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Forest Health in the Blue Mountains: A Plant Ecologist's Perspective on Ecosystem Processes and Biological Diversity

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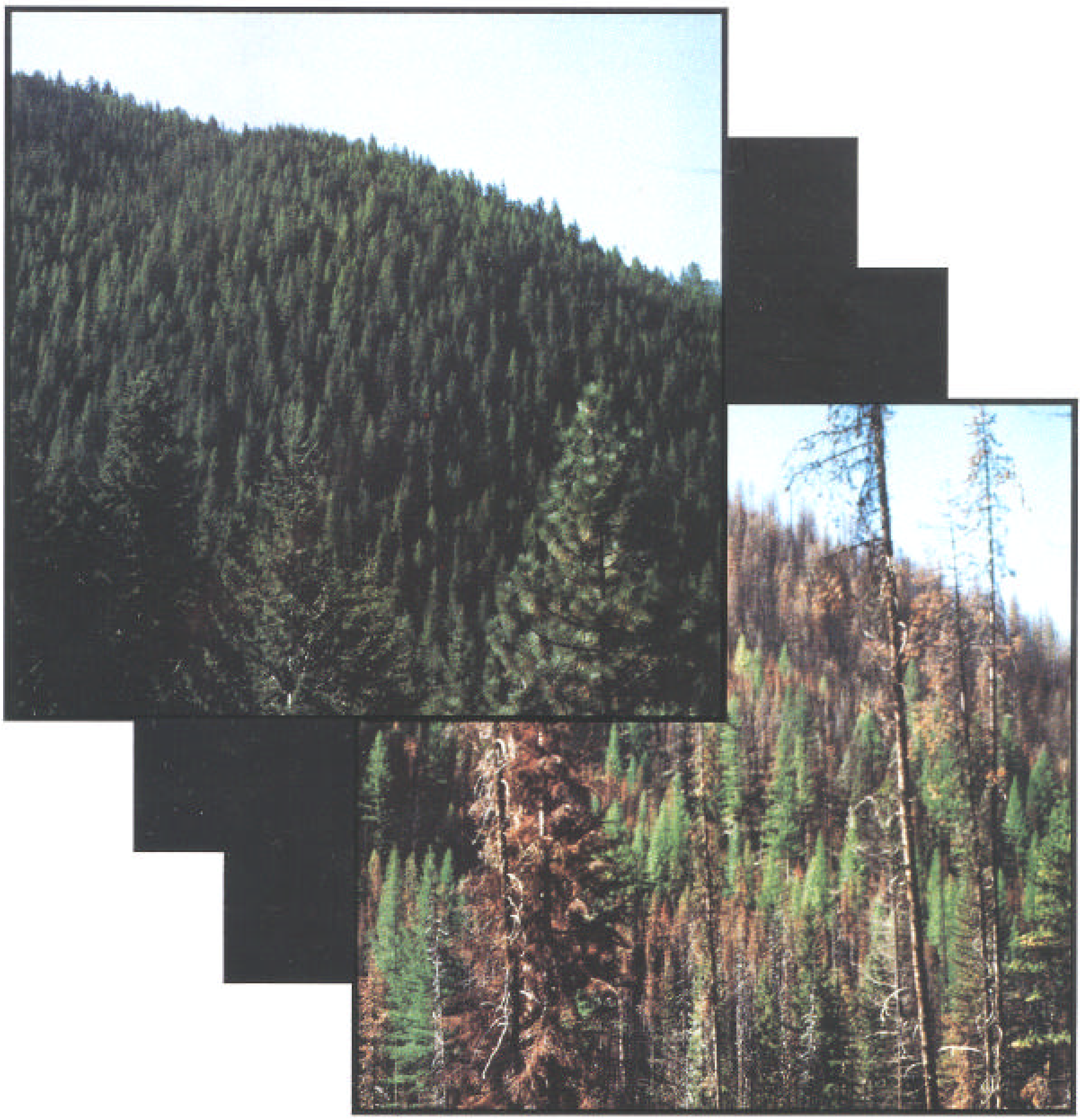

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This paper is one of a series on Forest Health in the Blue Mountains by the Blue Mountains Natural Resources Institute, of which the Pacific Northwest Research Station and the Wallowa-Whitman National Forest are partners:

Cover Photo

Contrasting views of grand fir-dominated north slope communities. The upper view shows a homogeneous coniferous forest overstocked by Douglas-fir, western larch, and grand fir due to lack of fire in the forest ecosystem. The lower view shows a similar forest where fire has performed a sanitation function by killing lodgepole pine and grand fir trees. Western larch was retained. A "new" forest emerges as a result, which adds a different structure, composition, and age as a patch on the landscape. Biological diversity is enhanced as a result.

Forest Health in the Blue Mountains: Science Perspectives

Thomas M. Quigley, Editor

Forest Health in the Blue Mountains: A Plant Ecologist's Perspective on Ecosystem Processes and Biological Diversity

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Abstract

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Natural disturbances are important to ecosystem processes. Disturbances historically have occurred in the vegetation of the Blue Mountain area of northeastern Oregon and southeastern Washington. The primary modifying events that historically have cycled through most of its plant communities are fire, grazing and browsing, insect and disease epidemics, windthrow, flooding, and erosion. Knowledge of plant successional pathways enables managers to predict the probable course of community development for a disturbance regime. Recommendations for restoring the Blue Mountains area are to reintroduce fire into the ecosystem, restore rangelands, and enhance biological diversity by practicing landscape ecological management and by emulating natural patterns on the landscape. Periodic and timely sampling after these activities is critical to assessing the results for adaptive management needs.

Keywords: Disturbance ecology, landscape ecology, fire, prescribed fire, grazing, browsing, ecosystems.

Preface

The Blue Mountains of northeast Oregon and southeast Washington are composed of a complex mix of ecosystems, habitats, landforms, and economies. Several consecutive years of drought, epidemic insect infestations, and catastrophic fire are threatening the natural resources and the social and economic systems within the Blue Mountains. The general health of the forests is not good and may be worsening. A primary factor leading to the current deteriorated condition has been the exclusion of fire. Past timber management practices also have contributed.

This publication is part of a series on forest health in the Blue Mountains. The goal of this series is to provide a discussion of forest health issues from various science perspectives. The series will include discussions on several aspects: insects and disease; economic and social issues; fire; fish, riparian areas, and water quality; ecology and range; wildlife; and a summary of forest health public forums held throughout the Blue Mountains.

The Blue Mountains Natural Resources Institute has been the focal point for much of the discussion regarding the science issues associated with forest health. This organization, which includes 80 partners, has broad representation and a strong interest in restoring health to the forests and communities of the Blue Mountains area. The Institute has fostered publication of these papers as one more step in the long process of restoring health to east-side forested landscapes.

Thomas M. Quigley

Introduction

This paper is the result of a compilation of observations and experiences over the past 23 years about plant communities occurring in the Blue and Wallowa Mountains and adjacent canyons. Results revealed that most of the plant communities exhibited the composition and structure systematic of past and ongoing disturbance regimes peculiar to the area.

Forest health in the Blue Mountains has been a topic of regional interest for the past 3 years (Caraher and others 1992, Gast and others 1991, Mutch and others 1993, Quigley 1992, Wickman 1992), primarily due to the occurrence of insect and disease epidemics in forested communities. In addition, severe wildfires occurred across large portions of northeastern Oregon, a phenomenon attributed to the buildup of fuels resulting from the lack of periodic fire, the continuing regional drought, and the mortality of trees from insect epidemics. Consequently, there is public interest in how land management agencies will solve a perceived problem; diminishing the levels of epidemic insect infestations and reducing the levels of high-intensity wildfire.

The purpose of this paper will be to expand the discussion beyond trees, forests, and fires to provide a larger perspective of what is occurring in the Blue Mountains. The larger, more severe fires, coupled with high levels of insect defoliation, are symptomatic of a larger problem, which must be approached from a broad perspective. We will need to think in terms of landscapes instead of stands, vegetation mosaic instead of forests, and ecosystem processes instead of species. In essence, a more holistic approach to the problem is needed to initiate changes that can correct the imbalance currently existing.

