur on stream terraces likely were cleared by homesteaders. Continued pressure from firewood gatherers of this highly sought-after wood, also contributes to the loss of larger trees in much of the woodland's range.

Non-native weeds have also increased in this zone, similar to the shrub-steppe region. Cheatgrass is common on the upland portions of the woodland and invasion by knapweed *(Centaurea spp.)* and other invasive weed species are of concern (Lillybridge et al. 1995). Unlike the shrub-steppe that is dominated by fire intolerant shrub species, the fires associated with cheatgrass invasions may not be as problematic to this fire adapted ecosystem.

TABLE 5. OREGON WHITE OAK VEGETATION TYPES

Citation	Vegetation Type	Type code
Lillybridge et al. 1995	*Quercus garryana/Agropyron spicatum*	QUAG4/AGSP
Lillybridge et al. 1995	*Quercus garryana/ Calamagrostis rubescens-Carex geyeri*	QUAG4/CARU-CAGE2
Lillybridge et al. 1995; Kovalchik and Clausnitzer 2004	*Quercus garryana/ Corylus cornuta-Symphoricarpos albus*	QUAG4/COCO23-SYAL

Riparian Shrub and Deciduous Forest Vegetation

Definition

This unit of the landscape is composed of the riparian shrublands and deciduous forests –riparian as well as upland deciduous forest types. While it represents a large segment of the environmental gradient (wet to mesic), nevertheless, the type is characterized by the dominance of deciduous shrub and tree species in the uppermost canopy layers. Identification through remote sensing techniques and delineation on small scale maps is aided by this definition of the subunit. Further division is difficult and affects subsequent mapping accuracy. Broad planning objectives would be met with this typically deciduous vegetation subunit that includes deciduous forest types (both upland and riparian) and riparian shrub types.

Riparian shrub and deciduous forest vegetation types are made up of both shrubland and forest in which deciduous species are reproducing successfully and coniferous species are subordinate or confined to microsites (Kovalchik and Clausnitzer 2004). Deciduous forests are sometimes referred to as hardwoods or broadleaf forests or woodlands. Some of the vegetation types in this group are dominated by species considered wetland obligates; they are dependent on a perpetual source of water, sub-irrigation, or a seasonally high water table for survival. Others species are facultative wetland species and occur in a variety of habitats including riparian sites. For example, quaking aspen, a facultative wetland species, occurs on a variety of sites in the planning area, from riparian sites to uplands. These communities often form a narrow interface between aquatic and terrestrial ecosystems and are surrounded by much drier upslope vegetation. Typical genera include cottonwoods and aspen (*Populus*), birch (*Betula*), dogwood (*Cornus*), willow (*Salix*), alder (*Alnus*) and maple (*Acer*). Riparian and deciduous vegetation also includes vegetation found on transitional or xero-riparian sites; sites that are subirrigated and lie between riparian sites and uplands. Transitional sites do not have true hydrophytic vegetation such as sedges and willows, yet are uniquely different from uplands (Kovalchik and Clausnitzer 2004).

Climate is variable in this vegetation group because representative sites occur from low elevation shrub-steppe areas to the subalpine zone at upper elevations. Because riparian locations receive cold air drainage and have low solar insolation, they are generally cooler than adjacent areas and often contain low elevation extensions of higher elevation or upslope vegetation types (Daubenmire 1980). Cold air draining downhill into broad flats, basins, and valley bottoms can create severe summer frost problems in riparian areas. In contrast, sites next to larger bodies of water, especially lakes, may have air temperatures moderated by the standing water (Kovalchik and Clausnitzer 2004). Summer droughts, common in the uplands, are largely moderated by soil moisture available throughout the entire growing season.

Upland deciduous shrublands are discussed in the montane shrublands section. Riparian coniferous forests are discussed under cool mesic forest types in a separate document devoted to forest vegetation.

Distribution

Deciduous riparian vegetation types (including cottonwood, aspen, birch, alder, willow, maple, and dogwood) may be found throughout the planning area wherever soils have seasonally or

perennially high water tables. They often occur as stringers or a mosaic of different vegetation types influenced in the broad sense by climate, geology, and stream or valley gradient and morphology. Riparian sites include fluvial surfaces such as stream banks, active channel shelves, active flood plains, and overflow channels (Kovalchik 1993). Transition sites include inactive floodplains, terraces, toe-slopes, and meadows which have seasonally high water that recede to below the rooting zone in mid to late summer (Kovalchik 1993). Deciduous riparian types grade into all upland vegetation types extending from shrub-steppe to subalpine parklands. They may also grade into aquatic ecosystems, forblands or meadows.

Quaking aspen types are found in upland sites, transitional areas, riparian sites and depressions throughout the planning area. Kovalchik and Clausnitzer (2004, page 109) describe them as having "wide ecological amplitude in the Northwest . . . found from low elevation shrub-steppe environments up to subalpine areas." Quaking aspen are most common in areas with a continental climate but are also found in areas with strong maritime influence (Kovalchik and Clausnitzer 2004).

In the ICBEMP analysis, Quigley and Arbelbide (1997) report the greatest changes to riparian vegetation distribution were due to urban development and agriculture. Since the late 1800s there has been a marked shift in distribution of riparian shrub and forests from low elevation to montane with the majority of the areas now on public lands. The ICBEMP analysis did not foresee a continuation in loss of these areas.

Classification

Kovalchik and Clausnitzer (2004) have completed a comprehensive classification of riparian forests and shrublands on national forest lands within the planning area. They identified and described six deciduous forest series and 13 deciduous shrub series (Table 6). In addition, keys are provided that identify plant associations within each of the series. To date, this is the only comprehensive classification of these types in the planning area. Locally, Layser (1980) briefly describes black cottonwood forest in Pend Oreille County, and Alverson and Arnette describe a lowland stream canyon type with cottonwood, but neither is a classification. Adjacent classifications are available from Montana (Hansen et al. 1988), the Gifford Pinchot and Mount Hood National Forests and Columbia River Gorge National Scenic Area (Diaz and Mellen 1996), and eastern Oregon (Kovalchik 1987; Crowe and Clausnitzer 1997).

