Project Title: Restoration of dry, montane meadows through prescribed fire, vegetation, and fuels management: A program of research and adaptive management in western Oregon

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Abstract

In many regions of the western U.S., long-term suppression of wildfire has facilitated encroachment of natural meadows by conifers. Encroachment is widespread on many dry, montane slopes in the western Cascade Range. In a region dominated by coniferous forests, montane meadows contribute greatly to landscape diversity, wildlife habitat, and many other ecological functions and societal values. Faced by gradual loss of these critical habitats, resource managers have begun to experiment with prescribed fire as a tool for meadow restoration. With limited knowledge of the historical role of fire in these systems, managers have little information to guide restoration efforts. We propose a program of experimental research, adaptive management, and outreach that will contribute to our understanding of the natural dynamics of these systems, to their restoration and maintenance, and to public appreciation of the roles of scientists and land managers in restoring ecosystem health. We bring together scientists and resource specialists with a long, successful history of collaboration to develop a demonstration center at Bunchgrass Meadow on the Willamette National Forest, Oregon.

We propose two integrated studies at Bunchgrass. The first—which documents the history of invasion and the current range of vegetation conditions—provides the historical and ecological contexts for the second, primary study, which evaluates vegetation responses to experimental restoration treatments. Thinning and prescribed burning will be implemented across replicate sites representing the full range of vegetation conditions at Bunchgrass. Permanent transects and nested plots sampled prior to treatment will be used to assess changes in species composition and diversity, mortality of residual trees, and establishment of conifer seedlings. Uni- and multivariate statistical techniques will be used to explore the nature and range of vegetation responses, and to identify the initial conditions that lead to successful outcomes. We have designed these studies to yield useful short-term products for scientists, managers, and the public, and in doing so, to provide opportunities for ongoing research, experimentation, and education. Our goal is to build a solid basis for successful restoration of meadows throughout the western Cascades, using Bunchgrass Meadow as a regional center for research, adaptive management, and outreach.

1. Introduction

1.1. Project Justification. Dry, montane meadows comprise a small portion of the western Cascade landscape, but serve a host of important ecological and societal functions. In a region dominated by dense coniferous forest, montane meadows create natural fire breaks, support distinctive plant and arthropod communities (Hickman 1968, Halpern et al. 1984, J. Miller pers. comm.), provide habitat and summer forage for wildlife, and offer unique recreational opportunities. Decades of fire suppression coupled with historical changes in climate and land use, are leading to widespread encroachment of conifers into dry meadows of the Pacific Northwest, with profound consequences for local and regional biodiversity. Faced by gradual loss of these important habitats, land managers have begun to experiment with prescribed fire as a potential restoration tool. On the Willamette National Forest, Oregon, experimental burning in relatively open meadows has met with equivocal success. Although tree mortality has been achieved in some areas, little effort has been devoted to monitoring changes in vegetation or subsequent establishment of conifers. As a consequence, it is unclear whether meadow restoration is possible when there has been significant encroachment of conifers—where native plant communities have been degraded and fire effects are likely to be more severe. With limited knowledge of the historical role of fire in these systems, managers have little information to guide future efforts at meadow restoration. In this proposal, we propose a program of research, adaptive management, and outreach to fill these gaps in knowledge. We suggest that successful restoration will require: (1) improved understanding of the history of conifer encroachment and its consequences for meadow composition and structure, (2) experimental studies that quantify the range of potential responses to prescribed fire and fuel reduction treatments, (3) collaboration and information sharing between researchers and managers, and (4) a process of adaptive management by which experimental outcomes guide new approaches to restoration.