Land management practices of the 20th century in the Blue Mountains have influenced the periodicity and intensity of some ecosystem processes; the addition of alien elements to portions of ecosystems have contributed to unstable conditions. Insects, diseases, and fire are how stability is maintained naturally in the ecosystem. Agents of "destruction" to forests and trees are also agents of "change" that direct the forest ecosystem toward future changes, stability, and perhaps what we would term "catastrophes."

This paper will address natural disturbances occurring throughout the east-side landscape.[1] The frequency and severity of these disturbances cause changes in the composition and structure of the plant community. They result in a mosaic of different-sized patches across the mountains and canyons of the area that may enhance the quality and quantity of habitats for wildlife and help maintain biological diversity.

Unnatural disturbances also will be addressed. When our management of and occupation on the land have inhibited the ability of the ecosystem to rebound naturally, a "new" vegetation has supplanted the native community. Examples are provided where forested stands are replaced with exotic and alien vegetation because of extreme modification resulting in environmental changes prohibitive to the growth and establishment by the native vegetation. Other examples are provided where native bunchgrasses are replaced on primary rangelands by the impact of overgrazing by ungulates (horses, cows, sheep, elk), thereby resulting in a degraded site. This often leads to a loss of topsoil with resultant loss in the productive potential of the sites, naturalization by alien plants, and reduc-

[1] As used in this paper, the term "east side" refers to the inland Pacific Northwest. This is the land area east of the Cascade Range crests and west of the Continental Divide in Washington, Oregon, northern Idaho, and western Montana.

tion of inherent biological diversity provided by the natural grassland. This paper will exemplify the natural and management-induced disturbances to one of our primary bunchgrass plant associations to depict the role of disturbances in creating ecosystem change.

The scope of problems associated with widespread insect and disease outbreaks, the increased severity of wildfires, and the high level of degraded rangelands has created a heightened awareness of a severe management problem. These events require a broad program containing several land initiatives to mitigate the problem over decades. There is no easy way to remedy that which has taken several decades to evolve. Initiatives taken to improve ecosystems in the Blue Mountains are the reintroduction of fire, the implementation of landscape ecological approaches to management, and perhaps most importantly, the changing of attitudes to a new land management ethic. The professional shift from commodity management to ecosystem management is the basis for this new initiative and is promoted in this paper as it applies to the National Forest landscape and plant communities of northeastern Oregon and southeastern Washington.

Disturbance as a Natural Event in Blue Mountain Ecosystems

The Blue Mountains area of Washington and Oregon has a history of natural disturbances important to ecosystem processes. Unlike some ecosystems in which stability is measured in centuries, these east-side ecosystems are considered stable when the period between modifying events is in decades. Vegetation reflecting the climate and topography of the Blue Mountains is comprised of plants with reproductive mechanisms capable of withstanding severe and frequent disturbance.

The principal modifying events that historically have occurred have provided the vegetation with adaptations to persevere with periodic disturbances. The primary events that cycle through the various plant communities of the Blue Mountains are fire, grazing and browsing by ungulates, insect and disease epidemics, windthrow, flooding, and erosion (mass wasting).

Fire as a Rejuvenating Event

Throughout the pre-settlement period, fire was an integral part of the maintenance and function for most ecosystems occurring east of the Cascade Range in Washington and Oregon. The seasonal cycling of fire through the landscape was as regular as the incidence of late summer lightning in the canyons and mountains of the Blue Mountains region (fig. 1). The interval between fire events in certain plant communities has been determined by investigators for many forested plant associations and has been estimated for several key grassland plant associations (Volland and Dell 1981). Depending on the composition and structure of the community and the buildup of dead plant biomass, fire resulted in burns of various intensities and sizes across the landscape. The shorter the return interval between fire events, the less dramatic would be the result of the fire on total plant composition. With infrequent return intervals, stands tended to burn more completely and be replaced by a vegetation often different in composition, structure, and age than the one it replaced.

The landscape variation, its relief, climatic patterns, and disturbance patterns all have combined to provide a rich mosaic of plant communities across this region (fig. 2). As the annual lightning storms played across this landscape, plots of various sizes, textures, and vegetation types resulted. This mosaic was as resilient and dynamic as the annual occurrence of storm-induced fire. The probability of fire in any given place would be a function of chance, the position of fire on the landscape in relation to storm-building geographic features, and the vulnerability of the plant community to ignite.

Figure 1—The southern Blue Mountains in October where particulates add a bluish cast to the ridges from Indian summer fire activity.

Figure 2—Prescribed natural fire and manager-ignited prescribed fire can assist in promoting biodiversity by enhancing the mixture of tree species (hardwoods and conifers) and shrubs, structural variation, and age classes.

The period since settlement and subsequent growth of industry by Euro-Americans in the Blue Mountains area has seen the curtailment of fire as a periodic modifying event in most of the east-side plant communities. Over the past 130 years–and even more dramatically in the past 60 years–the vegetation has changed from stands dominated by seral fire species to stands and communities in which fire-susceptible species predominate and form "unhealthy" stand configurations. The classic example has been the disappearance of open, park-like stands of ponderosa pine *(Pinus ponderosa* Dougl. ex Laws.) and the ingrowth of grand fir *(Abies grandis* (Dougl. ex D. Don) Lindl.) trees as a result of fire exclusion in vast areas of east-side montane topography. Likewise, in grand fir plant associations where ponderosa pine is not seral to grand fir, fire has not been allowed to perform its natural role of stand-replacement burning. The poor vigor of these stands has contributed to the incidence of increased outbreaks of insects and epidemic diseases that have further increased the probability of large-scale fires with greater stand-replacing capabilities (Hall 1980).

Wildfire has been a governing factor in all vegetative aspects of the Blue Mountains landscape. Today, the unprecedented combination of decreased low-intensity surface fires, increased conflagration crown fires, and fire-exclusion management practices has resulted in plant communities with more uniform stand composition and structure. The current vegetation composition and structure probably did not exist at this scale on the Blue Mountains landscape in pre-settlement times. Those stands resulting from fire exclusion contain a higher percentage of true fir composition in the tree understories, thereby resulting in mixed-age structures and dense, suppressed tree stocking. Fire once controlled stand age, species composition, and stand density. If our long-term goals are to perpetuate stands of ponderosa pine, the judicious use of prescribed fire seems warranted in communities where ponderosa pine is seral to Douglas-fir *(Pseudotsuga menziesii* (Mirb.) Franco) and grand fir plant communities (Arno and others 1985, fig. 3).

Grazing and Browsing as Natural Modifying Activities

The relatively dry, warm summers, and cold, moist winters of the Blue Mountains area have promoted open forest; forest interspersed with shrublands, grasslands, or both; and a high percentage of non-forest vegetation. The bunchgrass vegetation and the rhizomatous sedges and grasses of these east-side plant communities are very well adapted and stimulated by disturbance from grazing animals. Under controlled and managed conditions, these plants are enhanced in the community by selective use by ungulates. Consequently, the vegetation has provided an ideal habitat for coevolving, ungulate species that depend on grasses and grass-like plants and shrubbery for their sustenance. Historically, various ungulates occurred across the eastern Washington and Oregon pre-settlement landscape. Many centuries ago, the Blue Mountains area was probably subjected to grazing and browsing by many North American mammals that became extinct about 10,000 years ago (Martin 1967). Few elk were present in eastern Oregon and Washington from 1800 until about 1930 (Shay 1954, Townsend 1905). Early trappers speak of deer, elk, mountain sheep, antelope, and occasional bison in the valleys and canyons of the region (Evans 1991). These animals had wide-ranging mobility and along with their preferential use of vegetation, affected vegetation condition moderately. Natural predators, more varied and numerous during pre-settlement times, helped keep the ungulates in balance. Climate was a major factor in causing peaks and crashes of large herbivore populations. As Euro-Americans settled the region, many predators were displaced from their natural rangelands. As the domestic livestock industry gained prominence, first with cattle beginning in the 1860s and peaking at the turn of the century (followed by sheep peaking in the 1930s and 1940s), the effect of too many animals too early in the season and for too long during the season began to adversely affect native vegetation (fig. 4).

