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STUDY PLAN

CONSEQUENCES OF FIRE AND FIRE SURROGATE TREATMENTS– THE HUNGRY BOB PROJECT, WALLOWA-WHITMAN NATIONAL FOREST

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I. Introduction

Current forests in many fire-dependent ecosystems of the United States are denser and more spatially uniform, have many more small trees and fewer large trees, and have much greater quantities of forest fuels than did their presettlement counterparts (Mutch and others 1993, Agee 1994, Harrod and others 1998). In the Pacific Northwest, causes include fire suppression, past livestock grazing and timber harvests, and changes in climate (Bergoffen 1976, Dolph and others 1995, Arno and others 1997). The results include a general deterioration in forest ecosystem integrity and an increased probability of large, high-severity wildfires (Wickman 1992, Mutch and others 1993). Such conditions are prevalent nationally, especially in forests with historically short-interval, low- to moderate-severity fire regimes (Agee 1993, Agee 1994, Kilgore and Taylor 1979, Taylor and Skinner 1998). This situation was addressed in the 1995 Federal Wildland Fire Management Policy Review and Report that contributed to the development of a new Federal fire policy. That policy directs Federal agencies to achieve a balance between suppression capability and the use of fire to regulate fuels and sustain health ecosystems.

In 1996, a team of PNW Station and Oregon State University scientists initiated a project titled "Alternative fuel reduction methods in Blue Mountain dry forests" with support from USDA National Research Initiative Competitive Grants Program and substantial cooperation with the Wallowa-Whitman National Forest and the Wallowa Valley Ranger District. The project became known as "Hungry Bob" and involved a direct comparison of using prescribed fire, mechanical thinning, and a combination of fire and thinning to reduce fuels and accelerate the development of last-successional stand structure in low-elevation ponderosa pine and Douglas-fir forests of northeastern Oregon. The research team attempted to ensure an uncharacteristically high level of integration by assessing fuel reduction, stand dynamics, soil disturbance and below ground processes, changes in soil fungi, and economics of operations by collecting data on a set of potentially interacting variables for both one year pretreatment and the first year post-treatment from a set of common geo-referenced plot centers.[1] Funding limited the team to only a single post-treatment assessment.

In the 1998 appropriation, Congress, with the support of the Administration, provided a more flexible funding authority to support the aggressive use of fire and mechanical fuel treatments. At the same time, there was a growing recognition that disturbance by fire can have both positive and negative effects on human and environmental values. Congress also expressed a concern that consistent and credible information about fuel conditions, risk, fire regimes, effects on other resources, and priorities for treatment in the context of the values to be protected was lacking, and recognized the need for studies to understand the long-term consequences of altering fire regimes on the structure and health of plant communities, wildland fuels, fire severity, and air and water quality. Congress directed the Department of Interior and the Forest Service to establish a Joint Fire Science Program to supplement existing fire

[1]Hungry Bob application for funding through USDA NRI and study file, on file, LaGrande FSL.

research capabilities. The Joint Fire Science Program requested proposals to assess fire and fuel treatment effects on ecosystem productivity and health, plant community structure and dynamics, plant species mortality and regeneration, fuel loading and distribution, hydrology and water quality, soil properties and below ground processes, wildlife habitat, fisheries, and air quality, all across a variety of ecosystems in different climatic regimes. In early January 2000, funding for a five-year “National study of the consequences of fire and fire surrogate treatments” (FFS) was awarded to a network steering committee representing 11 sites from the Pacific Northwest to southern Florida. The study was designed as an integrated network of long-term interdisciplinary research sites utilizing a common “core” design to facilitate broad applicability of results (Weatherspoon and Skinner, in press). Hungry Bob was selected as one of the 11 sites. This study plan addresses research activities at Hungry Bob linked to the national FFS network.