A unique opportunity exists at Bunchgrass Meadow, a 100-ha Special Habitat Area on the McKenzie District of the Willamette National Forest, to develop a program of research, adaptive management, and outreach that will contribute to our understanding of the ecology and dynamics of these systems, to their rehabilitation and maintenance through use of fire and fuel reduction treatments, and to public appreciation of the roles of scientists and land managers in restoring ecosystem health. We initiated this research-management collaboration in 1999, with a series of small grants from the National Science Foundation–Long-term Ecological Research (LTER) Program and regional non-profit organizations interested in restoration of native plant communities (Halpern 1999). In this proposal, we outline a comprehensive program of study to examine the ecological outcomes of current approaches to meadow restoration in the region. We address elements of Tasks 2 and 3 of the *Joint Fire Sciences Program RFP*, with a focus on local biological effects of fire and fuels treatments (*Task 2*) and effects of fire on endemic flora (*Task 3*) in dry meadows of the western Cascade Range. Our study is designed to yield useful results within the project timeframe, and in doing so, to initiate opportunities for long-term research, adaptive management, and public education.

We bring together a team of scientists and land managers with a long and successful record of research-management partnerships and technology transfer. These include researchers and resource specialists from the Andrews Experimental Forest (http://www.fsl.orst.edu/lter/), the Cascade Center for Ecosystem Management (http://www.fsl.orst.edu/ccem/), and the Central Cascades Adaptive Management Area (http://www.edo.or.blm.gov/ccama/). Our goal is to build a solid ecological basis for successful restoration of meadows throughout the western Cascades, using Bunchgrass Meadow as demonstration site. Given considerable investment to date in a resource management plan, a large and diverse mosaic of forest and meadow amenable to experimentation, and its accessibility to both research scientists and the public, Bunchgrass Meadow can serve as a regional center for meadow restoration research and adaptive management. We seek to develop and demonstrate a working model of adaptive management in which we test underlying assumptions, design experiments to evaluate alternative strategies, and modify management approaches to achieve resource objectives.

1.2. Project Objectives. The objectives of the proposed work are:

Research:

- to establish reference conditions for evaluating restoration treatments, by reconstructing the history of conifer encroachment at Bunchgrass and describing associated changes in meadow composition and structure (Study 1);
- to quantify vegetation responses to experimental restoration treatments (Study 2).

Adaptive management and outreach/education:

- to identify the existing communities under which restoration treatments produce either successful or undesirable outcomes; and, if necessary,
- to suggest alternative approaches to restoration for future experimental evaluation;
- to communicate these findings with federal, state, and tribal land managers and others, through various media, field trips, and workshops.

1.3. Background. Our research-management partnership has an established record of research on natural and prescribed fire in Northwestern forests, and on application of ecological knowledge to resource management (Cissel et al. 1999). Dendrochronology (Teensma 1987, Morrison & Swanson 1990, Weisberg 1998), paleoecology (Sea & Whitlock 1995), archival research (Burke 1979), and long-term successional studies (Halpern 1988, 1989) have been used to interpret fire history and to understand the ecological effects of fire in forests and watersheds. Studies of prescribed fire in meadow ecosystems will add to this portfolio of research, management, and education.

1.3.1. History of conifer encroachment into dry, montane meadows. Although direct evidence for natural or anthropogenic burning is sparse, dry montane meadows in western Oregon likely owe their origin and maintenance to fire (Vale 1981, Teensma 1987). Dendrochronological research indicates that prior to suppression, fires of variable frequency, intensity, and spatial extent occurred at intervals of 95-150 yr (Teensma 1987, Morrison & Swanson 1990, Weisberg & Swanson in press), but probably less often at higher elevations (Agee 1993). Historical documents suggest that native Americans and, subsequently, sheep herders burned montane meadows to increase forage (Burke 1979, Vale 1981). However, with cessation of sheep grazing (Rakestraw & Rakestraw 1991), regional changes in climate, and exclusion of wildfire, conifer encroachment has become widespread. Triggered by release from intense grazing pressure of the previous decades and by an extended period of cooler, wetter weather, conifer seedlings began to invade many dry-site meadows in the 1940s and 50s (Vale 1981, Miller & Halpern 1998) (see **Fig. 1,** below). In many locations seedling recruitment has accelerated with time, facilitated by a "positive feedback" mechanism in which established trees modify the conditions that once inhibited establishment—by shading out competitive grasses and forbs (Magee & Antos 1992) and by introducing local sources of ectomycorrhizal fungi into soils deficient in these symbionts. Biotic and abiotic conditions have been so altered in some meadows that invasion has continued even during periods of relatively unfavorable climate (i.e. warmer, drier weather).