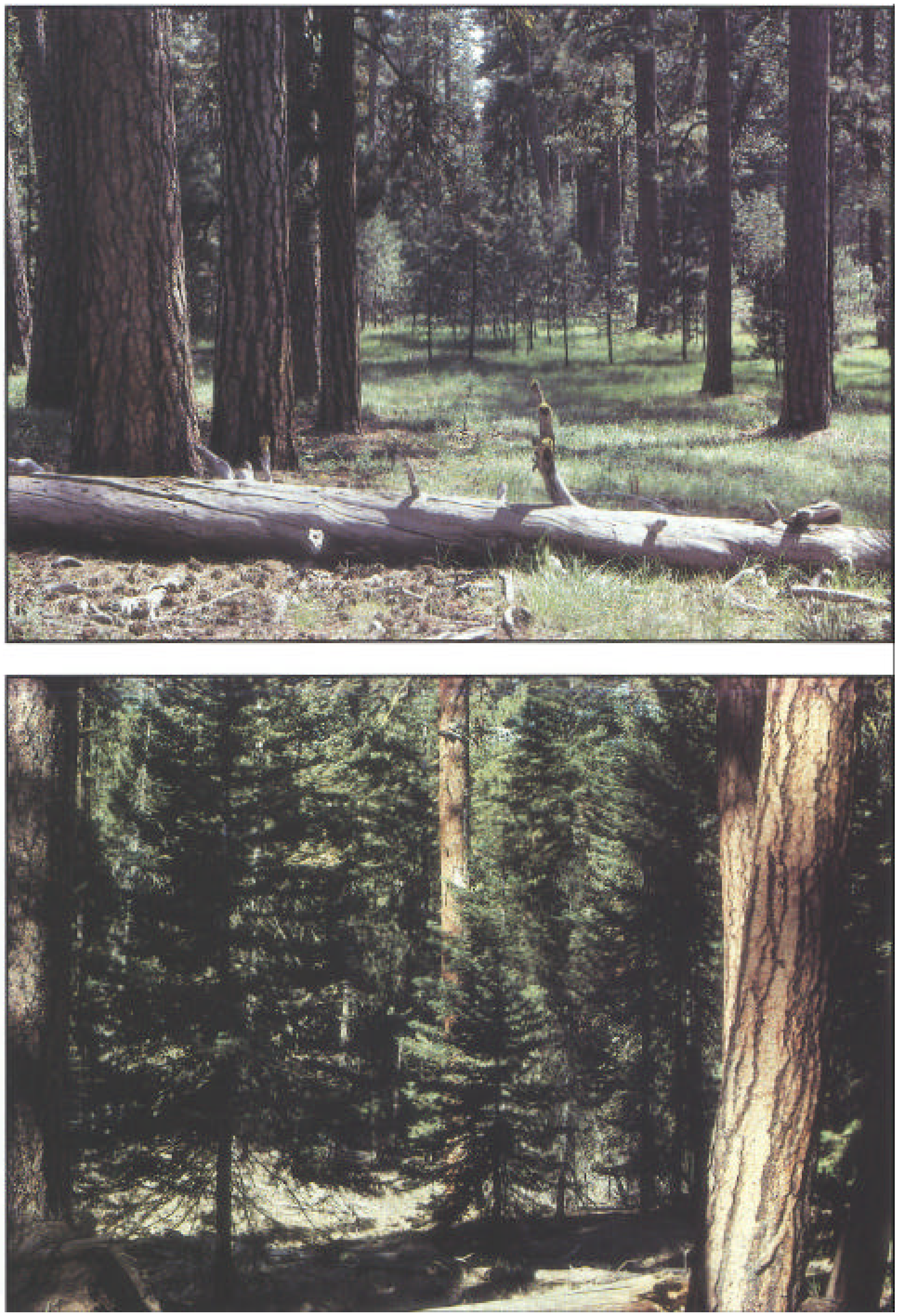

Figure 3= "Resuming our journey, we commenced the ascent of the mountain through an open pine forest of large and stately trees..." Captain John C. Fremont, 1843, on ascending the Blue Mountains (Evans 1991).

The scene may have been much like the upper view depicting an early seral grand fir plant association where ponderosa pine dominates owing to regular fire underburns, which have retarded succession to the fir species. The lower view is of the same plant association. Because of curtailment of fire in this stand, grand fir has been able to achieve pole and sapling growth stages. The forest community is now vulnerable to a stand-replacing fire.

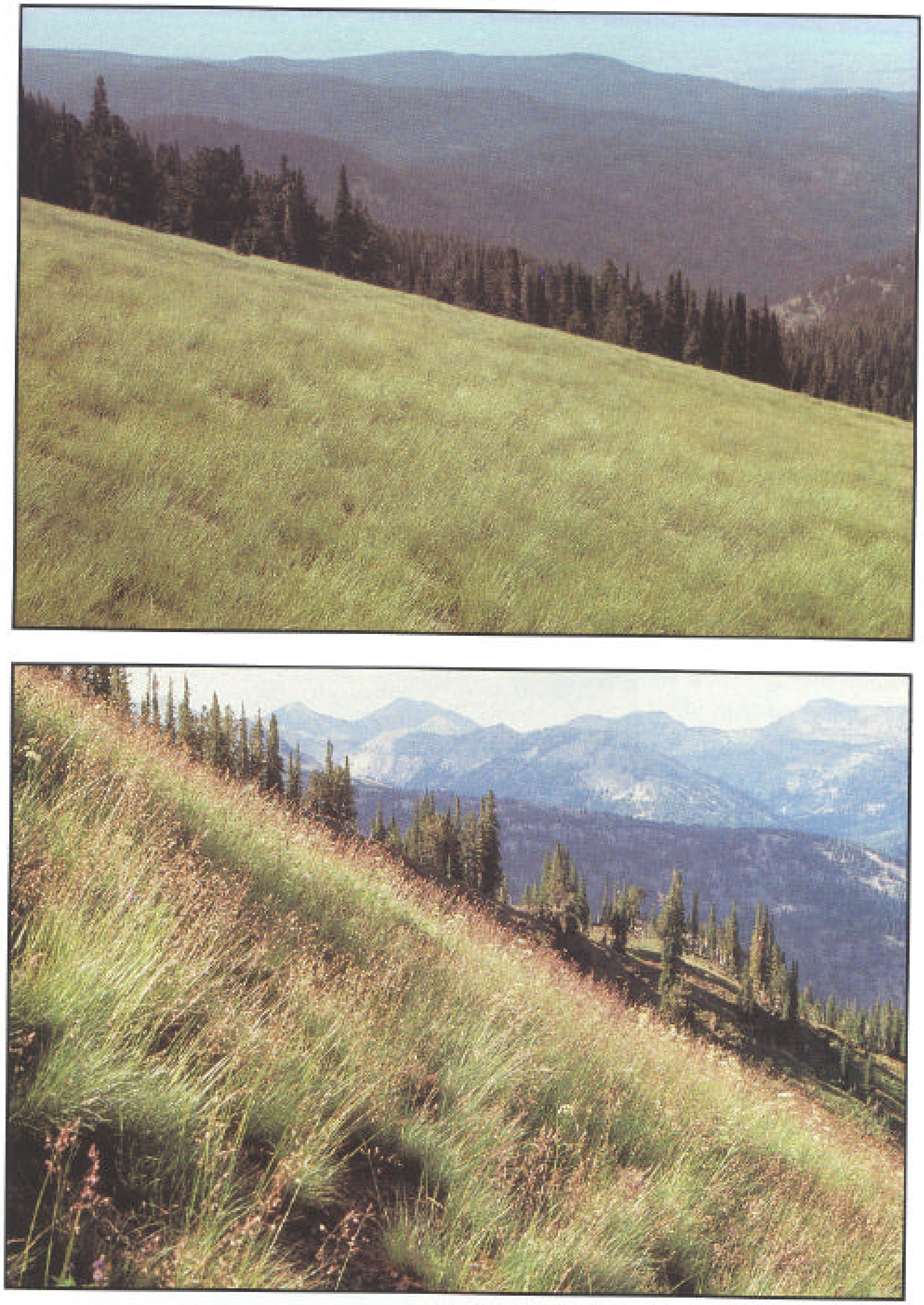

Figure 4-A contrasting pair of grassland views taken in the high Wallowa Mountains appear cosmetically desirable. The upper view is a site capable of producing the green fescue community of the lower view. However, the upper view portrays a needlegrass (*Stipa* spp.) community where past overgrazing has eliminated the green fescue. The more desirable fescue communities produce more forage, have a more diverse plant composition, and consequently offer a more varied habitat for wildlife (lower view).