II. Problem Reference

The program charter for the Managing Disturbance Regimes Research, Development and Application Program contains two integrated issues and five supporting component areas. Work under this Hungry Bob FFS study will directly contribute to Problem 1: managing disturbance regimes to restore and enhance ecosystem health in the Pacific Northwest and Alaska. In addition, completion of this study will contribute to Problem 3) understanding and managing fuels, fire, and smoke; Problem 4) understanding and managing forest and rangeland dynamics; Problem 5) understanding and managing forest insects and pathogens; and Problem 6) understanding and managing disturbance effects on plant and animal habitats. In addition, work at Hungry is listed as a major contributor to the draft Blue Mountains Demonstration Area research objectives, specifically in aiding in the development of integrated management options to restore and maintain desired conditions (objective 4c).

III. Literature

The significance of the proposed research is that timely information will be provided to managers faced with restoring more than three million acres of forested public lands in the Blue Mountains of Oregon and Washington (Caraher and others 1992). The type of information provided is also significant, because it will be grounded in a systemic understanding of the interactions among biologies, operational feasibility and economics. For a complete discussion of the rationale and importance of the study objectives and benefits of a successful study, see the full proposal for support from the USDA National Research Initiative Competitive Grants Program, “Alternative fuel reduction methods in Blue Mountain dry forests,” on file at the LaGrande FSL, and the full FFS proposal and working plans on file at the LaGrande FSL or at the URL: http://ffs.psw.fs.fed.us/.

IV. Objectives

Objectives of the Hungry Bob project are as follows:

1) Assess the extent to which treatments reduce fuels.

2) Determine operation production rates and economics, and identify the principal factors that explain them.

3) Determine the value of timber products removed.

4) Identify how different stand conditions and fuel loadings effect the economics of operations and the value of resources removed.

5) Assess how treatments directly influence residual tree damage or mortality, vegetation, soil structure, soil chemistry, the soil and litter food web, wildlife habitat, and insect and disease populations.

6) Determine how treatment impacts on fuels, the chemical and physical properties of soils, and residual trees influence wildlife habitat and insect and disease populations.

7) Develop a matrix that identifies economic and environmental tradeoffs that occur among treatments.

V. Methods

Actual fieldwork at Hungry Bob was initiated in 1996 after a careful analysis of implementing the project at three other locations within the Blue Mountains. The Hungry Bob project is located on the Wallowa Valley District between Davis and Crow Creek drainages, 45 km north of Enterprise, Oregon (figure 1). The study is a complete randomized design of four treatments and four replications, resulting in 16 experimental units.

Treatments– The following suite of four FFS treatments will be implemented at Hungry Bob:

1) untreated control

2) prescribed fire only, with periodic reburns

3) initial and periodic cutting, each time followed by mechanical fuel treatment and/or physical removal of residue; no use of prescribed fire

4) initial and periodic cutting, each time followed by prescribed fire; fire alone also could be used one or more times between cutting intervals.

Figure 1. Location of the Hungry Bob Fuel Reduction Project in northeastern Oregon, a site in the national FFS network

These four treatments span a useful range both in terms of realistic management options and anticipated ecological effects. Treatments 2, 3, and 4 will be guided by a desired future condition or target stand condition. The desired future condition is defined in terms of the tree component of the ecosystem and live and dead fuel characteristics. The following fire-related minimum standard served as a starting point for desired future conditions throughout the FFS network:

> Each noncontrol treatment shall be designed to achieve stand and fuel conditions such that, if impacted by a head fire under 80th percentile weather conditions, at least 80 percent of the basal area of overstory (dominant and codominant) trees will survive.

Hypotheses– Four common hypotheses for forest ecosystem restoration and management currently being discussed in the scientific and environmental conservation community relate directly to our four treatments:

> Hypothesis A) Forest ecosystems are best managed by passive approaches, with no active manipulation of ecological processes such as fire, or forest structure such as by cutting, except for a continuation of fire suppression. Operationally this hypothesis leads to treatment 1, the untreated control.
>
> Hypothesis B) Forest ecosystems are best managed by restoring ecosystem processes—i.e., by reintroducing frequent, low intensity fire. This hypothesis leads to treatment 2, the prescribed fire only treatment.

Hypothesis C) Forest ecosystems are best managed by restoring ecosystem structure—i.e., by using judicious thinning to restore density, species composition and spatial pattern of the tree component. This hypothesis leads to treatment 3, the periodic cutting treatment.