1.3.2. Consequences of conifer encroachment for meadow composition. In many locations in the western Cascade Range, conifer encroachment has drastically reduced the areal extent of meadow and greatly diminished the vigor, abundance, and diversity of native meadow plants. For example, permanent plots at Bunchgrass Meadow indicate that the abundance and richness of meadow forbs and graminoids are markedly reduced in areas that support a tree canopy (see **Table 1**, below) (Halpern 1999). Cover of graminoids averages 75% in meadow openings, but is reduced to <30%

where trees have established. Meadow forbs show a similar trend, with many taxa showing marked declines in frequency, or even local extirpation.

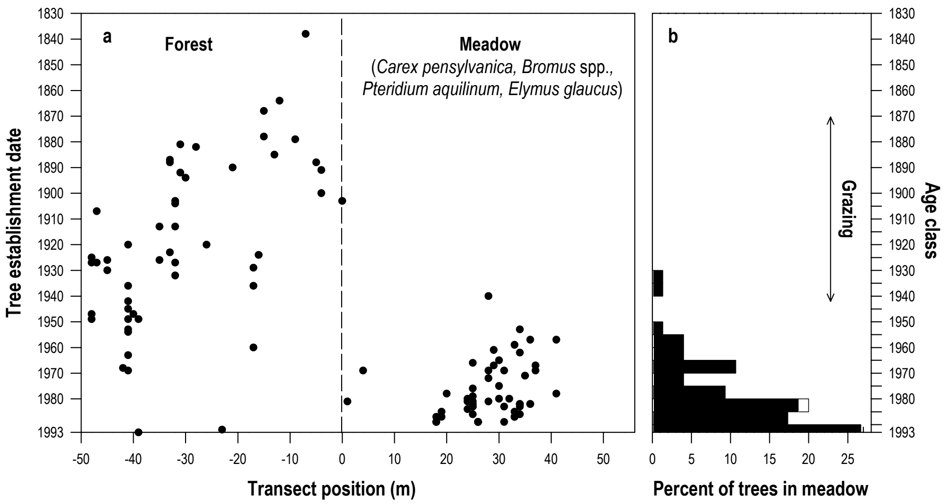

Figure 1. Three Sisters Wilderness, Oregon: Spatial and temporal patterns of conifer establishment across a SW-facing forest/meadow ecotone at 1500 m elevation. **(a)** Dates of establishment vs. distance from forest edge (vertical dashed line); transect is 10 m wide. **(b)** Age structure of trees in the meadow. Species are grand fir (solid bars) and Douglas-fir (open bar). The period of sheep grazing is defined by the two-ended arrow. (From Miller & Halpern 1998).

Table 1. Bunchgrass Meadow: Frequency (%) and cover (%) of common meadow species in areas without (Meadow) and with tree cover (Forest). Forest locations were sampled with 127 plots (1 x 1 m) and meadow with 210 plots. Only species with frequency ≥10% in meadow plots are shown. Cover of growth forms is the sum of all species (including those not listed).