Vegetation thresholds were regularly surpassed by overgrazing on many rangelands of the Pacific Northwest. Accounts of ridgetops white with hundreds of sheep and dust lingering in the sky from cattle being driven across stock driveways are found in written accounts by the early administrators of the public lands (Strickler 1961).[2] [3] Significant upland areas on the east-side landscape have lost the capacity to support the native vegetation that once covered the slopes and ridges where livestock and wild ungulates competed for fescues and other bunchgrasses. Streamside vegetation also was vulnerable because streamside areas were relatively isolated across the landscape of dry hills, canyons, and mountainous areas of the region. Many meadows and stringers of grasses were irreversibly changed by the overuse of the rangelands in the late 1800s and early 1900s after the removal of beaver from these ecosystems during the fur trapping era.

Just as curtailing fire has brought a response by the vegetation to restore stability to the ecosystem, the lack of the grazing animal in the bunchgrass ecosystem, along with the lack of frequent fire, can result in unnatural grasslands. The annual grazing of standing biomass by selective animals can maintain the intensity of bunchgrass communities by reducing decadent tissue, reducing litter buildup, stimulating vigorous new tissue, and promoting dissemination and germination of the grasses. Grazing as a modifying activity generally has been viewed negatively because of overuse over too long a period. Highly productive sites have retrogressed to earlier sera) stages in which biological diversity has lessened as species richness has declined.

Insects and Diseases as Modifying Agents

Vegetation is not stable. Environmental factors influencing east-side vegetation subtly change in response to disturbances within and among stands. Consequently, when disturbances are absent for an extended period, instability is heightened for a vegetation that naturally receives periodic disturbances. When this happens, plant community composition cannot be maintained. A downward trending succession proceeds, which increases the possibility for a catastrophic event to occur, thereby resulting in an irreversible change to the community. For example, if fire does not cause the event that induces change, native insects or diseases, or both, will. Lodgepole pine *(Pinus contorta* Dougl. ex Loud.) forests historically are replaced and rejuvenated by stand-replacing fires. Lodgepole pine in the Blue Mountains live about 90 to 125 years. In the early 1970s, foresters were surprised by the wholesale mortality of lodgepole pine from mountain pine beetle *(Dendroctonus ponderosae* Hopkins) damage. This shift from low population to outbreaks of the beetle in east-side lodgepole pine forests was an ecosystem response to the lack of stand-replacement fire that normally would have burned many lodgepole pine stands before they would become susceptible to bark beetles. Foresters did not actively harvest lodgepole pine forests because other forest products of greater economic value were being sought by industry.

Other Modifying Event

Flooding, windthrow, and erosion are less recognized as principal modifiers of east-side vegetation and plant communities than are fire, grazing, insects, and diseases. They are natural processes, however, that influence the composition, structure, and age of vegeta-

[2] Tucker, G.J. [Date unknown]. Historical sketches of the Wallowa National Forest. On file with: the Supervisor's Office, U.S. Department of Agriculture, Forest Service, Wallowa-Whitman National Forest, Baker City, OR 97814.

[3] Personal communication. 1985. W.B. Hall. (Range Staff Officer -retired); Wallowa-Whitman National Forest, P.O. Box 907, Baker City, OR 97814.

tion on the landscape. Occasional windstorms reach high velocities that can topple many trees, thereby resulting in large-scale patches of renovating forest. Winds more commonly provide a continual element of change to the character of the forest stand by creating smaller pockets of blowdown that create canopy gaps and opportunities for vegetation that requires sunlight. Root diseases, snow loading, and ice breakage often interact with wind as a factor in stand modification.

Windstorms often break or uproot trees where the wind is channeled by local topography, and severe windstorms can overturn trees across large areas. Trees easily snap off or break at their root collars in windstorms if they are in overcrowded stands, or they can uproot if on shallow soils. Trees blown over by winds create conditions favoring other disturbances–insects and fires. Where only some trees are blown over, the partial shade of remaining trees promotes shade-tolerant species such as true firs.

Flooding, an annual feature of wetland ecosystems, is a natural, creative, and nurturing event to many wetland communities. The infusion of new microsites for colonization and the delivery of nutrient-charged substrates ensure that these riverine or riparian communities will continue.

Erosion is a negative event when it produces changes that cannot be rectified naturally. Erosion, however, is also a natural part of an ongoing, sculpting process that provides landform patterns by deposition and mass-wasting activities. Although this period is relatively quiescent from a standpoint of geologic time, the creation of new landforms by rotational slumping, landslides, avalanches, and other debris-depositing events is natural and provides new landscape segments and patches for the enhancement of diversity and ecosystem health.

The natural disturbance regimes generally have provided invigorating responses to Blue Mountains vegetation. Plants that comprised east-side ecosystems have gradually adapted to the effects of fire, grazing, and other disturbances. The long-term consequences of natural disturbances tend to enhance biological diversity.

Management-Induced Disturbances

The activities of human occupations and industry (especially Euro-American) have modified the natural order in ways both complementary and detrimental to Blue Mountains ecosystems. The effects of land management treatments made at the stand level are often additive overtime and space and therefore greatly influence vegetation patterns at the landscape level.

Prudent management of these landscapes would seek to emulate the natural disturbances by considering landscape level responses to yield a predictable ecosystem response. Unnatural changes to the landscape have resulted from management activities undertaken without full understanding of the need to design periodic disturbances similar to those that naturally occur on the landscape. At the other extreme, the avoidance of disturbances from a protectionist management stance has led to violent perturbations over the long term.

Fragmentation of the landscape can result in too many patches, loss of old growth, and fewer management options in the short term for wildlife and vegetation management. If the position of the vegetation patches is unplanned, important "corridors" for gene flow and wildlife movements may be constricted or terminated.

Projects designed to encompass the various plant communities making up the landscape, and which seek to increase genetic, species, and landscape diversity by creating patches that emulate the natural sizes and shapes inherent in that landscape, will provide a starting point for protection from large-scale landscape modifying events.

Harvesting

With western expansion, the same treatment of forests by Euro-Americans found in the East was continued across the continent to the Pacific Northwest (Billington 1967). The east-side forests were exploited along major valleys and around centers of population growth as industrial growth required forest products from the 1860s to the 1920s. Public lands provided commodities for a new Western-based society. In the 1930s, 1940s, and 1950s, forest practices were essentially conducted along streamcourses with road building for extractive activities. Silvicultural practices usually were conservative.

Starting in the 1960s, and intensifying in the 1970s, however, a change in forest management philosophy and practices evolved to dramatically accelerate the volume of timber products being removed from the forests of the east side. The active suppression of fire for more than 50 years had allowed the ingrowth of fire seral (that is, ponderosa pine) and climax (that is, grand fir) tree species to overstock forest stands that previously had undergone periodic underburning or stand-replacement fire. The large-scale removal of slower growing, older trees was promoted with intensive thinnings of smaller dimension trees to reduce stocking and encourage rapid growth of wood fiber on the residual trees. The first clearcuts were performed in many areas of the east-side region during the 1970s, where stand replacement was deemed necessary for sanitation and faster rejuvenation of forests. Also, total tree-overstory removals became a common practice to harvest ponderosa pine trees that had stopped growing at increments acceptable to silvicultural guidelines for site capability and to allow better growth of residual trees. Thus, many acres of park-like ponderosa pine forests, which had become dense with grand fir, Douglas-fir, and pine saplings and pole-sized trees as a result of fire exclusion, were now converted, through management practices from pine dominance to greater dominance by fir species.

Fire was little used silviculturally during this period. If stocking was not adequate from the ingrowth under the older trees, nursery stock was planted. Seed-bearing trees generally were removed for wood instead of being left to provide future progeny. Without fire as a promoter of seedbeds for pine seedling establishment, these sites became more conducive to fir. In the 1980s, with stocking still too high for thrifty, vigorous trees and with forest composition different from the norm, the populations of insects, both defoliators and bark beetles began to occur.