Disturbance

Climate change is likely to affect riparian areas indirectly by changes to precipitation rates and timing. Less snow pack and an earlier snow melt may see less spring flooding, but increases in summer precipitation could see expansion of transition zones. Periods of drought and low water are associated with conifer encroachment (Kovalchik and Clausnitzer 2004).

Riparian forest and shrublands are not placed in any single fire regime group because of the highly variable nature of fire occurrence in these vegetation types. The ICBEMP analysis describes the historical fire regime of riparian shrublands and riparian forests separately. Riparian shrublands were dominated by non-lethal and mixed fire severity that occurred at 25 to 50 year intervals. This represents fire regime groups I and III. Riparian forests, on the other hand, were described as having a fire regime of mixed and lethal fires occurring on 65 to 150 year intervals. This represents fire regime groups III and IV. They note that the fire season was short in both vegetation types, generally starting in August and ending in early September, but only during drought years (Quigley and Arbelbide 1997).

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The standard surface fuel model (Anderson 1982) characterizes fire behavior in closed canopy hardwood and broadleaf types, and in cool, moist shrub types as slow moving with low intensity. The foliage of hardwoods and broadleaf types has low to moderate flammability, though under dry fuel conditions and hot, dry windy days, fire can move rapidly with high intensity. Agee's (1994) review of several fire studies east of the Cascade crest concluded that riparian areas generally do not burn or if they burn then fire occurs at a low intensity. This fire behavior results from both the wet nature of these high biomass riparian sites as well as the higher moisture levels in the live and dead fuels. Schellhaas et al. (2001) found riparian types played an important role as natural fire breaks in the subalpine parkland zone of the eastern Cascades. However, if winds are channeled from upslope areas, high biomass headwater riparian sites may burn with greater intensity than surrounding slopes (Agee 1974). It seems likely that riparian areas burned infrequently at low intensities, but if burned under extreme fire conditions then high intensities were possible.

Fire suppression affects riparian areas by allowing fuels to build up in adjacent stands. The fuel build up increases the likelihood of stand-replacing or high severity fires in adjacent stands which, in turn, increases the potential of high severity fires in the riparian areas. Riparian species are particularly vulnerable to fire because many of them are thin barked and top killed by even low intensity fires. However, most riparian species readily resprout from roots or root crowns but others, like mature black cottonwood, do not (Kovalchik and Clausnitzer 2004). Fire may also affect riparian areas indirectly by changing the rate and timing of water runoff from adjacent upland areas. Runoff from burned uplands tends to be of greater magnitude than in unburned areas. Subsequent flooding can lead to downcutting of the streambed and dewatering of the existing stream banks.

Flooding is a unique disturbance agent in riparian areas. Historic flood cycles typically occurred at 20 to30 year intervals on major rivers, and 10 to 20 year cycles in montane areas (Quigley and Arbelbide 1997). For some riparian species flooding is an integral part of their success. Black cottonwood, a common species of low to mid-elevation riparian forests, relies on flooding to provide the exposed mineral soils necessary for seedling establishment (Borman and Larson 2001). Flooding is also an important disturbance agent for redistributing organic matter and preventing conifer establishment. Today, flood events on larger rivers are largely controlled by dams. Flood prevention and grazing pressures combined with overstory removal has resulted in a shift in riparian forest structure toward mid seral stands (Quigley and Arbelbide 1997). A related disturbance agent, ice flows during the winter, may affect riparian vegetation types differentially and promote shrub establishment. The impact of global warming on the frequency and magnitude of disturbance from this agent is unknown.

Historic grazing pressures by native ungulates was probably widely scattered during drought years (Quigley and Arbelbide tech. eds. 1997). Overuse of riparian areas can cause bank sloughing, loss of canopy and ultimately down cutting of streams and dewatering of the existing stream bank (Hansen et al. 1988). Persistent high levels of grazing by cattle and wildlife can affect the longevity of riparian forests by preventing recruitment of aspen sprouts and cottonwood seedlings (Kovalchik and Clausnitzer 2004). Quaking aspen stands surveyed on the Okanogan and Wenatchee National Forests found most were experiencing some level of grazing by cattle, deer or elk. Lack of sprout recruitment in some aspen stands was linked to elk or cattle use (Hadfield and Magelssen 2004). Kovalchik and Clausnitzer (2004, page 125) note that "with moderate to heavy prolonged grazing pressures, most shrubs would be eliminated from the understory, converting the stand to nonpalatable herbs and shrubs such as Kentucky bluegrass and woods rose".

TABLE 6. RIPARIAN SHRUB AND DECIDUOUS FOREST VEGETATION TYPES

Citation	Vegetation Type	Type code
Kovalchik and Clausnitzer 2004	*Acer circinatum* Series	ACCI
Kovalchik and Clausnitzer 2004	*Acer glabrum var. douglasii* Series	ACGLD4
Kovalchik and Clausnitzer 2004	*Acer macrophyllum* Series	ACMA3
Kovalchik and Clausnitzer 2004	*Alnus incana* Series	ALIN2
Kovalchik and Clausnitzer 2004	*Alnus rubra* Series	ALRU2
Kovalchik and Clausnitzer 2004	*Alnus sinuata* Series	ALSI3
Kovalchik and Clausnitzer 2004	*Betula papyrifera* Series	BEPA
Kovalchik and Clausnitzer 2004	*Cornus stolonifera* Series	COST4
Franklin and Dyrness 1988; Daubenmire 1970	*Crataegus douglasii/ Heracleum lanatum*	CRDO2/HELA4
Franklin and Dyrness 1988; Daubenmire 1970	*Crataegus douglasii-Symphoricarpos albus*	CRDO2-SYAL
Alverson and Arnett 1986	*Lowland Stream Canyons*	Lowland Stream Canyons
Kovalchik and Clausnitzer 2004	*Oplopanax horridum* Series	OPHO
Kovalchik and Clausnitzer 2004	*Populus tremuloides* Series	POTR5
Williams et al. 1983	*Populus tremuloides/ Calamagrostis rubescens*	POTR5/CARU
Kovalchik and Clausnitzer 2004; Williams et al. 1983; Williams et al. 1995	*Populus tremuloides/ Symphoricarpos albus*	POTR5/SYAL
Kovalchik and Clausnitzer 2004	*Populus trichocarpa* Series	POTR15
Daubenmire 1970	*Populus trichocarpa/ Cicuta douglasii*	POTR/CIDO