Hypothesis D) Restoration of sustainable forest ecosystems requires both structural and process restoration. This hypothesis leads to treatment 4, the combined burning and cutting treatment.

From these general ecological hypotheses, we established specific hypotheses of how the fuel reduction treatments will effect the system and how that effect will change over time at Hungry Bob, and selected actual core variables to measure that relate to the hypotheses:

Hypothesis 1) The three active treatments (fire, thin, thin/fire) will create distinctly different standing vegetation and down woody structure in the short-term (<5 years post-treatment).

Hypothesis 2) Insects and disease will cause further divergence in standing vegetation structure among treatments in the intermediate term (5-10 years post-treatment) due to differences in vegetation mortality.

Hypothesis 3) The treatments will create different short-term responses in chemistry and the microbial food web of the soil and forest floor, which will lead to further divergence in standing vegetation structure for the intermediate term.

Hypothesis 4) The treatments will create different qualities in down wood in the short term, which will lead to a divergence in the insect fauna of down wood in the intermediate term.

Hypothesis 5) Wildlife species will track changes in stand structure and down wood in the short term, and will diverge even more at later stages as a consequence of among-treatment divergence in standing structure and down wood.

The primary management objective of the Hungry Bob project is reestablishing the stand structure characteristic of presettlement times through fuel reduction and thinning from below. We assume that prescriptions written to obtain short-term structure objectives will result in the long-term large structure goal after several entries, and that short-term structural objectives are the same regardless of whether fire or thinning is used. Fire and thinning have fundamentally different effects on the ecosystem, starting with the immediate effects on standing vegetation and down woody structure (Hypothesis 1). The first hypothesis will be tested by measuring a suite of vegetation and fuel variables including vegetation structure and composition, tree demographics, and both surface and vertical fuels. Post-treatment data on these variables will then be used to model crown fire potential, fuel consumption, and immediate fire effects in the context of fuel moisture, crown bulk density, and weather. We expect that stand structure will diverge further after a few years due to qualitative differences in how treatments influence the activities of insects and disease (Hypothesis 2). Variables measured to test this hypothesis include bole scarring, ectomycorrhizae, crown condition, tree radial growth rate, root disease incidence, and tree mortality caused by bark beetles. Because bark beetle populations operate at spatial scales much larger than the average treatment unit, interpretation of the bark beetle response to treatment will also require information on recent historical and current bark beetle populations from an area surrounding each treatment unit. The effect of fire on soils and the forest floor is expected to cause divergence in several measures of stand structure and composition (Hypothesis 3) through changes in stand productivity. Soil and forest floor variables that represent nutrient capital, available nutrients, nutrient cycling, physical properties, and biodiversity will be measured and compared. Values of these variables, especially in the short term, will be used to predict the suite of stand structure variables described for the test of Hypothesis 1. Even if the three active treatments result in a similar *quantity* and *size distribution* of down wood, prescribed fire is expected to change the *quality* of this resource, in part through case hardening of the surface and heating of the interior. This may lead to changes in rates of colonization and persistence of key insect species, such as carpenter ants and wood boring beetles (Hypothesis 4). Four variables will be measured to test this hypothesis, including log abundance and distribution, and down wood insect abundance and diversity. Modification of stand structure is expected to effect vertebrate species, through changes in habitat quality. Short-term structural modification will offer different opportunities for vertebrate species, and any structural divergence in the intermediate term is expected to change habitat quality accordingly (Hypothesis 5). Variables used to test Hypothesis 5 include small mammal species diversity and abundance, bird species diversity and abundance, bird nest productivity, and bird functional foraging responses. Since many bird species have home ranges larger than each treatment unit, interpretation of bird species diversity and abundance will also require information on the history, current treatment and current structure of the landscape surrounding each treatment unit.