Not all acreages, however, could be silviculturally treated. Thinnings lagged behind or were not scheduled on poorer growth sites. Consequently, the ingrowth of fir was rapid and widespread. Insects that normally occur as part of the natural processes of tree and stand mortality increased in stagnant stands where tree vigor had declined. Moreover, insects that prefer Douglas-fir and true firs proliferated in areas where the dense, slow-growing seedlings, saplings, and pole-sized trees were becoming available. Most importantly, however, fire in its normal, cleansing role, was not present in sufficient frequency or intensity to control the infestations. Drought in the 1980s only provided a boost to the growing populations of insect pests by weakening the natural defenses of the tree due to loss in vigor. Insect outbreaks historically occurred periodically, but the incidence, frequency, and extent have increased dramatically in the 20th century as fire was excluded from its role as a discriminating force against fir succession under pine-dominated stands.

Today, with many acres of severely diseased and defoliated trees throughout the eastside forests, the public has protested the management of both public and private forests.

Professional land managers and specialists have joined with natural resource scientists to determine how to improve forest health (Gast and others 1991). After several years of intensive study and communication, several initiatives have emerged to improve the forests.

Emphasis generally has shifted from management of even-aged and single-species stands to that of uneven-aged stand management, promoting seral fire species (ponderosa pine, Douglas-fir, and western larch (*Larix occidentalis* Nutt.)). Fire is being reintroduced (both naturally and by planned ignitions) into the forest ecosystem. Land management agencies have championed assessing and managing ecosystems rather than forest commodities and benefits .[4] [5] This ecosystem focus has diminished the emphasis on extractive activities and heightened the awareness of how sensitive various ecosystems are to management activities.

Part of the work of the 1990s and beyond will be to restore and rehabilitate landscapes and ecosystems. Some of the disturbances created during the accelerated extractive period were too severe for the sites and have caused successional shifts that took the vegetation beyond stages where later seral vegetation can return because either basic habitat elements (soil, water) or plant propagules have been lost.

Overgrazing as an Induced Disturbance

Livestock grazing has caused perhaps the most disturbance throughout the east-side region. The mobility of the various ungulates across western rangelands has affected almost all segments of the landscape to some extent, especially along watercourses, in basin meadows, and on ridgetops where stock driveways and bedding grounds were used for many years. The degrading of native vegetation on some sites has been so complete that a "new" potential vegetation has occurred. This "new" vegetation is usually either simpler biologically or composed of invasive, less desirable or noxious plants (Johnson and Simon 1987).

In 1911, the combined total for permitted sheep on the Wallowa and the Whitman National Forests was 301,000 animals. By 1940, the sheep using both Forests had declined to 111,000. Fifty years later in 1990, domestic sheep grazing on the Wallowa-Whitman National Forest had declined to 6,100 animals.[6] '

Sheep grazing practices were particularly detrimental to the vegetation. The annual migration and pattern and the duration of use created severe overgrazing on primary rangelands. The numbers of bands were large; the travel routes were the same annually; usage was extreme; and timing was often detrimental to the plants (annually a pattern of use reoccurred with use of plants before phenologic maturity and when the soils were still saturated from receding snowbanks). By the turn of the 20th century, many rangelands could no longer support the number of livestock that had used those areas before 1900 (fig. 4).

[4] Overbay, J.C. 1992. Speech at national workshop on taking an ecological approach to management. April 27, 1992. Salt Lake City, UT: On file with: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest, P.O. Box 907, Baker City, OR 97814.

[5] Robertson, F.D. 1992. News releases from the Chief of the Forest Service on ecosystem management of the National Forests and Grasslands. June 4, 1992. On file with: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest, P.O. Box 907, Baker City, OR 97814.

[6] Johnson Jr., Charles G. Unpublished range use data. On file with: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Wallows-Whitman National Forest, P.O. Box 907, Baker City, OR 97814.

The impact of deer and elk is almost the reverse of the domestic grazing history. Deer were numerous in the early 1900s, reached a peak about 1950, and declined. Elk on the other hand, occurred in only a few small bands in northeastern Oregon and southeastern Washington during the 1890s and early 1900s. Elk now have increased greatly throughout the Blue Mountains because of improved habitat conditions due to intensive harvest practices, improved livestock grazing management, and adaptation of elk to the varied topography.

Thirty percent of the lands administered by the Malheur, Umatilla, and Wallowa-Whitman National Forests are grasslands and shrublands, with 43 percent of the three National Forests being unsuitable for timber commodity production. With such a significant portion of the landscape comprised of nontimber-producing plant communities, the ecologic condition of these lands also should be addressed for a complete understanding of the current health of vegetation in the Blue Mountains.

According to accounts by land managers who experienced the peak years of domestic livestock use during the first 40 years of this century, our rangelands are recovering well and are in better condition now than in previous years. In many cases, however, the recovery is cosmetic or superficial. That is, although rangelands may look better, compositionally, the desirable late seral ("decreaser") perennial plants have been replaced by earlier seral plants ("increasers" or "invaders'. Examples of early seral grasslands are found on highly degraded ridgetops, flats, benches, and near water where ungulates habitually and historically have concentrated (fig. 5).

Examples of highly disturbed communities resulting from overgrazing sites that can support communities of climax Idaho fescue *(Festuca idahoensis* Elmer.) (Idaho fescue plant associations) are usually devoid of any bunchgrasses. Ridgetop communities, once dominated by fescue, are now growing simplified communities dominated by annual vegetation because of degradation caused by past overgrazing. Deeper soil fescue sites carry dense stands of cluster tarweed *(Madia glomerata),* which inhibits germination and establishment of other plants by exuding toxic resins (Carnahan and Hull 1962, Hull 1971). Shallower soil fescue sites may contain noxious populations of gumweed *(Grindelia* spp.*),* pussytoes *(Antennaria* spp.*),* or knotweeds *(Polygonum* spp.*).* Meadows have been severely affected in the Blue Mountains as well. Examples of invasive communities that have overtaken Blue Mountains wetlands are streamside terraces dominated by Kentucky bluegrass *(Poa pratensis)* and annual brome *(Bromus* spp.*)* grasslands. Incising the fluvial channel to greater depths as a secondary result of the overgrazing activities has reduced availability of moisture to the meadow vegetation and permitted invasion by more xeric plants (for example, sagebrush flats dominated by mountain and big sagebrush species *(Artemisia tridentata* spp. *vaseyana; A. tridentata* spp. *tridentata)* that were meadows before incision of the channel).

Native American and Euro-American Land Burning

Although the extent and intensity of fires before Euro-American settlement is unknown, accounts by fur traders, explorers, missionaries, and early immigrants say that fires were actively set throughout the east-side forests and grasslands to improve rangelands for livestock and to help in hunting game (Evans 1991). Early settlers also used fire to clear land and promote non-forest vegetation, irretrievably altering principal valleys where the combination of settlements and agricultural pursuits rapidly replaced the native vegetation.

The effect of settling the West was the gradual loss of the influence of fire in modifying vegetation. With the diminishing of the Native American presence and lifestyle in the late

Figure 5--Highly disturbed grasslands are found on ridgetops, flats, benches, and meadows and near streams and rivers where ungulates have historically concentrated. Ridgetop communities, once dominated by bunchgrasses, are commonly found growing more simplified plant communities dominated by annual vegetation. Cluster tarweed *(Madia glomerata*) is a noxious annual plant occurring on deep soil fescue sites (upper view). Reseeding of these sites is costly but can result in productive perennial grasslands (lower view).

1700s and early 1800s, and as meadows and grasslands were converted to farmlands by the immigrants, fire was gradually no longer a periodic modifier of the landscape. The young settlements were prone to destruction by fire, so fire prevention was politically motivated. That fire was an integral part of the natural cycle in the intermountain Pacific Northwest landscape was not recognized.

Fire provides an important regulatory role in the maintenance of rangeland vegetation in northeastern Oregon and southeastern Washington. The periodic burning of grassland foliage in late summer and early fall has helped stimulate vigorous new growth, consume decadent plants, and successfully thwart tree and shrub invasion in many grassland communities. The grazing animal and the incidence of fire have combined to shape the present grassland plant communities. Domestic herbivores influenced fire frequency, intensity, and distribution by removing of fine fuels capable of sustaining the spread of fire.