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Citation	Vegetation Type	Type code
Layser 1980	*Populus trichocarpa/ Cornus stolonifera-Crataegus*	POTR15/COST-CRATA
Kovalchik and Clausnitzer 2004	*Potentilla fruticosa* Series	POFR4
Kovalchik and Clausnitzer 2004	*Rhododendron albiflorum* Series	RHAL2
Kovalchik and Clausnitzer 2004	*Rubus spectabilis* Series	RUSP
Kovalchik and Clausnitzer 2004	*Salix* Series	SALIX
Kovalchik and Clausnitzer 2004	*Spiraea douglasii*	SPDO
Kovalchik and Clausnitzer 2004	*Symphoricarpos albus* Series	SYAL

Shrub-Steppe Vegetation

Definition

Shrub-steppe vegetation has been described as a bunchgrass and forb dominated vegetation (steppe) in which there is a conspicuous (but discontinuous) layer of shrubs (Franklin and Dyrness 1988). Shrub cover in the shrub-steppe varies widely but in undisturbed stands is generally less than 25 percent (Daubenmire 1970). Due to the stand-replacing nature of fire in the shrub-steppe, the shrub component tends to be even-aged, dating from the last fire event (Agee 1994). Common genera include sagebrush (*Artemisia)*, bitterbrush (*Purshia)*, fescue (*Festuca)*, and wheatgrass (*Agropyron)* (Table 7).

Like the low elevation herbaceous group, shrub-steppe distribution is largely a product of the low precipitation in the rain shadow of the Cascade Mountains (Daubenmire 1970). Climatically this area is arid to semi-arid with warm to hot dry summers and relatively cold winters. Continental-type climatic conditions prevail, but the maritime influence is great enough in the planning area to differentiate it from the Great Basin (Franklin and Dyrness 1988). The shrub-steppe group occupies some of the driest low elevation portions of the planning area (Daubenmire 1970, Quigley and Arbelbide 1997). Across the Columbia Basin, shrub-steppe intergrades with low elevation herbaceous vegetation. At higher elevations this type intergrades with forested communities where it primarily occupies southerly facing slopes and, or, sites with edaphic conditions limiting tree growth (Daubenmire 1970, McLean 1970). These higher elevation areas may support bitterbrush or snowberry (*Symphoricarpos sp*.), components of vegetation types that extend into montane shrublands.

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Distribution

The shrub-steppe and low elevation herbaceous groups form a contiguous non-forested landscape stretching across the Columbia Basin from the eastern foothills of the Cascade Mountains to the Idaho boarder and extending up into Okanogan and Columbia River valleys (Daubenmire 1970). Elevations range from several hundred feet along the Columbia River to several thousand feet at the lower forest boundary, though this type may finger into forested communities on south facing slopes and as edaphic climax types (McLean 1970). Vegetation types dominated by sagebrush extend across the planning area, though communities dominated by bitterbrush are more prevalent on the Okanogan and Wenatchee National Forests. Mesic types, typically supporting a strong forb component, are found on the Colville National Forest and in the eastern Cascade foothills; essentially, they form a ring around the drier Columbia Basin types (Daubenmire 1970). Seasonal distribution of precipitation, topography, degree of drought and soil depth influences the distribution of shrub-steppe and steppe community types (Daubenmire 1970; Driscoll 1964; Youtie et al. 1988).

Soils vary widely, though mollisols and inceptisols are typical in the drier areas, as are calcium carbonate and salt accumulations. Many of these soils are suitable for agriculture and approximately 30 percent of shrub-steppe has been converted (Quigley and Arbelbide 1997). As a result, a greater proportion of the remaining shrub-steppe is now found at higher elevations where they are adjacent to woodland or dry forest types. Given the current trend of increased rural development on private lands, conversion of the remaining shrub-steppe is predicted to continue (Quigley and Arbelbide 1997).

Classification

Daubenmire (1970) classified shrub-steppe habitat types of the Columbia Basin. The shrub-steppe classification included 6 climatic climax types, divided into two groups. The first, termed “meadow-steppe,” occupies slightly arid climates just below lower timberline and encircles the second group. Distribution of the vegetation types within this group is “related more to differences in the seasonal distribution of precipitation than to the total annual amount” (Daubenmire 1970, page 8). Meadow-steppe types include Idaho fescue as a dominant, but lack big sagebrush. Here common snowberry and rose occur as a constant yet inconspicuous member of the community while forbs are prevalent as associates of the dominant fescue. The second group Daubenmire identified is more arid with geographic distribution determined by intensity of aridity or the seasonal distribution of precipitation. This group generally includes big sagebrush and bluebunch wheatgrass as dominants but lacks a strong forb component. McLean (1970), working in the Similkameen Valley of British Columbia, found three vegetation types similar to Daubenmire’s dry group occurring below and within the ponderosa pine zone.

Daubenmire (1970, page 5) also identified 32 edaphic climax vegetation types where soils “become sufficiently shallow, stony, poorly drained or chemically abnormal to produce a significantly different climax.” Many of these do not occur or are unknown to occur within the planning area. Of note are edaphic types occurring on fractured basalt where soils are shallower than 30 cm and frost heaving common. These types may be found north of Spokane, south of the Okanogan Highlands, and on table mountains adjacent to the Cascades. They typically consist of a low growing buckwheat species (*Eriogonum sp.*) in the shrub layer over Sandberg bluegrass. In Shiflet ed. (1997) these basalt types were grouped into a single rangeland type called bluegrass scablands.

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Disturbance Regimes

Global warming models indicate that warmer conditions would likely see an expansion of xeric vegetation into marginally forested areas, particularly the lower elevation of the ponderosa pine and Douglas-fir forests (Henderson 2003). Because the model considers steppe and shrub-steppe vegetation together the extent to which shrub-steppe expands independent of steppe vegetation is unknown.

Shrublands retain little evidence of historic fire regimes. At best, fire information from shrublands is limited to time since last fire (Agee 1994). As with the low elevation herbaceous vegetation group, Native Americans likely played some role in fire occurrence near populated areas, but the evidence of their impact at a larger spatial scale is inconclusive. It is likely that fuel conditions and weather were the more important drivers of historic fire regimes (Whitlock and Knox 2002).