	Meadow		**Forest**			**Meadow**		**Forest**	
Species	**Frq**	**Cov**	**Frq**	**Cov**	**Species**	**Frq**	**Cov**	**Frq**	**Cov**
Grasses and sedges		**74.6**		**28.4**	*Hieracium gracile*	72	4.6	—	—
Carex pensylvanica	98	25.0	48	4.6	*Fragaria* spp.	58	14.8	87	9.4
Festuca rubra	96	27.6	20	4.1	*Aster radulinus*	49	5.7	89	1.4
Bromus carinatus	88	8.6	43	3.0	*Phlox diffusa*	45	9.1	4	0.5
Danthonia intermedia	69	3.0	—	—	*Iris chrysophylla*	42	2.5	20	0.9
Festuca idahoensis	54	2.8	9	0.5	*Commandra umbellata*	37	0.5	—	—
Elymus glaucus	54	4.8	50	15.7	*Erigeron aliceae*	34	2.0	15	0.2
Agropyron repens	38	1.3	3	0.1	*Viola nuttallii*	25	0.2	2	0.0
Stipa occidentalis	28	0.8	—	—	*Arenaria macrophylla*	24	0.5	89	1.4
Agrostis scabra	18	0.1	13	0.4	*Orthocarpus imbricatus*	23	1.4	—	—
Forbs and sub-shrubs		**66.3**		**53.2**	*Lathyrus nevadensis*	15	1.7	60	5.1
Achillea millefolium	94	8.7	41	1.4	*Pteridium aquilinum*	15	4.6	13	1.7
Lupinus latifolius	74	5.5	3	0.1	*Rumex acetosella*	10	0.1	20	0.4
Cirsium callilepes	68	1.7	30	0.9					

With growing concern for loss of these habitats, land managers on the Willamette National Forest are beginning to experiment with thinning and prescribed fire to restore the areal extent and natural diversity of meadows. Although broadcast burning has a long history of application in the region, and the consequences for forest understory communities are fairly well understood (Halpern 1988, 1989), application of fire to meadow ecosystems has received limited attention. In the following sections, we outline research that tests the efficacy of current approaches to restoration (i.e. fuel reduction with prescribed burning).

2. Materials and Methods

2.1. Study Area. Bunchgrass Meadow occupies a gently sloping plateau at an elevation of 4000 - 4500 ft (1220-1375 m) along the western slope of the Cascade Range (44°17'N, 121°57'W) (**Fig. 2)**. It supports a large (250 acre/100 ha) and diverse mosaic of forest and dry meadow. Bunchgrass was designated as a Special Habitat Area in the 1990 Willamette N. F. Land and Resource Management Plan and was targeted as a high priority restoration project during the Upper McKenzie Watershed Analysis (1995). The primary objectives in the management plan include: (1) improving wildlife use by enhancing forage quality and abundance, (2) reducing excessive fuel loadings, (3) maintaining and restoring grass- and forb-dominated communities and associated ecological processes, and (4) protecting and preserving historic and prehistoric heritage resources (Wilson et al. 1999).

In the distant past, indigenous Molalla Indians used fire to encourage forage for wildlife and to enhance cultural plant resources; from the late 1800s to the 1920s the Warm Springs tribe grazed ponies and used fall burning to maintain open meadows. Aerial photographs dating back to 1946 indicate that, although portions of Bunchgrass supported mature forest for much of the 20^{th} century, many former meadows have been filled by encroaching trees (**Fig. 2**). Older forest islands are dominated by grand fir (*Abies grandis*), with lesser amounts of Douglas fir (*Pseudotsuga menziesii*) and lodgepole pine (*Pinus contorta*); recent encroachment is primarily by lodgepole pine and grand fir. Where meadows have not been invaded by trees, ground-layer communities are vigorous (mean of 140% total plant cover) and diverse (mean of 13.2 species per m^2), and dominated by perennial forbs, grasses, and sedges (see **Table 1**, above; Halpern 1999). Several non-native plant species are present, but contribute minimally to plant cover and diversity.