Other Induced Disturbances

Mining, railroad logging, road building, dams, and agricultural pursuits all combined to dramatically alter the east-side landscape. In particular, these activities often were conducted in streambottoms, along river terraces, and on the most fertile lands of the region. Where these activities occurred, native plant communities generally have been replaced by exotic or invasive communities.

Idaho Fescue Plant Associations

The following is an example of the relation between disturbances and community structure, composition, and distribution using a grassland plant association.

The bunchgrass vegetation of the canyons in northeastern Oregon provide a mosaic on a contorted landscape sculpted over geologic time by mass-wasting after Pliocene flooding of the Snake River and its major tributaries (Baldwin 1964). The grassland soils are highly variable. Canyon slope soil depths are strongly related to the proximity of buried basaltic flows or distance from eroding exposed rimrock. Bunchgrass community composition differs accordingly. The aspect of bunchgrass sites also influences the kind of vegetation that can establish on them, based on orientation to solar radiation and desiccating temperatures. The elevation of bunchgrass sites also contributes to the relation of temperature to moisture. Sites capable of supporting fescue plant association vegetation generally occur between extremes of 1,000- and 8,000-foot elevation (Johnson and Simon 1987). The relation with moisture availability influences the ability of fescue to persist at lower canyon elevations. Subsurface moisture emanating from the basaltic flows beneath the colluvium will often determine whether moisture is sufficient to sustain fescue communities.

Idaho fescue, bluebunch wheatgrass *(Agropyron spicatum* (Pursh)), and Sandberg's bluegrass *(Poa sandbergii* Vasey) are the most common native bunchgrasses in northeast Oregon. Of the three, fescue requires more abundant moisture and cooler temperatures than do the other two grasses (Daubenmire 1972). Therefore, where temperatures are warmer and soil moisture is less, plant communities representing bluebunch wheatgrass plant associations establish where the more sensitive fescue communities are unable to persist. Sandberg's bluegrass plant associations are found on shallow, dry, warm sites where soil depth and moisture are insufficient for establishment by the larger bunchgrasses (Johnson and Clausnitzer 1992).

Natural Disturbances as Modifying Events in Community Structure, Composition, and Distribution

As with the vegetation as a whole in east-side plant communities, Idaho fescue bunchgrass communities rely on periodic disturbance to rejuvenate and maintain vigor and vitality of the associated plant composition. The following events are ongoing and cyclic within bunchgrass communities of Idaho fescue plant associations.

Soil and slope movement—Most of these communities reside on steep colluvial slopes or on gentle ridgetops. The steep colluvial slopes are in constant movement. "Stable," late seral bunchgrass communities have demonstrated 3- to 5-foot downslope movements over 15 to 20 years on 40- to 60-percent slopes. These movements were detected by realignment of fixed transects across slopes from anchor positions at rim outcrops. On gentle slopes and ridgetops, fescue communities also dominate where soil movement results in 10- to 15-percent bare ground with up to 50-percent rock and gravel on the surface. These bare patches are prone to frost heaving in the early spring after the late winter period of saturation and then freezing and thawing of the soil mantle.

Fire—Ignitions of fire by late summer and early fall thunderstorms historically burned across these bunchgrass slopes with a haphazard, interfingering extension based on daily temperatures, wind velocities, and the microrelief of the slope. Fire was not uniform in its effects on the vegetation. Areas were burned intensively where standing biomass was dense and grass crowns were dry. In other areas, burns would be rapid and leave the crowns of the grasses living to provide new tillers and sprouts with the onset of fall moisture. Of the three primary bunchgrasses, fescue is considered the most sensitive to fire. When the most mesic fescue associations burn intensely, associated forbs are promoted, and succession regresses to earlier stages, where forbs dominate until the reemergence of bunchgrass dominance in later successional stages. Natural fire regimes tended to burn about every 10 years in open forest stands of the southern Blue Mountains (Hall 1980). The periodicity of fire on bunchgrass vegetation was probably as frequent and had minor effects on the plant composition. When fires burn across the fescue-bearing landscapes today (after decades of fire exclusion by humans) the effect of the burns is greater because of the buildup of dry, dense litter in the bases of the grasses.

Grazing—The modification of climax fescue communities has been greatest where grazing animals have had easiest access to the rangeland. In northeast Oregon canyons, fescue provides an early succulent plant for the grazing ungulate. Fescue is preferred over the taller bluebunch wheatgrass plant by elk, cattle, and sheep in spring. Because soils are often wet in spring, early grazing on fescue tends not only to consume the foliage but also to dislodge plants from the ground. Perhaps the greatest detrimental grazing practice, which has caused the vigor of bunchgrass to decline, has been use by ungulates too early in the season and for too many sequential early seasons over time.

After continued pressure season after season, the stand of bunchgrass dies. As degradation continues in fescue communities, other plants tend to increase or invade to "heal the wound." Plants that increase are perennial (orbs and grasses and annual forbs and grasses.

Because grazing causes structural and compositional changes to the fescue community after overuse and abuse, the community, which was dominated by bunchgrass in late seral stages, has forb-grass codominance in midseral stages and simpler communities dominated by either annual grasses or forbs in early seral stages.

[7]Johnson Jr., Charles G. Unpublished trend data. On file with: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest, P.O. Box 907, Baker City, OR 97814.

Grazing, like fire, can be a stimulus to the bunchgrass plants and provide a natural, beneficial role to plant vitality and community stability. The key to maintaining and enhancing bunchgrass communities lies in the timely use of plants and moderate use of the community. Studies have shown that early and repetitive use before seed set injures bunchgrass plants (Blaisdell and Pechanec 1949, Mueggler 1974, Pond 1960). Different classes of ungulates tend to graze the bunchgrass community preferentially seeking different plant species within the community. This variety can benefit the vigor and vitality of the total vegetation.

Management-Induced Disturbances of Idaho Fescue Grasslands

Idaho fescue grasslands form a natural mosaic caused by topographic landform undulations that in turn produce microclimates promoting different grassland structures and compositions. Added to this diverse landscape are the superimposed modifications by past disturbances that have combined to form various sera) stages across the land. All this variety is desirable ecologically. Pristine grasslands (where lack of disturbance has resulted in late sera) vegetation dominated by bunchgrasses to the virtual exclusion of other plants) may provide the best forage for grass-eating ruminants. The greater diversity in plant species composition in midseral stages of fescue plant associations, however, may provide the most balanced offering to all users of the grasslands (Thomas and Towel) 1982; fig. 6). The early and very early sera) stages of fescue grasslands that have increased as a result of earlier use by land managers are the cause for concern to land managers today.

Many sites capable of supporting Idaho fescue bunchgrass communities are so modified that they appear to be bluebunch wheatgrass or Sandberg's bluegrass climax communities, or they have been so thoroughly degraded that they contain no bunchgrass vegetation. Management for the next century must focus modern restorative techniques on these degraded sites. Some of our grassland communities are so degraded that attempts at rehabilitation may be in vain. The principal problem beyond economics is the ability to protect restoration efforts from wild grazing animals long enough to establish the new community.

Introduction of Exotic Grass Species

Intermountain Pacific Northwest grasslands have had repeated rangeland improvement seedings to rectify the damage of the past. Most of these seedings have failed because of the use of highly preferred grass species that ungulates grazed as soon as they germinated. Also, some seeded exotic species were inappropriate for the environment. The restoration of the grasslands, as well as efforts in other vegetation, should rely on the use of native species, especially those midseral and early sera) species that are naturally promoted by disturbances. In other words, the forbs and grasses dominating in early sera) and midseral stages are most likely to respond and be maintained on a degraded site. Native plant species would be our best choices for successful restoration of grassland ecosystems. Local nurseries probably will need to be developed to provide the necessary seed from local populations.