The shrub-steppe vegetation zone falls into the fire regime group II, of high frequency (0-35 year mean fire return interval), high severity fire (greater than 75 percent of the dominant canopy layer replaced) (USDA Forest Service Fire Regime Condition Class (FRCC) 2004). Fires in this regime typically kill non-sprouting or weakly sprouting shrubs such as big sagebrush and bitterbrush. These plants usually regenerate from seed following fire and become dominant within a decade or more, depending on the season and intensity of the burn (Tirmenstein 1999). Fire serves an important role in rejuvenating decadent sagebrush stands, but if fires occur too frequently no seed source is produced between fires and nonsprouting shrubs are lost from the site. Where fire regimes are sufficiently altered, sites are converted from shrub-steppe to grassland (steppe) vegetation (Quigley and Arbelbide tech. eds. 1997).

The Interior Columbia Basin Ecosystem Management Project (ICBEMP) found fire regimes altered by either the lengthening or shortening of fire return intervals. Shortened fire return intervals were typically associated with the invasion of exotic annual grasses, particularly cheatgrass (*Bromus tectorum*) into the shrub-steppe zone (Franklin and Dyrness 1988, Brooks et al. 2004, Quigley and Arbelbide1997). When dry, this annual grass is a highly-flammable fine fuel that readily carries fire between shrub clumps. Where cheatgrass invades fires tend to be larger and less patchy in distribution than previously occurred. This reduces the number of unburned shrubs in an area, eliminating the replacement seed source (Quigley and Arbelbide 1997, Brooks et al. 2004). Cheatgrass also dries and carries fire earlier in the season than native perennial grasses, making the cheatgrass-infested shrub-steppe community prone to fire over a longer fire season. Thus, when cheatgrass invades the shrub-steppe, it creates an altered fire regime in which annuals are favored over perennial shrubs and grasses (Brooks et al. 2004). The ICBEMP assessment found this scenario to be the most dominant for shrub-steppe on Bureau of Land Management and Forest Service land (Quigley and Arbelbide 1997).

Fire regimes altered by lengthened fire return intervals are associated with our increased ability to put fires out, largely due to increased road density, and to grazing. Grazing is associated with lengthening of fire regimes because heavy grazing removes the more palatable grasses (particularly bluebunch wheatgrass and Idaho fescue) (Quigley and Arbelbide 1997). These large perennial grasses are not adapted to heavy grazing by ungulates (Daubenmire 1970). They evolved in an environment in which such animals were sparsely represented, and they rarely recover to their former status after severe overgrazing (Franklin and Dyrness 1988). Removal of

the grasses reduces the ability of fire to spread in these systems, until ultimately the shrubs become dense enough or weather severe enough for fire to carry. Daubenmire (1970) observed over a sixteen year period that where grazing pressure continued shrubs increased in density and cover. Consequently, fires that occur in these areas with increased fire return intervals can be devastating due to the large amount of fuels and high fire intensities.

TABLE 7. SHRUB-STEPPE VEGETATION TYPES

Citation	Vegetation Type	Type code
Daubenmire 1970	*Artemisia rigida/Poa secunda*	ARRI2/POSE
Daubenmire 1970; McLean 1970	*Artemisia tridentata/Agropyron spicatum*	ARTR2/AGSP
Daubenmire 1970; McLean 1970	*Artemisia tridentata/Festuca idahoensis*	ARTR2/FEID
Annable and Peterson Date 1988	*Artemisia tridentata/Festuca idahoensis-Pseudoroegneria spicata*	ARTR2/FEID-PSSP6
Daubenmire 1970	*Artemisia tridentata/Poa sandbergii (P.secunda)*	ARTR2/POSE
Franklin and Dyrness 1988, McLean 1970; Daubenmire 1970	*Artemisia tridentata/Stipa comata*	ARTR2/STCO4
Daubenmire 1970; McLean 1970	*Artemisia tripartita/Agropyron spicatum*	ARTR4/AGSP
Daubenmire 1970	*Artemisia tripartita/Festuca idahoensis*	ARTR4/FEID
Franklin and Dyrness 1988; Daubenmire 1970	*Artemisia tripartita/Stipa comata*	ARTR4/STCO4
Daubenmire 1970	*Artemisia tridentata/Poa sandbergii (P.secunda)*	ARTR2/POSE
Franklin and Dyrness 1988; Daubenmire 1970	*Eurotia lanata/Poa sandbergii (P.secunda)*	ERLA5/POSE
Daubenmire 1970	*Festuca idahoensis/Rosa nutkana*	FEID/RONU
Daubenmire 1970	*Festuca idahoensis/Symphoricarpos albus*	FEID/SYAL
Franklin and Dyrness 1988; Daubenmire 1970	*Grayia spinosa/Poa sandbergii (P.secunda)*	GRSP/POSE
Franklin and Dyrness 1988; Daubenmire 1970	*Purshia tridentata/Stipa comata*	PUTR2/STCO4
Hall 1972	*Purshia tridentata/Agropyron inerme-Festuca idahoensis*	PUTR2/AGIN5-FEID
Alverson and Arnett 1986; Daubenmire 1970	*Purshia tridentata/Agropyron spicatum*	PUTR2/AGSP
Daubenmire 1970	*Purshia tridentata/Festuca idahoensis*	PUTR2/FEID
Franklin and Dyrness 1988; Daubenmire 1970	*Sarcobatus vermiculatus/Distichlis stricta*	SAVE4/DIST3

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Citation	Vegetation Type	Type code
Daubenmire 1970	*Eriogonum niveum/Poa secunda*	ERNI2/POSE
Daubenmire 1970	*Eriogonum sphaerocephalum/ Poa secunda*	ERSP7/POSE
Daubenmire 1970	*Eriogonum douglasii/Poa secunda*	ERDO/POSE
Daubenmire 1970	*Eriogonum compositum/Poa secunda*	ERCO12/POSE
Daubenmire 1970	*Eriogonum thymoides/Poa secunda*	ERTH4/POSE

Subalpine Parkland Vegetation

Definition

Subalpine parklands are high elevation areas generally considered marginal for tree establishment. They typically support trees arranged in clearly defined patches along sharp environmental gradients (Douglas and Bliss 1977). The gaps in canopy between patches of trees are dominated by herbaceous and shrub communities described elsewhere in this document. Tree species include whitebark pine (*Pinus albicaulis*), mountain hemlock, subalpine fir, lodgepole pine, and subalpine larch (*Larix lyallii*). The environmental conditions where this group occurs are harsh and snow pack is retained for much of the year. The growing season is short and degree days (days warm enough for root or shoot growth) are few. The exposure is extreme with high solar insolation and severe desiccating winds. Temperature fluctuations from day to night are large, and the average daily minimum temperatures are very low. Low temperatures mean slow organic decomposition, so nutrients tend to be locked up in organic matter for relatively long periods of time. Due to these harsh conditions, trees often exhibit krummholz or dwarfed stature, or if erect, have flagged tops.