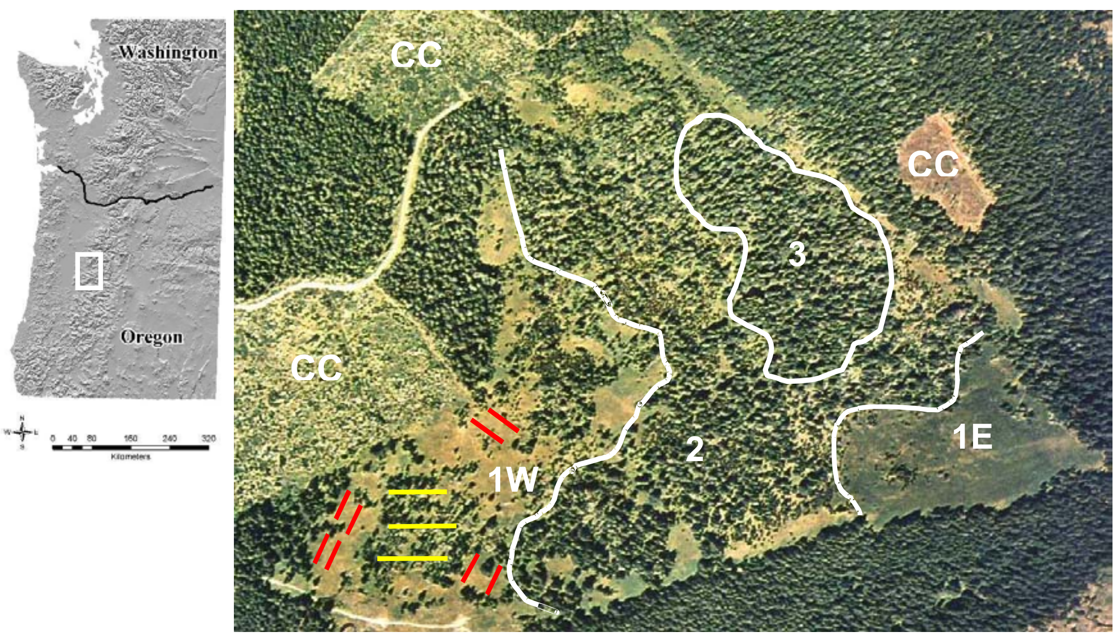

Figure 2. Bunchgrass Meadow: Location of study area, and a 1990 aerial photograph of the forest-meadow mosaic. Zones 1-3 (defined in the Special Habitat Area Management Plan; Wilson et al. 1999), reflect broad differences in invasion history (see **2.1. Study Area**). Permanent transects were established in 1999 to study vegetation responses to prescribed burning in open meadow (red lines) and forest (yellow lines). Several clearcuts (CC) lie adjacent to Bunchgrass.

Meadow soils at Bunchgrass are Typic Cryoborolls, moderately deep to deep mollisols with a loamy texture; these soils are thought to have developed during the Holocene maximum (3000 - 5000 ybp) (Appendix D; Wilson et al. 1999). Beneath the oldest islands of trees, soils are lighter in color, but are still classified as mollisols. Transition to the surrounding forest is abrupt, however: mollisols are replaced by inceptisols (Dystric Cryochrepts), poorly developed loams to sandy loams that developed beneath a coniferous forest canopy.

To aid in the design and implementation of restoration treatments, District resource specialists have identified three "Management Zones" at Bunchgrass, largely defined by the history and density of conifer encroachment (**Fig. 2**) (Wilson et al. 1999). Zone 1 supports the most extensive meadows, but contains some areas of recent (and past) encroachment. Zone 2, contains some small meadow openings and other areas with moderate to dense encroachment (50-80 yr old conifers). Zone 3 is largely closed-canopy forest and has likely been so for hundreds of years.

2.2. Study Design. Field research for this project will consist of two integrated studies. The first will document the history of conifer encroachment and resulting changes in meadow composition at Bunchgrass. It will provide the historical and ecological contexts for the design and interpretation of the second, focal study of responses of existing communities to experimental restoration treatments.

2.2.1. Study 1: Historical and ecological context. Sampling for this study will span the three Management Zones at Bunchgrass (**Fig. 2**), encompassing the broad range of encroachment histories and vegetation compositions. Aerial photographs with ground verification will be used to delineate coarsely defined "structural types," including open grassland, open forb meadow, young lodgepole pine, older mixed conifer, and possibly other types. For each of the identified structural types, 3-5 replicate sampling locations will be chosen. Where logistically feasible, the same locations will be used for experimental restoration treatments (**Study 2**).