Alien Invasion and Naturalization

The fescue-dominated grasslands of northeastern Oregon have diminished. The gentle benches and ridgetops have been severely affected by the plow and grazing animals. Alien forbs and grasses have become so firmly established that natural succession to native bunchgrass vegetation is impossible without intervention by land managers. Examples of invasion can be found in cluster tarweed monocultures growing on deep, fertile ridgetop soils completely replacing native vegetation. Other ridgetop locations may appear on first inspection as thin-soil scablands. An example is a onespike oatgrass *(Danthonia unispicata* Thurb.) dominated stand found on deep soils of fescue sites where severe overgrazing has all but eliminated deep soil bunchgrasses in favor of the shallow-rooted bunchgrasses (such as onespike oatgrass) as moisture retention is diminished.

Figure 6-The fescue-dominated grasslands form a natural mosaic on a canyon slope. This mosaic is the result of topographic landform undulations with superimposed modifications provided by past disturbances (fire, grazing, and slumping of soil). The result is a highly desirable display of varying seral stages with shrub-grass communities providing a balanced offering to all grassland and shrubland users.

Perhaps the most degraded fescue sites are found on the structural benches of the Snake, Imnaha, and Grande Ronde River canyons. These gentle benches (less than 20-percent slope) result from differential erosion of two prominent basaltic formations. These benchlands contain deep, clayey soils with abundant moisture where springs and seepages are many. Therefore, homesteaders, early ranchers, sheepherders, and wild ungulates all converged on these benches for the available water, lush vegetation, and ease of movement.

Today the bunchgrasses are absent or nearly so on the benches. Kentucky bluegrass has become the primary invasive species to dominate these sites, but red three-awn (*Aristida longiseta* Steud.), annual bromes (cheatgrass *(Bromus tectorum* L.*),* Japanese brome (*B.* japonicus Thunb.), rattlesnake brome *(B. brizaeformis* F. & M.), and goatweed *(Hypericum perforatum* L.*)* all may be found in large patches throughout these benchlands (Johnson and Simon 1987).

Presettlement vegetation cannot be brought back on these sites. Attempts to do so would require the impossible task of ridding the grasslands of all naturalized aliens, the most notorious of which is cheatgrass. Virtually all plant communities in the canyons contain this species along with one or two other naturalized aliens. It would be wise to rebuild biological diversity of the plant community by adding earlier sera) forbs and bunchgrasses.

Biological Diversity Considerations

The forests of the Blue Mountains are dominated by coniferous tree species today. Landscape-modifying events (especially fire) that develop patches of earlier seral vegetation, however, have stimulated shrub and hardwood species to greater prominence in the forests of the past. As the role of fire to modify the landscape has been reduced or eliminated, hardwood tree and shrub populations have been reduced by loss of light, ground water, and nutrients used by the dominant coniferous tree species (Riegel and others 1992).

Hardwood trees and shrubs are complementary to the biological diversity of the forested landscapes. Shrublands and hardwood trees add a vital dimension to the overall complement of wildlife occupying the forest, to ecotonal areas between nonforest and forest communities, and to improving soil fertility through valuable nutrient cycling. As the richness of the forest plant community increases, there is a corresponding increase in birds, mammals, and other fauna.

To achieve long-term biodiversity goals, management needs to imitate both the natural heterogeneity of the physiographic setting and the natural pattern of disturbances inherent on the landscape. A difficult task, however, is assessing when, where, and how to conduct management activities that promote the landscape heterogeneity envisioned for the desired future condition of associated stands.

A balance must be found between the total lack of perturbational events (whereby no activities for promoting vigor, vitality, or diversity are implemented) and the combination of natural and human-caused disturbances that are conducive to improving the three primary diversities–genetic, species, and landscape. To accomplish this, land managers need to do the following: (1) emphasize the management of ecosystems (as opposed to the stand-emphasis of the past); (2) recognize that the harvest of larger overstory trees results in a loss of structural, compositional, and functional landscape diversity when implemented at a scale that provides an even-aged expanse across the landscape; and (3) understand when, and avoid letting, plant communities reach an irreversible threshold.

The condition of the Blue Mountains must be assessed regularly. Therefore, management-induced changes to improve the health of the plants, stands, communities, and landscapes require a more intensive level of monitoring community change over time. Documentation of the changes from permanently established locations designed and installed for long-term followup and assessment is critical to the success of strategic planning and implementation. Monitoring needs to be cyclic and consistently accurate for timely and reliable results.

By emphasizing landscape-level planning and project implementation in the Blue Mountains, the current harvest of coniferous tree species by insect defoliators should diminish over time. As the acreage burned increases, the landscape should become less prone to widespread, higher intensity fires. By increasing the proportion of hardwood trees and shrubs, forbs, grasses, and sedges to coniferous trees across the Blue Mountains, the vitality of the plant communities will be strengthened with a concurrent enhancement of biological diversity. Planning needs to incorporate management of species and see that the position of the natural and created patches do not fragment the overall vegetation such that important corridors are lost to the flow of faunal species and genetic pathways. The restoration of the various ecosystems of the Blue Mountains will be successful when we understand, and are sensitive to, the components of each ecosystem and how they are part of interconnected processes impacting plants, animals, soil, water, and humans.

Sustaining East-Side Vegetation

The east-side landscape has been modified by disturbing agents and activities. Some of these modifications are natural to the ecosystems and are part of the process of ecosystem maintenance. Other modifications have been induced by human activities on the landscape; Euro-Americans have had the greatest impact over the past century. The principal question that land managers ask about maintaining or enhancing ecosystems is: what can be done without surpassing the capacity of the sites to rebound toward desirable successional pathways from highly disturbed communities? In other words, At what point has a particular site, or complex of sites, been so severely affected as to be unable to respond to enhancing activities (Laycock 1991)?

Variables that influence thresholds also determine the capacity of a site to develop a particular kind of plant community. Soil fertility, moisture and temperature variation, and presence of disseminules are the main factors influencing plant community development. When some modification degrades a site, any or all of these factors may be negatively affected. For example, continued overgrazing of a late seral bunchgrass community will increase the percentage of bare ground exposed to erosion. Premature grazing may compact the soil through trampling. Moisture availability may be curtailed earlier than normal in the growing season because of removal of standing herbage and subsequent loss of shading by growing foliage and litter (both of which have been removed by overgrazing). The lack of standing foliage and the loss of litter also cause the microsite to become too warm for plants that require cooler, moister conditions. Likewise, lichen and mosses, which often occur between rocks, gravels, and plants on the soil surface, are affected by trampling from grazing animals. As disturbance increases, the microclimate of the ground surface changes. Temperatures become lethal to mosses and lichens on the site. Additionally, the severe effect of overgrazing of the bunchgrass foliage results in the inability of the plant to produce seed. The plant itself is too weakened to send out new tillers. The moisture-temperature relation has changed such that the plant species is no longer sustainable on the site.

This scenario is one that has occurred not only in bunchgrass communities, but also on sites supporting shrublands, forests, and wetlands. Some sites are incapable of response after the cessation of a degrading activity. The vegetation cannot return to a structure and composition similar to the original climax community on the site. Therefore a "disclimax" is created by the degrading activities. To regain a semblance of the original vegetation on the site, people must now intervene at great expense in time, energy, and cost.

The key to planning restoration of these ecosystems resides in our ability to maintain its functions as we create changes through disturbances (Diaz and Apostol 1992). To begin to understand ecosystems requires the talents and wisdom of trained professionals, experienced technicians, and leadership of an interdisciplinary team. This team must understand that information is insufficient to make decisions correctly on behalf of all ecosystem components. It also must understand fully those processes the ecosystem requires to maintain itself in light of the modifications being planned. Decisions must therefore be made to avoid errors that would take the system beyond a self-sustaining threshold.

Passive management is not the best choice after the long tenure we have had administering the land. Improving degraded ecosystems and landscapes will require active use of tools and techniques, including those still being developed. The key will be to shift from functionalism to multifunctional projects performed on a large scale. Degraded landscapes and vegetation in the Blue Mountains cannot be improved without planning, conducting, and monitoring enhancement-oriented projects at a landscape scale.

The State of the Landscape on the East Side

After more than a century of active land management, the various ecosystems and plant communities that constitute the intermountain Pacific Northwest are in need of nurturing assistance. In comparison with other sectors of the United States and other countries in the World, this part of the planet is in a relatively natural condition: we have not placed entire provinces of the region under intensive agriculture, nor have we converted large segments of our forested landscape to subsistence agricultural pursuits; we have not displaced a great number of plant and animal species to the point of extinction; and our human population has not yet overwhelmed the region to the extent of making quality of life unacceptable to most of its occupants.