Distribution

The subalpine parkland vegetation group occurs along the east side of the Cascade Mountain crest, in the Kettle Mountains of the Okanogan Highlands, and in the Selkirk Mountains, a northern extension of the Rocky Mountains. It is generally found at elevations above 6,000 feet (1,839 meters) but variation occurs depending on aspect, soils, longitude, and latitude. In general, this zone occurs at higher elevations in the east portion of the planning area due to more favorable soils and topography, and earlier snow melt (Franklin and Dyrness 1988). This trend falls off along the Idaho boarder where high snowpack occurs due to prevailing maritime influences. The upper elevations of this type give way to alpine and subalpine grasslands, shrublands and meadows. At lower elevations this type grades into cool forest types with continuous tree cover dominated by subalpine fir, mountain hemlock, lodgepole pine, Pacific silver fir, and Engelmann spruce.

Whitebark pine occurs throughout the planning area on high elevation ridges and slopes in droughty locations generally where snowpack is shallow due to snow movement and wind removal. Subalpine larch is limited to areas near the Cascade crest. It is unable to tolerate drought, but does tolerate exposure to winds and driven snow better than whitebark pine due to its

deciduous nature. Generally, these two vegetation types occur on complimentary locations with little to no overlap. Mountain hemlock is a strong maritime associate occurring where snowpack is very deep and slow to melt. Within the planning area mountain hemlock stands are restricted to the vicinity of the Cascade crest (Lillybridge et al. 1995), though due to the eastern maritime influence mountain hemlock stands are also found in Montana (Pfister et al. 1977) and northern Idaho (Cooper et al. 1991). Subalpine fir occurs throughout the planning area extending well into the forested zone. Lodgepole pine is found throughout the planning area and occasionally at the uppermost extent of tree distribution in these parklands. It is better represented as a pioneer tree species in the closed canopy forests below where it regenerates quickly following high intensity fires.

No loss of this group was noted by the ICBEMP analysis due to agriculture or urban development and none is expected in the future (Quigley and Arbelbide 1997).

Classification

Subalpine parkland vegetation types have been classified in the planning area primarily from data collected in the Cascades (Lillybridge et al. 1995; Williams et al. 1995; Williams and Lillybridge 1983). Local surveys of parklands include Alverson and Arnette (1986) from above Lake Chelan, and Layser (1980) from Pend Oreille County, though neither is a formal classification. Classifications available from adjacent areas include Hamann (1972) from the northeast side of Mount Rainier, Pfister et al. (1977) from Montana, and Cooper et al. (1991) from northern Idaho. Clausnitzer and Zamora (1987) discuss a subalpine larch-whitebark pine type from the Colville Indian Reservation.

Subalpine larch is classified on a range of sites ranging from more xeric locations with common juniper (*Juniperus communis*) to mesic maritime location with Mertens' moss-heather (*Cassiope mertensiana*) and partridgefoot (*Luetkea pectinata*) (Lillybridge et al. 1995). Mountain hemlock types include associations with species indicative of the maritime influence like dwarf bramble (*Rubus lasiococcus*) and beargrass (Lillybridge et al. 1995; Cooper et al. 1991). Whitebark pine's tolerance for droughty conditions is indicated by the drought tolerant nature of associated species like pinegrass, green fescue and common juniper (Lillybridge et al. 1995). The most common subalpine fir parkland vegetation type includes grouse huckleberry (*Vaccinium scoparium*) and smooth woodrush (*Luzula hitchcockii*) in the understory. These ubiquitous high elevation species are also associated with whitebark pine on the Wenatchee National Forest (Lillybridge et al 1995) and in Montana (Pfister et al. 1977), and with subalpine larch and mountain hemlock in the Cascades (Lillybridge et al. 1995).

Disturbance

High elevation environments are believed to be vulnerable to global climate changes. Global warming models predict that subalpine and alpine areas would become more favorable to tree establishment which would allow the upper limit of continuous forest to increase (Bachelet et al. 2000; Henderson 2003). Vegetation types associated with parkland, like subalpine larch and whitebark pine, are able to outcompete subalpine fir and other forested species because these high elevation tree species are better adapted as pioneers in the harsh environments near treeline. If temperatures warm these parkland types may be replaced by lower elevation species as the parkland habitat is "squeezed" off mountain tops.

Fire is an important disturbance agent in subalpine parkland vegetation types where trees and large fuels are available (Agee 1994). Small fires are common throughout this zone because of

the high frequency of lightning strikes, but large scale fires are rarer since extreme weather and dry contiguous fuel conditions for large conflagration fires seldom occur. The historic fire regime group of the subalpine parkland zone is type IV, with a fire return interval of 35 to 100 or more years. Fire severity is considered high because trees in this zone are thin-barked and killed in moderate intensity fires while the dominant layers in the herbaceous and shrub vegetation mosaic are consumed, too.

Variation occurs within parklands both between vegetation types, and between watersheds. Agee (1994) notes in his summary that subalpine larch stands rarely ever burn, while whitebark pine forests have relatively short fire return intervals. Fire patterns are also highly variable because conditions vary greatly between watersheds (Agee 1994, Schellhaas et al. 2001). Schellhaas et al. (2001) compared fire return intervals on 1/20th acre plots in the Upper Entiat River watershed on the Wenatchee National Forest, and the Loup Loup Summit (north) on the Okanogan National Forest. They found fire return intervals averaged approximately 96 years. However, fire return intervals ranged from 28 to 291 years with shorter fire return intervals occurring on the Okanogan. They attributed the more frequent fires to a gentler terrain supporting a more contiguous fuel bed, and slightly drier conditions. Natural fuel breaks like valley bottoms (riparian areas) and major ridges were found to influence fire extent in this study and in a similar study from Mount Rainier (Hemstrom 1979). Fire patterns are not as predictable in subalpine areas as in lower elevation forest types (Agee 1994).