The five hypotheses also establish a framework for an integrated analysis of the core variables. The first step will be the analysis of each response variable for post-treatment year 1, with treatment as the independent variable. We expect that active treatments will differ the least in standing structure, down woody structure and in wildlife variables, and the most in stand damage, soil, and activity fuel variables. These latter three variables, the result of different treatments, are expected to cause further divergence in stand structure in the intermediate term. Hence they will be used as independent variables (along with treatment) for analysis of effects on stand structure and wildlife in the intermediate and long term. While the primary test of hypotheses will consider the plot as the experimental unit in analysis of variance, the common sub-plot sampling grid will also allow regression analysis to establish linkages among variables at a smaller spatial scale. This will add insight on potential cause and effect relationships among variables, especially for the burn plots, where the treatment effect is expected to be particularly heterogeneous at the small scale.

Desired future condition-- Guiding the implementation of treatments at Hungry Bob was a common short-term desired future condition of stands after the initial set of treatments. Although discussed within the framework of the FFS program, treatments other than one initial mechanical entry or one initial prescribed burn are beyond the scope of this plan. The desired future condition of stands is as follows:

> Through mechanical thinning, reduce basal area from about 27.5 $m^2 \cdot ha^{-1}$ to about 16 $m^2 \cdot ha^{-1}$, leaving dominant and codominant crown classes; accept wide distribution in spacing to account for natural clumps; retain all old and late seral structural live trees greater than 53 cm DBH; remove competing conifers within 9 m of dominants to prolong structural characteristics.
>
> Through prescribed fire, reduce basal area from about 27.5 $m^2 \cdot ha^{-1}$ to about 16 $m^2 \cdot ha^{-1}$ by underburning, leaving 70 to 80% of the pretreatment ponderosa pine, 60 to 80% Douglas-fir, and

up to 30% grand fir between 20 and 51 cm DBH; reduce basal area of trees larger than 51 cm by no more than 20% for ponderosa pine, 30% for Douglas-fir, and 50% for grand fir; reduce fuel bed mass in the 0 to 8 cm size class to less than 21,800 $kg \cdot ha^{-1}$.

Timeline-- Site selection, NEPA, and unit selections were completed by December 1997 in collaboration with the Wallowa Valley Ranger District. Unit reference points and 50 m grid points were established by A. Youngblood and J. McIver by May 1998 for all 16 units. All pretreatment measurements (except wildlife) across all 16 treatment units were collected in the summer of 1998. Thinning in 8 units was completed by September 1998. A prescribed fire burning plan was written for 8 units and was planned for fall 1999 but was postponed until fall 2000 because of weather. First-year post-treatment measurements in the 8 thinned units is scheduled for summer 2000. Complete post-treatment measurements will be taken in summer 2001. Observations of birds will continue in 2002 and 2003. Complete reevaluation of all response variables in 2004 will complete the current funding cycle. These events are summarized in Table 1. This study plan addresses work beginning in calendar year 2000. Core variables, responsible individuals, and methodology for pretreatment measurements follow.

Treatment and plot layout-- Treatment units are whole, discrete stands or portions of larger stands all having irregular boundaries. In some cases small adjacent stands were combined and are treated as a single experimental unit. Structure in these stands was categorized by District planners as early, mid or late based on age-class distributions, and plant association based on composition of diagnostic species. Reference points outside treatment units were staked and tagged with numbered round metallic tags, and compass bearing and distance to the first grid point noted on treatment unit maps (appendix A). Distribution of grid points resulted in about one grid point per acre. Grid points were established along compass lines with tape and staff compass to fall at least 50 m from stand boundary. Grid points were marked with painted stakes and buried monuments, geo-referenced by GPS. Figure 2 is a schematic representation of sample locations on a plot. Table 2 provides the assigned treatment, unit size and number of plots for each unit.

Core variables– A major aspect of the common design approved by the Joint Fire Science Program for the FFS project was a set of core variables to be measured at all network sites using common measurement protocols and a consistent within-unit sampling approach. The following represent core measurement variables for the network unless indicated otherwise. In general, the response variable of interest is the index represented by the difference between pretreatment and post-treatment value for a given variable summarized by treatment unit.