<u>Part A. Temporal patterns of conifer encroachment</u>. At each location, one or more 10- to 30-m-wide belt transects will be established, and the positions and sizes (diameter, height) of all trees will be recorded. Several such transects have already been installed and sampled in Zone 1 (Halpern 1999). Tree establishment dates will be obtained destructively (small trees) or using standard dendrochronological (tree-ring) methods employed in previous studies of meadow encroachment (Miller & Halpern 1998). These data will be used to develop a population age structure for each location that portrays the timing, rate, and density of conifer encroachment (see **Fig. 1b,** above).

<u>Part B. Relationships between overstory structure and ground-layer composition</u>. At the same time that tree age data are collected, we will examine relationships between conifer encroachment and ground-layer composition. Our objectives are (1) to quantify the range of ground-layer communities present at Bunchgrass, (2) to identify those attributes of overstory structure that show strong relationships with ground-layer characteristics, and (3) to develop regression models to predict these characteristics from simple measures of overstory structure.

Within each belt transect, a series of line transects and nested plots will be used to sample the cover and diversity of ground-layer species and the structural attributes of the overstory (e.g., age structure, canopy cover, stem density, basal area, height to live crown) (Halpern 1999). We will employ correlation analysis, multiple regression, and non-parametric models to explore relationships between overstory predictors and the mean and maximum response of understory variables (McKenzie et al. 2000). Sampling locations and their attributes (aerial extent, structural class, encroachment history, and ground-layer community) will be entered into a GIS, contributing to a baseline map of the historical development and current ecological conditions at Bunchgrass.

Structural types delineated in **Part A** (above) will be used as a basis for siting experimental treatments in **Study 2** (below). Models of the relationships between overstory structure and ground layer composition (**Part B**) will be used to interpret the results of experimental treatments in **Study 2** and to develop management applications. For example, short-term responses to treatments may be dictated by initial composition. Thus, if there are strong relationships between stand structure and ground-layer composition, it may be possible to predict treatment responses from easily obtained measures of stand structure.

2.2.2. Study 2: Vegetation responses to experimental restoration treatments (fuel reduction with prescribed burning). Current approaches to restoration of dry, montane meadows in this region include manual thinning of established trees and prescribed burning of resulting slash and live ground fuels. Our primary study will test the efficacy of this approach applied across a broad range of initial vegetation conditions. We pose the following questions: (1) Can the combination of thinning and prescribed burning be used to restore the composition of former meadow communities? (2) For which structural types and ground-layer communities are these restoration treatments likely to lead to successful recovery of meadow composition, and for which of the initial vegetation conditions will treatments be unsuccessful? (3) What modifications in approach (e.g., periodic burning, seeding of native species) are suggested by short-term responses?

Baseline surveys (Halpern 1999) and site reconnaissance suggest considerable variation exists in the composition, diversity, and vigor of meadow communities at Bunchgrass. Where trees are sparse, ground-layer communities are dominated by meadow forbs and graminoids. Where there has been a longer history of invasion, meadow vegetation has been replaced by shade-tolerant herbs or shrubs. Where canopies are dense, little to no understory is present. As with forest understory communities in this region, initial composition may dictate the trajectory of post-disturbance response (Halpern 1988). Given the broad range of conditions at Bunchgrass, it is critical to identify the full range of responses, which we anticipate to be large.