Subalpine fir trees are found in association with whitebark pine, particularly in subalpine parkland areas. In many of these stands whitebark pine is considered seral to subalpine fir and in the absence of disturbance may be replaced by the fir. Slow growth rates and high longevity of the pine help to maintain their presence (Clausnitzer and Zamora 1987) however, where fire and white pine blister rust (*Cronartium ribicola*) have removed whitebark pine, subalpine fir becomes more important (Williams et al. 1995; Agee 1994). Where subalpine fir is subordinate to whitebark pine, the removal of whitebark pine has in effect lowered timberline because the diminutive subalpine fir need the protective structure of the pine to survive (Lillybridge et al. 1995).

Long fire return intervals (periods between fires) in the subalpine parkland generally mean that fire suppression activities have had little effect on these vegetation types. Agee (1994) proposes that at the landscape scale there may be a slight shift toward late seral and away from early seral communities. Others have proposed that fire suppression has allowed for the broad-scale invasion of trees into green fescue and *Phyllodoce-Vaccinium* communities (Ratliff 1985). However tree invasions can also be explained by periods of low rainfall and warm summers (Franklin and Dyrness 1977) or, management such as grazing (Agee 1994). Due to the slow growth rate of trees in this zone, patches opened by fire or disease tend to stay unforested for long periods (McLean 1970, Agee 1994). It is likely that disturbance is instrumental in creating and maintaining openings in a shifting mosaic pattern in the lower elevations of the subalpine parkland (McLean 1970).

Subalpine larch, subalpine fir, and whitebark pine can reproduce asexually by layering. Layering occurs where long-lasting snowloads bend lower branches and thin, flexible stems onto the soil and they take root. Associated with krummholz tree structure, it is not uncommon to see multi-stemmed trees or entire patches resulting from layering. Asexual reproduction is a strategy employed in this harsh environment where seedling establishment is difficult. Reproduction from seed is most noted in whitebark pine where it is linked to the presence of Clark's Nutcrackers. One study in Wyoming found that "by winter each nutcracker had harvested about 129,000 seeds, of which 76 percent were stored in the soil" (Lanner 1996). The whitebark pine seeds were

cached within two miles of the seed source tree, thus, making nutcrackers both establishers and dispersers of whitebark pines.

The upper elevation soils in the northern Cascade Mountains are generally poorly developed with the least developed soils, Entisols, associated with unstable snow bed sites or high windswept ridges and plateaus (Douglas and Bliss 1977). Inceptisols typically occur under herbaceous dominated communities including poorly drained snow bed types to the well-drained dry grass and dry sedge communities. Spodosols are associated with both forest patches and shrublands. The Okanogan Highland subalpine ecosystems exhibit better developed soils due to more gentle terrain and deep glacial and ash deposits.

Tree growth in stands dominated by whitebark pine or subalpine larch is very slow and stocking low to very low. According to Williams et al. (1995) overstory removal increases potential for severe frost heaving, winter desiccation and drought, and there is no known technique assuring reforestation. Removal of these high elevation forest types could effectively lower timberline elevations because tree establishment is hindered by the environmental extremes. Vegetation types in this zone dominated by subalpine fir also exhibit very slow growth rates and can incur, with canopy removal, many of these same reforestation limits. Timber harvest does not act as a surrogate in these ecosystems for stand replacing fire because the snags left by fire play a vital role in moderating site temperatures and protecting seedlings (Williams et al. 1995).

Fire can convert subalpine fir stands to lodgepole pine dominance, a common seral species that responds well to fire. Lodgepole pine can persist in a burned area for many years to be slowly replaced by subalpine fir or Engelmann spruce, a process that can take more than two centuries. Often another fire occurs before the replacement sequence is complete and lodgepole pine is again favored. This process is common in many of the upper cold forested and parkland areas of the Colville National Forest (Williams et al. 1995).

TABLE 8. PARKLAND VEGETATION TYPES

Citation	Vegetation Type	Type code
Cooper et al. 1991	*Abies lasiocarpa/Luzula hitchcockii*	ABLA2/LUHI4
Williams and Lillybridge 1983	*Abies lasiocarpa/ Phyllodoce empetriformis*	ABLA2/PHEM
Williams et al. 1995	*Abies lasiocarpa/Vaccinium scoparium*	ABLA2/VASC
Mclean 1970	*Abies lasiocarpa/Vaccinium scoparium H.T. Phyllodoce empetriformis phase*	ABLA2/VASC-PHEM
Lillybridge et al. 1995	*Abies lasiocarpa/ Vaccinium scoparium/Luzula hitchcockii*	ABLA2/VASC/LUHI4
Williams et al. 1995	*Abies lasiocarpa/Xerophyllum tenax*	ABLA2/XETE
Clausnitzer and Zamora 1987	*Abies lasiocarpa-Pinus albicaulis/Arctostaphylos uva-ursi*	ABLA2-PIAL/ARUV
Williams and Lillybridge 1983	*Larix lyallii*	LALY