Vegetation, entomology, and pathology protocol– Circular 400-m^2 reconnaissance plots (radius = 11.3 m) will be centered on each grid point. On each plot, the following environmental parameters will be collected to characterize the plot: elevation to the nearest 50 feet taken from USGS quad map; aspect to the nearest 1° by using a compass; slope to the nearest 1°by using a clinometer; the horizontal topography of the prevailing slope, either a ridge top, convex slope, an even slope, a concave slope a swale, the bottom of a slope, or a flat; the percent of exposed mineral soil ocularly estimated to the nearest 5%; the percent of area with surface disturbance, defined as the area with surface depressions or ruts at least 2.5 cm deep, ocularly estimated to the nearest 5%; a measure of total live overstory canopy cover, taken as five observations with a GRS densitometer at five regularly spaced points, points are at the plot center and at each cardinal direction, 2 m from plot center.

Soil and air temperature (not addressed by FFS) will be monitored by locating soil and air recording thermistors (HOBO) after treatment near the center of each unit (Table 3). Thermistors will be programmed to record at 6 hr intervals for a full year (Appendix B). Air HOBOs will be placed 1.37 m above the ground within a white radiation/thermometer house on fence post, 25 m between two centrally-located plot centers. Soil HOBOs are placed 20 cm deep, 24 m from the plot center.

All tree stems will be inventoried by species and noted as live or dead, diameters measured to the nearest 0.1 cm with a diameter tape at 1.37 m in height, total tree height measured to the nearest 0.1 m with a clinometer or telescoping height pole, live crown ratio estimated ocularly to the nearest 10%, and the tree characterized as undamaged or damaged. Damage to stems will be assessed by visible signs of mechanical damage or the presence of insects, root disease, or dwarf mistletoe; presence of dwarf mistletoe and any bark beetle (mountain pine, Douglas-fir, spruce, western pine, pine engraver, fir engraver, or red turpentine) visibly assessed as light, moderate, or severe. Types of mechanical damage resulting from thinning or underburning include smashed or crushed foliage, snapped or broken terminal leaders, snapped or broken branches, root systems partially wrenched from lateral stresses to the bole, bark scraped, bole scarred, bole charred, and crown scorched. Wrenching will be assessed by noting movement of the root wad when the bole is shaken. A bole scar is defined as the removal of bark and exposure or destruction of the cambium. The maximum vertical and horizontal dimensions of scars at the root collar and on the lower 2 m of bole will be measured to the nearest cm.

Height of bole char will be measured to the nearest 0.1 m; height of crown scorching will be inferred from live crown ratio. Damage location will be characterized as either on surface or exposed roots, below breast height and in contact with the ground, below breast height, above breast height on the lower third of the bole, on the middle third of the bole, on the upper third of the bole, or at multiple locations. Char height is measured or estimated to the closest 0.1 m. Within the whole plot, canopy cover by species of vascular plants ocularly estimated to the nearest 1% below 10% and to the nearest 10% above 10%. Total cover of advance regeneration (seedlings, ≤1.37 m in height), ocularly estimated to the nearest 5%.