We must realize, however, that the pressures exerted by society can cause our vegetation, natural resources, landscapes, and ecosystems to be overexploited and forever modified. We must, therefore, immediately begin to focus on the landscape by emulating the disturbances that have created and shaped the plant communities; by actively initiating large-scale projects that use modifying events to enhance the combined plant communities of the included ecosystems; and by ceasing destructive activities that do not replace elements required by the ecosystem to sustain itself.

Conclusions

People observe succession in a life span that is equivalent to a few frames in a motion picture. We have envisioned idealized stable cycles and classified vegetation into artificial units based on our perceptions of how plants interact competitively over time. We have imagined the forest and grasslands primeval as pristine vegetation. Paleovegetation studies have shown that vegetation has changed dramatically in composition and extent in the intermountain Pacific Northwest over the past 20,000 years (Johnson and others 1993). The forest and steppe plants have responded rapidly to environmental disturbance. Change is continual and unpredictable, and climatic shifts will continue to exert a large influence on the forest and non-forest interface in the future.

Successional pathways depict the probable course of community development within a framework of defined community types for a disturbance regime. Altered abiotic and biotic interactions may lead to different responses by individual plant species and the identification of different successional pathways. Knowledge of plant succession is the foundation of a sound vegetation management program with the primary goal of retarding, arresting, or accelerating the natural forces of vegetation change. Many investigators have studied community responses to a single disturbance; now the variations of community responses to different disturbance regimes must be studied (Johnson and others 1993).

Both natural and human disturbances have long-term influences on the appearance and species composition of east-side vegetation. The long-term consequences of natural disturbances are, for the most part, enhancing to biological diversity. The natural disturbances which created the vegetation need to be reintroduced and used with the clear understanding of probable responses by the current vegetation. The scale of the modifying events and activities needs to shift from species and stand to the landscape scale. Activities that do not replace elements and processes needed for maintaining and enhancing ecosystems must be curtailed.

Recommendations

The following are recommended actions we should take to reintroduce fire into the ecosystem, enhance biological diversity, restore rangelands, and begin practicing landscape ecological management in the Blue Mountains.

1. Reintroduce fire into the ecosystem

- Use prescribed natural fire and manager-ignited prescribed fire when they are considered to have an ecological value to the overall landscape. Because fires tend to burn haphazardly and with different intensities, the results would provide a varied mix of unburned, lightly to moderately burned, and high-intensity burned vegetation containing a mix of species, ages, and structures. Promote hardwood trees and shrubs to improve diversity of composition, structure, and distribution.

- Collect, store, and evaluate fire effects data from prescribed fire projects and after natural burns. Learn from burning programs. Information about response of vegetation after fires of differing severities and frequencies will be needed to improve prescribed fire techniques for Blue Mountain landscapes.

- Provide public education programs with messages that foster a change in thinking regarding the vision of the healthy forest. Use public involvement sessions and actively employ the media to promote the natural role of fire as a key ecosystem component necessary for balance in the forest, grassland, and shrubland ecosystems of the Blue Mountains. Revise the fire prevention messages, and campaign to show that fire, when used wisely, carefully, and effectively, has an important role in protecting and promoting a healthy and productive forest. Provide the visitor to the National Forests with information explaining that particulates in the air are as natural to the mountains of northeast Oregon as the vegetation that cloaks them. Demonstrate the reduction of high fuel loadings by combined tree thinning and prescribed burning practices designed to lower fire intensity and control the extent of burn.

- Seek legislative help at state and Federal levels for greater use of fire and smoke management as a natural part of the environment in the Blue Mountain area. Develop the concept of the Blue Mountains landscape containing patches of early seral vegetation, openings, blackened trees, snags, brushfields, and stately older trees as a more natural, healthy landscape than one composed of homogeneous green expanses.

- Establish demonstration areas in the Blue Mountains to conduct intensive monitoring, evaluate postburn effects, and test application of fire when results are still uncertain. The approach toward managing ecosystems involves many unknowns, some of which will be known only long after the practitioner has left the scene. A structured monitoring process and ongoing evaluation of all effects of fire will be crucial to the ability to plan and implement those activities that achieve desired biodiversity.

- Use prescribed fire to an extent that emulates its historic role in modifying and rejuvenating the vegetation of the Blue Mountains. Existing vegetation patterns and known fire tolerances of certain plant species indicate that the historic role of fire in the Blue Mountains ranged from low-intensity surface burns to total stand replacement burns. A similar array of burns will be necessary if we wish to achieve the vegetational mosaic historically common to the Blue Mountains. Due to the long period of fire exclusion, however, the reintroduction of fire to these ecosystems must be performed under tight prescriptions to achieve the desired plant composition and structure. Silvicultural pretreatment of forest stands may be necessary to reduce the fuel loading and eliminate ladder fuels for successful underburning programs.

2. Enhance biological diversity in the Blue Mountains

- Instill a fundamental resource ethic that values ecosystems. The understanding of ecosystem functions and processes is a challenging task for any scientist or land manager. Collectively, groups of scientists, specialists, and land managers can make decisions and devise projects that consider a broad spectrum of ecosystem elements. Then through adaptive management, the understanding of processes, cause and effect relations, and critical elements of ecosystems can be better understood.

?? As part of a comprehensive landscape based plan, employ modifying activities that can be used to change species composition and stand structure in a mosaic of age classes, seral stages, and patches that emulate the natural size and shape of the landscape.

3. Restore rangelands

?? Improve biodiversity of the Blue Mountains rangelands by initiating enhancement projects to reintroduce native decreaser species on those sites capable of supporting them. Decreaser species are those most frequently sought and often overgrazed to the point that plant density declines.

?? Continue to build a rangeland vegetation management philosophy and attitude among rangeland managers. The caretaker attitude for maintenance and enhancement of rangeland vegetation is fundamental to improved grasslands through aggressive rehabilitation and restoration projects and firm permit administration.

?? Discontinue practices and operations that are detrimental to the natural ability of the land to sustain itself. Consider all future options relative to a given rangeland and its native vegetation and animal communities so that future generations can have choices as to how to manage the land for diverse offerings and inherent potentials.

4. Practice ecological landscape management

?? Emulate natural disturbances to achieve predictable vegetation composition and structures by using management activities that are sensitive to the capability of the native vegetation to respond to the treatments.

?? Design projects to encompass the various plant communities that make up a landscape. Create patches that imitate the natural sizes and shapes inherent in that landscape. Plan for positioning of patches to retain important corridors for genetic and wildlife flow within the elevational and horizontal dimension of the landscape.

?? Analyze the land from an "area" perspective to begin viewing vegetation as part of a landscape. Use teams of specialists and managers to address the complex values inherent in the various ecosystems of the project area.

5. Restore the Blue Mountains

?? Promote the use of native species, especially those midseral and early seral species that are naturally promoted by disturbances. These are the most likely to respond and establish on degraded sites.

?? Mimic both the natural heterogeneity of the physiographic setting and the natural pattern of disturbances in the landscape in project planning, design, and layout.

?? Design monitoring as a primary activity requiring on-the-ground sampling of the ecosystem components before and after projects designed to enhance biological diversity and improve ecosystems.

?? Success will have been achieved when we understand, and are empathetic toward, the components of each ecosystem and how they are part of interconnected processes impacting plants, animals, soil, water, and humans.

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Natural disturbances are important to ecosystem processes. Disturbances historically have occurred in the vegetation of the Blue Mountain area of northeastern Oregon and southeastern Washington. The primary modifying events that historically have cycled through most of its plant communities are fire, grazing and browsing, insect and disease epidemics, windthrow, flooding, and erosion. Knowledge of plant successional pathways enables managers to predict the probable course of community development for a disturbance regime. Recommendations for restoring the Blue Mountains area are to reintroduce fire into the ecosystem, restore rangelands, and enhance biological diversity by practicing landscape ecological management and by emulating natural patterns on the landscape. Periodic and timely sampling after these activities is critical to assessing the results for adaptive management needs.

Keywords: Disturbance ecology, landscape ecology, fire, prescribed fire, grazing, browsing, ecosystems.

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