Citation	Vegetation Type	Type code
del Moral 1977	*Larix lyallii/Antennaria alpina-Poa cusickii*	LALY/ANAL4-POCU3
Lillybridge et al. 1995	*Larix lyallii/Cassiope mertensiana-Luetkea pectinata*	LALY/CAME7-LUPE
Lillybridge et al. 1995	*Larix lyallii/Dryas octapetala*	LALY/DROC
Lillybridge et al. 1995	*Larix lyallii/Juniperus communis*	LALY/JUCO6
del Moral 1977	*Larix lyallii/Phyllodoce empetriformis/ Luzula hitchcockii*	LALY/PHEM/LUHI4
Lillybridge et al. 1995	*Larix lyallii/Vaccinium deliciosum-Cassiope mertensiana*	LALY/VADE-CAME7
Lillybridge et al. 1995	*Larix lyallii/Vaccinium scoparium/ Luzula hitchcockii*	LALY/VASC/LUHI4
Cooper et al. 1991	*Larix lyallii-Abies lasiocarpa*	LALY-ABLA
Williams et al. 1995	*Pinus albicaulis*	PIAL
Alverson and Arnett 1986	*Pinus albicaulis woodland*	PIAL/FEVI
Lillybridge et al. 1995	*Pinus albicaulis/Calamagrostis rubescens*	PIAL/CARU
Williams and Lillybridge 1983	*Pinus albicaulis/Calamagrostis rubescens*	PIAL/CARU
Lillybridge et al. 1995	*Pinus albicaulis/Cassiope mertensiana-Luetkea pectinata*	PIAL/CAME7-LUPE
Lillybridge et al. 1995	*Pinus albicaulis/Dryas octapetala*	PIAL/DROC
Lillybridge et al. 1995	*Pinus albicaulis/Festuca viridula*	PIAL/FEVI
del Moral 1977	*Pinus albicaulis/Juncus parryi-Penstemon davidsonii*	PIAL/JUPA-PEDA2
Lillybridge et al. 1995	*Pinus albicaulis/Juniperus communis*	PIAL/JUCO6
del Moral 1977	*Pinus albicaulis/Phlox diffusa*	PIAL/PHDI3
Lillybridge et al. 1995	*Pinus albicaulis/Vaccinium scoparium/ Luzula hitchcockii*	PIAL/VASC/LUHI4
Annable and Peterson Date?	*Pinus albicaulis-Abies lasiocarpa/ Juncus parryi-Lupinus sulphureus*	PIAL-ABLA2/ JUPA-LUSU5
Lillybridge et al. 1995	*Tsuga mertensiana/Luzula hitchcockii*	TSME/LUHI4
Lillybridge et al. 1995	*Tsuga mertensiana/Phyllodoce empetriformis-Vaccinium deliciosum*	TSME/PHEM-VADE
Lillybridge et al. 1995	*Tsuga mertensiana/Vaccinium scoparium/ Luzula hitchcockii*	TSME/VASC/LUHI4

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Wetland/Riparian Herbaceous Vegetation

Definition

This unit of the landscape is composed of the emergent vegetation at pond and lake margins, wet meadows (graminoid-dominated), and forb-dominated wetlands. While it represents a large segment of the environmental gradient, nevertheless, the type is characterized by the singular dominance of herbaceous vegetation (forbs and graminoids). Sites have a moisture regime from aquatic to wet and typical temperature regimes from warm to cold. Within this wetland complex, Kovalchik and Clausnitzer (2004) have described three vegetation series for the planning area: the aquatic series, the meadow series, and the forb series.

The AQUATIC series includes all herbaceous associations supporting rooted vascular or emergent vegetation that grows in deep water or in shallow water along the shoreline of permanently standing water. The numerous plant species used to characterize the AQUATIC series are widely distributed across the temperate and subarctic latitudes of North America. Most of these plants occur from Alaska to southeastern Canada, and extend south through much of the northern United States. These wetland species include: creeping spike-rush (*Eleocharis palustris*), water horsetail (*Equisetum fluviatile*), northern mannagrass (*Glyceria borealis*), western mannagrass (*G. occidentalis*), Indian water-lily (*Nuphar polysepalum*), cow-lily (*N. variegatum*), bur-reed species (*Sparganium* spp.), common cattail (*Typha latifolia*), pondweed species (*Potamogeton* spp.), softstem bulrush (*Scirpus validus*), and hardstem bulrush (*S. acutus*).

Many of the graminoids used to define the MEADOW series are characteristic of northern latitudes. These indicator species occur from Alaska to eastern Canada and south into the United States. Several of the species are circumboreal; others are very widespread and extend well into the southern states. Taxa characteristic of the MEADOW series include: water sedge (*Carex aquatilis* var. *aquatilis*), Sitka sedge (*C. aquatilis* var. *sitchensis*), bluejoint reedgrass (*Calamagrostis canadensis*), slender sedge (*C. lasiocarpa*), Buxbaum's sedge (*C. buxbaumii*), black alpine sedge (*C. nigricans*), Holm's sedge (*C. scopulorum* var. *bracteosa*), saw-leaved sedge (*C. scopulorum* var. *prionophylla*), showy sedge (*C. spectabilis*), bladder sedge (*C. utriculata*), awned sedge (*C. atherodes*), inflated sedge (*C. vesicaria*), few-flowered spike-rush (*Eleocharis pauciflora*), many-spiked cotton-grass (*Eriophorum polystachion*), small-fruited bulrush (*Scirpus microcarpus*), Columbia sedge (*C. aperta*), Cusick's sedge (*C. cusickii*), sheep sedge (*C. illota*), lenticular sedge (*C. lenticularis*), mud sedge (*C. limosa*), poor sedge (*C. paupercula*), beaked sedge (*C. rostrata*), russet sedge (*C. saxatilis* var. *major*), tufted hairgrass (*Deschampsia cespitosa*), tall mannagrass (*G. elata*), and reed mannagrass (*C. grandis*).

The numerous plant species used to characterize the FORB series are widely distributed in the mountains of temperate and subarctic North America. Most of these plants can be found from Alaska south through the mountains of British Columbia, Alberta, Washington, northern Idaho, Montana, and Oregon. Plant indicators of the FORB series include the following: alpine lady fern (*Athyrium distentifolium*), lady fern (*A. filix-femina*), oak fern (*Gymnocarpium dryopteris*), Lewis' monkey-flower (*Mimulus lewisii*), globeflower (*Trollius laxus*), twinflower marshmarigold (*Caltha biflora*), broadleaf lupine (*Lupinus latifolius*), dotted saxifrage (*Saxifraga puncata*), Merten's saxifrage (*Saxifraga mertensiana*), and brook saxifrage (*Saxifraga arguta*).

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Distribution

Climate is variable in this vegetation group because representative sites occur from low elevation shrub-steppe areas to the subalpine zone at upper elevations; although sites near larger bodies of water, especially lakes, may have air temperatures moderated by the volume of water and differ somewhat from ambient climates (Kovalchik and Clausnitzer 2004).