Figure 2. Schematic of sampling locations at each grid point at Hungry Bob

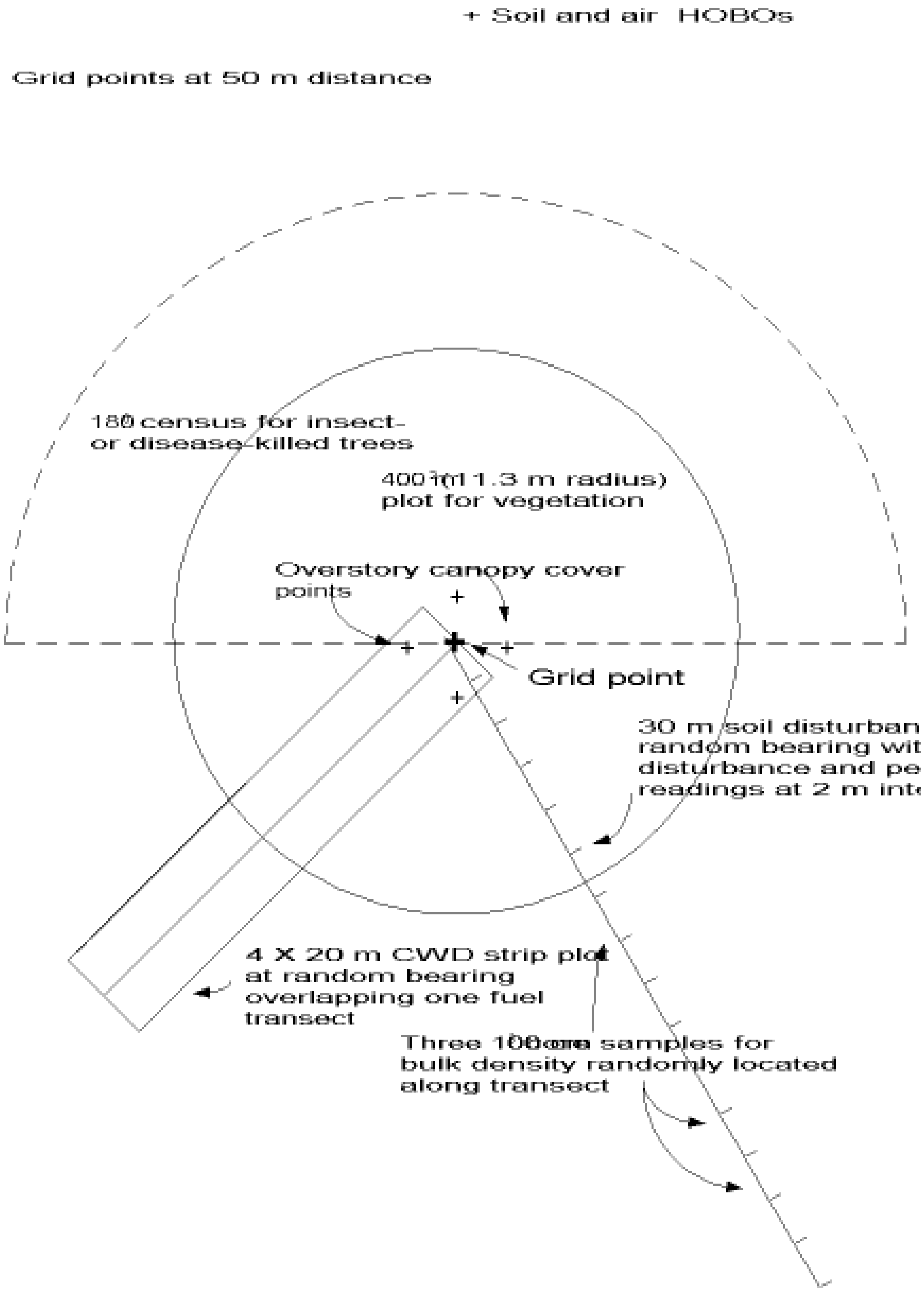

Table 1. Timeline of fieldwork activities at Hungry Bob, a site in the national FFS network

Season	Activity	Lead
Summer 1996	Site selection	McIver
Fall 1997 - Winter 1998	Sale design and NEPA	Wallowa Valley RD
	Unit layout and grid establishment	Youngblood and McIver
Spring - Summer 1998	Pretreatment measurements:	
	Vegetation, entomology, pathology	Youngblood
	Thatch ants, soil structure	McIver
	Ectomycorrhizae	Smith
	Soil food web and soil chemistry	Niwa
	Fuel loading	Ottmar
	Operations	Kellogg/Matzka/Coulter
Summer - Fall 1998	Treatment: mechanical thinning	Wallowa Valley RD
Fall 1999	Treatment: prescribed fire[1]	Wallowa Valley RD
Summer 2000	Partial post-treatment measurements:	
	Vegetation, coarse wood debris, entomology, pathology, soil structure, soil structure, soil chemistry	Youngblood
	Thatch ants	McIver
	Wildlife	McIver via JVA
	Unit soil characterization	McIver via contract
Fall 2000	Treatment: prescribed fire	Wallowa Valley RD
Summer 2001	Complete post-treatment measurements:	
	Operations	Matzka
	Post-treatment photo points	McIver
	Fire behavior	Ottmar, Ward
	Vegetation, coarse wood debris, entomology, pathology, soil structure, soil chemistry, soil food web	Youngblood
	Thatch ants	McIver
	Wildlife	McIver via JVA
	Fuel loading- burned and nonburned units	Ottmar
	Soil ectomycorrhizae	Smith
Summer 2002	Partial wildlife measurements (birds)	McIver via JVA
Summer 2003	Partial wildlife measurements (birds)	McIver via JVA
Summer 2004	Complete post-treatment measurements:	
	Vegetation, coarse wood debris, entomology, pathology, soil structure, soil chemistry, soil food web	Youngblood
	Thatch ants	McIver
	Wildlife	McIver via JVA
	Fuel loading	