To explore this variation, we will use the structural types described in **Study 1** as a basis for stratifying our experimental manipulations and interpreting vegetation responses. Within each structural class, we will select 3-5 five replicate treatment areas of ≥1.25 acres (0.5 ha) in size which will be subjected to experimental thinning and prescribed burning. If restoration logistics permit, we will use areas sampled in **Study 1**, as well as existing transects in Zone 1 (Halpern 1999). In each treatment area, a series of permanently marked transects with nested sample plots will be established and sampled for initial conditions: stand structural attributes and ground-layer composition (**Table 2**). In adjacent control areas that will not be treated, replicate transects will also be established. Controls will be particularly important for interpreting patterns in open meadow communities, where treatment effects may be masked by annual variation in climate (Halpern unpublished data).

Table 2. Independent variables and covariates used to assess vegetation responses (dependent variables) in experimental restoration treatments (Study 2).

Class of Variables	Specific Variables
Initial composition (Independent variables)	
Structural types	Open grassland, open forb meadow, young lodgepole pine, older mixed conifer
Stand structural attributes	Age structure, tree density, basal area, canopy cover, canopy height, height to live crown
Initial vegetation composition	See vegetation response variables below
Covariates	
Fuels: fine and coarse	Consumption of coarse and fine woody debris and duff
Ground surface characteristics	Cover of logs, residual slash, fine litter, mineral soil, burned duff
Residual stand attributes	Density or basal area of live and dead trees, distance to seed sources
Vegetation responses (Dependent variables)	
Meadow indicator species	Frequency and cover of key meadow species (e.g., see **Table 1**)
Functional groups defined by:	Frequency, cover, and richness of:
• Habitat preference →	meadow vs. forest taxa
• Growth form →	graminoids, forbs, sub-shrubs and tall shrubs
• Life history →	annuals, biennials, and perennials
• Geographic origin →	natives vs. exotics
Compositional change	Frequency and cover of all ground-layer species
Tree responses	Mortality of residual overstory trees; rate and density of seedling recruitment

Thinning of experimental areas will occur during fall 2003. Small trees (<7” dbh) will be cut and scattered; larger trees (7-11” in Zone 2 and 7-19” in Zone 3) will be yarded by helicopter as whole trees or with tops attached to the last log to reduce slash accumulation. Prescribed burning will follow in spring/early summer 2004. Based on initial responses, some experimental areas may be treated in future years to explore effects of repeated burns or other treatments (see question 3, above).

Following experimental treatments, vegetation responses will be sampled annually, including estimates of species cover, mortality of residual trees, and recruitment of tree seedlings (**Table 2**). In addition to the role of initial composition (**Table 2**), post-fire changes in species composition and conifer recruitment are likely to be affected by fuel accumulation and consumption, post-treatment ground conditions, and the abundance/proximity of any surviving trees in, or adjacent to, the transects (covariates in **Table 2**). These covariates will be measured at the time of pre- and post-treatment vegetation sampling using methods described in Brown (1974) and Halpern (1999).

A suite of uni- and multivariate statistical methods will be used to analyze variation in vegetation responses among structural types, and to identify other correlates of vegetation change. Clearly, species composition will differ among structural types before experimental treatments are applied. Thus, vegetation responses will be measured as the differences between pre- and post-treatment conditions. Analysis of variance (ANOVA) and covariance (ANCOVA) will be used to compare these responses among structural types or between treated and control plots. To explore the range of vegetation responses as functions of initial structural attributes or post-treatment covariates (**Table 2**), multiple regression and non-parametric models (classification and regression trees or CART; Breiman et al. 1984) will be used. Finally, direct and indirect ordination (DCA, CCA; Hill 1979, ter Braak 1987) will be used to compare temporal changes in species composition among structural types and to relate these changes to initial conditions (overstory structural attributes, understory composition) and post-treatment covariates.

3. Project Duration

Our studies will yield many useful results and products in its 3-yr timeframe (**Table 3**). Many aspects of project planning are complete or well advanced: a management plan has been developed and an environmental assessment is in progress; prescribed burning has been tested in Zone 1; sampling protocols have been devised for both open meadow and forest; and extensive baseline data have been collected (Halpern 1999). Mapping and field verification of vegetation structural types will begin in August 2002 using funds remaining in an existing NSF grant.