In the planning area the AQUATIC series includes natural ponds and lakes, seasonally flooded shorelines, beaver ponds, reservoirs, sloughs, or the quiet backwaters of Rosgen E and C channels. The most important factor determining the distribution of the AQUATIC series species and their corresponding associations is water depth. Secondary factors are wave action, water temperature, oxygenation, and chemistry. The elevation of the AQUATIC series ranges from 1,850 to 7,350 feet (560 to 2230 meters), with the majority of sites occurring below 5,500 feet (1667 meters).

Sites representing the MEADOW series are broadly characterized as fens, poor fens, meadows, and bogs. In eastern Washington climate, elevation, and hydrologic conditions (such as presence of water and its chemistry) are important factors determining the distribution of these graminoids and their plant associations. Annual precipitation varies from under 10 inches at low elevations in the Columbia basin to well over 80 inches along the Cascade crest. Typically, the MEADOW series is widespread and occurs from elevations below 1,000 feet (300 meters) in the Columbia basin to well over 7,000 feet (2121 meters) along the Cascade crest and over 6,000 feet (1818 meters) in the Kettle River Range and Selkirk Mountains.

All forb associations are grouped into one FORB series based on the singular occurrence of forb dominance. Each species responds to differences in water depth, temperature, chemistry, and aeration. Most associations are found along streams on moist, well-drained alluvium. They are associated with peak-flow flooding and “summer splash” from the adjacent stream. Some sites are also found in springs or fens. Elevation (a factor affecting both growing season and temperature) also strongly influences the plant species growing on these sites. Typically, the FORB series occurs between 3,000 and 7,000 feet (909 and 2121 meters).

Classification

Kovalchik and Clausnitzer (2004) have completed a comprehensive classification of wetland types on national forest lands within the planning area. They identified and described three herbaceous series (Table 9): the AQUATIC Series, the MEADOW Series, and the FORB Series. In addition, keys are provided that identify plant associations within each of the series. To date, this is the only comprehensive classification of these vegetation types in the planning area. Locally, Layser (1980) briefly describes fens and marshes in Pend Oreille County, but stops short of an ecological classification of sites. Adjacent classifications are available from Montana (Hansen et al. 1988), the Gifford Pinchot and Mount Hood National Forests and Columbia River Gorge National Scenic Area (Diaz and Mellen 1996), and eastern Oregon (Kovalchik 1987; Crowe and Clausnitzer 1997).

Disturbance

Climate change is likely to affect wetland/riparian herbaceous vegetation indirectly by changes to precipitation rates and timing. If resultant water tables are lowered or water levels in lakes and ponds recede, then these wetland/riparian sites could decline as drier vegetation or transition zones increase in area extent.

The AQUATIC series occurs on permanently or temporarily flooded soils, so the heat of fire cannot generally damage plants. However, rare fire events on shoreline and shallow water associations can consume the aboveground biomass. Plants survive and quickly resprout following a summer or fall fire. When organic soils become dry, due to drought or wetland drainage, ground fires may burn into the organic peat soils and cause widespread plant mortality as well as lowered soil surfaces (Kovalchik and Clausnitzer 2004). Consequently, hydarch succession is reinitiated when the site is restored to normal water levels.

Fen plant associations of the MEADOW series dominated by bladder sedge, water sedge, and slender sedge would carry fire in the late fall or early spring when the previous season's culms are dry. This is an unusual event and nonuse by livestock in the year preceding the fire is essential to provide continuity in fuels (Hansen et al. 1995). These sites are usually wet enough that the heat does not destroy underground rhizomes and plants quickly resprout during the growing season. Fire reduces litter accumulation and temporarily increases productivity. Species composition would not change appreciably from the pre-fire vegetation. Plant associations of this series that occur on drier, mineral soils at the edge of wetlands (for example, tufted hairgrass and bluejoint reedgrass) may be subject to more frequent fire. Bluejoint reedgrass is resistant to all but the most intense surface fire as it quickly resprouts from rhizomes. Tufted hairgrass is resistant to low and moderate intensity fire because of the dense, tufted plant base. Repeated high intensity fires could affect the composition of community dominants on these drier sites. Bog sites dominated by cotton-grass or spike-rush are resistant to damage by fire because of the saturated soils and subsequent post-fire rhizome sprouting. Extreme drought may dry the soils so that a deep, smoldering fire destroys organic soils, rhizomes, and plants. Reestablishment of seedlings from the soil seed banks or from wind-disseminated seed occurs quickly. An intense ground fire reduces the accumulation of peat and may change the site potential away from bog species toward short willows and sedges. Fens, poor fens, bogs, and wet meadows near timberline or in alpine zones rarely dry out enough to carry fire (Kovalchik and Clausnitzer 2004).

Many of the indicator species in the FORB series occur in moist forest valleys with long fire return intervals and are adapted to survive the infrequent fire by resprouting from rhizomes or the root caudex. Lupine, lady fern, and oak fern all respond to fire in this way, but can be damaged with a combination of drought followed by high intensity fire. In addition, lupine seeds are stored in the soil seed bank and respond with post-fire germination on newly exposed mineral soil (Kovalchik and Clausnitzer 2004).

Recurrent and persistent high levels of grazing by cattle and wildlife can affect the soil resource as well as plant association composition and structure. Livestock use of the AQUATIC, MEADOW, and FORB series is variable, though, depending on the wetness of the site and palatability of the associated graminoids and herbs. On larger fens and meadows, livestock use is usually less severe owing to abundant forage and wet soils. However, use and resultant long-term damage may be high on the drier, accessible fringe in associations such as tufted hairgrass and bluejoint reedgrass types. Bog associations are especially resistant to livestock use and damage because of the access to permanently wet soils and the generally lower palatability of the herbs (Kovalchik and Clausnitzer 2004).

TABLE 9. WETLAND AND RIPARIAN HERBACEOUS VEGETATION TYPES

Citation	Vegetation Type	Type code

Citation	Vegetation Type	Type code
Kovalchik and Clausnitzer 2004	AQUATIC Series	AQUATIC
Kovalchik and Clausnitzer 2004	MEADOW Series	MEADOW
Kovalchik and Clausnitzer 2004	FORB Series	FORB
Franklin and Dyrness 1988;	Pond Vegetation	POND

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