[1] Burning scheduled but postponed due to weather conditions

Table 2. Stand aggregation, treatment assignment, initial conditions, and number of sample plots for 16 experimental units at Hungry Bob, a site in the national FFS network

Unit	Plant Assoc.	_ SDI	_ BA (ft^2)	Forested Acres	Total Acres	Tmt	Number of plots
2 4 5	PSME/SYAL	233	122	17	35	C	21
6A	PSME/SYAL	214	113	29	29	T	26
6B	PSME/SYAL	186	103	27	27	T/B	29
7	PSME/SYAL	267	145	43	54	T	25
8A	PIPO/SYAL	210	114	40	40	T/B	23
8B	PIPO/SYAL	210	114	40	40	B	23
9	PSME/SYAL	190	107	80	134	T	23
10A	PIPO/SYAL	181	105	40	40	T/B	24
10B	PIPO/SYAL	181	105	70	70	B	21
11, 12	PIPO/SYAL PSME/SYAL	171	98	31	54	T/B	35
15	PSME/SYAL	178	102	40	68	C	20
18	PSME/SPBE	218	120	20	20	C	20
21	PSME/SYAL	211	112	33	36	B	30
22	PSME/SYAL	181	102	51	95	T	28
23	PSME/SYAL	230	128	77	162	C	28
24	PIPO/SYAL PSME/SYAL	228	123	40	76	B	23

On all trees within the circular plot (figure 2), signs of feeding activity by birds and insects will be noted, especially by bark beetles. At each successive grid point, an ocular scan of 180° will be made for trees inside or outside the circular plot that are clearly in decline or devoid of needles. As such trees are found, the direction and distance from the grid point will be determined, and each tree will be assigned a numbered metallic tag. For each tree, the tree species, bark beetle species responsible for mortality, tree diameter, and fading stage (color, i.e. lime or light green, straw colored, yellow, red, or grey (old dead)) will be recorded. These data will be collected at each grid point on each study plot. This will allow for bark beetle mortality to be spatial referenced for GIS analysis. For those down logs tallied in log transects (see coarse wood debris protocol), evidence of wildlife use by mammals and birds will be recorded.

Table 3. Location of HOBO thermistors in experimental units at Hungry Bob

Treatment	Unit	Plot
Control	5	3
Control	15	5
Control	18	15
Control	23	24
Thin only	6A	17
Thin only	7	12
Thin only	9	12
Thin only	22	17
Burn only	8B	14
Burn only	10B	9
Burn only	21	17
Burn only	24	15
Thin then burn	6B	15
Thin then burn	8A	10
Thin then burn	10A	11
Thin then burn	11	7

Survey protocol for tree pathogens will be similar to that for entomology. Observations will consist largely of above-ground crown symptoms based upon the same rating scale as used for bark beetles. Determinants involved in these crown symptom classes are based on foliar color, needle/leaf size, and internode length, with color being the primary character defining symptomatic trees. As such trees are found, the direction and distance from the grid point will be determined, trees will be assigned a numbered metallic tag, and their location marked to aid in finding again. Data collection on all symptomatic, putative root-diseased trees will consist of recording the above-mentioned crown symptoms, diameter at breast height, crown position, and signs of other distress agents (such as bark beetle pitch tubes, exit holes, etc.). Root samples from identified, symptomatic trees will be obtained during late fall or after insect flights have ceased. Several samples of wood per root will be obtained by coring the excavated (or exposed) root from the root collar to approximately one meter distally along the root. At least two such woody roots having a minimum diameter of five cm will be sampled per symptomatic tree. Roots from two to three healthy, asymptomatic, randomly selected trees in each treatment unit will also be sampled. In the event of a large number of symptomatic trees, a 20% sub-sample of trees will be sampled. Prior knowledge of root diseases on sites, past history, and existing conditions will also be important factors used in the interpretation of symptoms and sampling intensity. Extracted cores from all trees will be stored in ice chests. Isolations will be conducted according to standard lab techniques at the LaGrande FSL under the direction of C. Parks. Emerging relevant fungi from wood samples will be subcultured and identified.