Table 3. Bunchgrass Meadow: Schedule of research activities, experimental restoration treatments, and communications/outreach products.

	2002	2003				2004				2005			
Activities and Products	**Aut**	**Win**	**Spr**	**Sum**	**Aut**	**Win**	**Spr**	**Sum**	**Aut**	**Win**	**Spr**	**Sum**	**Aut**
Field sampling (Studies 1 and 2)	**1**			**1, 2**				**2**				**2**	
Thinning (T) and prescribed fire (F)					**T**		**F**						
Data entry, sample processing, data analysis													
WEB reports (W) and communiqué (C)					**W**				**W**				**C,W**
Journal articles (J) and graduate thesis (T)											**J**		**J,T**
Annual reports to Joint Fire Science Program													
Field tours (F) and workshop (W)				**F**				**F**				**F**	**W**

4. Deliverables and Technology Transfer

As evident from our CVs and the WEB sites referenced below, we have a strong history of communicating results to scientists, land managers, and the public through diverse media, field tours, and workshops. We expect numerous products to emerge from the proposed work, including:

Scientific papers submitted to ecological/restoration journals (Feb and Sep 2005). These will examine the history of conifer encroachment in montane meadows, effects of encroachment on native plant communities, and initial responses to restoration treatments.

A series of annual WEB reports and a communiqué produced by the Cascade Center for Ecosystem Management (http://www.fsl.orst.edu/ccem/) (annually: Oct 2003 and 2004, Sep 2005). These will address the ecological and management issues that have motivated meadow restoration efforts, review relevant literature, identify and interpret key results from our studies, and provide an annotated listing of related work. The Cascade Center was established in association with the Andrews Forest, Oregon State University, and the Willamette National Forest; its mission is to facilitate ecosystem management by applying and testing scientific knowledge in operational settings and by communicating results via diverse educational outlets.

Field tours for researchers and managers to discuss the ecological, management, and social relevance of restoration treatments (annually: Aug 2003 - 2005).

Progress reports to the Joint Fire Science Program (annually: Oct 2003 and 2004, Sep 2005).

A long-term ecological database managed by, and accessible through, the Forest Science Data Bank (FSDB). Managed cooperatively by OSU and PNW, FSDB supports data and metadata for more than 250 ecological studies of regional or national scope (http://www.fsl.orst.edu/lter/).

A system of permanent experimental plots and demonstration sites for future research and monitoring, demonstration, and public education.

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6. Qualifications of Investigators

The principal investigators have decades of research experience in forest and meadow ecosystems of the western Cascade Range, including expertise in fire history and fire effects (see CVs, below). We have contributed to a long, successful history of collaboration between science and management in the region, communicating with resource specialists, the public, elected officials, and others through field tours, workshops, and many types of publications. We have been successful in protecting field sites in diverse settings, for demonstration, long-term research, and public education.

We have strong support for this project from numerous participants and interested parties representing diverse local and regional perspectives. We are actively engaged with resource specialists on the McKenzie Ranger District and the Willamette National Forest in planning research, management, and outreach activities at Bunchgrass Meadow. We have interacted with representatives of the Warm Springs and Siletz Tribes who have been supportive of experimental burns on the Blue River and Sweet Home Ranger Districts and have participated in recent planning sessions at Bunchgrass. Finally, the McKenzie Watershed Council is very interested in our proposed project as a model of a research-management partnership that addresses a central goal of its Conservation Strategy—restoration of key habitats and plant communities in the McKenzie River Watershed. The Council is comprised of 20 partners representing local interests; private industry; and city, state, and federal agencies (http://www.mckenziewatershedcouncil.org/).

We have attached two supporting letters: a joint statement of support and commitment from Rob Iwamoto, Acting Forest Supervisor, Willamette National Forest, and John A. Allen, District Ranger, McKenzie Ranger District; and a letter of support from Jim Thrailkill, Coordinator of the McKenzie Watershed Council.