Vegetation response variables-- Plot descriptive data such as aspect, slope, elevation, topographic position, soil and air temperature, and soil type may be used as independent variables. Vegetation field measurements will be generalized as follows: stem density, basal area, and diameter class distribution per ha will be summarized by species, live and dead, for each treatment unit (16 total) across plots. Mean tree height and stem condition (damage) will be summarized by species for each treatment unit by averaging across plots. Stand density index (Cochran 1994) will be computed for each treatment unit based on the dominant species by averaging across plots. Proportion of stems damaged in each treatment unit will be computed by species and stem size because total number of stems within each treatment unit is not controlled. Mean char height and percent crown scorching by species and diameter class will be averaged across treated units (8 burn units) for regression against mortality. Constancy and canopy cover of vascular plant species, canopy cover of advance regeneration, and treatment unit overstory canopy cover will be computed by averaging across plots. Diversity of non-conifer vascular species for each treatment unit will be computed for each treatment unit. Entomology response variables used to detect treatment effects include, but are not limited to, percent mortality per tree species per bark beetle species per year, percent of mortality represented by group kills, mean number of trees per group kill, distribution of mortality by diameter class/bark beetle species, incidence (percentage) of bark beetle attacked trees also attacked by secondary insects, percent of tree mortality caused by secondary insects acting alone, and DBH distribution of tree mortality caused by secondary insects. Pathology response variables are similar to those of entomology.

Coarse woody debris protocol– The sampling protocols developed for estimating large woody material for fuels management are not adequate for describing the structural aspects of coarse woody debris (CWD) for wildlife purposes. For example, estimating the percentage of ground covered by logs may be an important variable relating to the abundance of small vertebrates and their food resource. Log density (i.e., number of pieces) and lengths have also been use to describe the foraging habitat of pileated woodpeckers (Bate, Torgersen, Garton and Wisdom, in prep.). In addition length, diameter, and decay class appear to be important aspects of CWD required by some wood boring insects (Shea unpublished data). The following protocols are recommended for estimating the structural aspects of CWD as potential wildlife and insect habitat. Sample plots will be established on at least every other grid point on all experimental units. At each sampled grid point, a strip-plot (4 X 20 m) will be established with the respective woody fuel transect line serving as the strip-plot center line. Within each strip-plot only logs or parts of logs that are at least 1 m in length and have a large end diameter 15 cm or greater will be measured and counted. The small end (>7.62cm) and large end diameters will be measured on all qualifying logs or parts of logs that fall within the boundaries of the strip-plot. If a piece extends outside the strip-plot, diameters are measured at the line of intercept of the strip-plot boundary and CWD piece. Piece lengths are the lengths of the CWD within the strip-plot area and are recorded. The length of the entire piece must be measured to determine the midpoint of the CWD. If the midpoint is within the strip-plot, the piece is given an additional rating of “1" for the Indicator Variable. If the midpoint falls outside the strip-plot the piece is given a rating of “0" for the Indicator Variable. In addition the species (if possible) and decomposition class of each log will be recorded. The following 5 log decomposition classes will be used to rate the CWD (from Thomas 1979):

Decomposition class 1) bark is intact; twigs are present; wood texture is intact; log is round; original wood color; log may be elevated on support points.
Decomposition class 2) bark is intact; twigs are absent; wood texture is sound or becoming soft; log is still round; original wood color; log elevated on support points but sagging slightly.
Decomposition class 3) bark has fallen off; twigs are absent; wood texture is hard; log is still round; original color of wood is faded; log is sagging near ground.
Decomposition class 4) bark is absent; twigs are absent; texture of wood is soft, blocky pieces; shape of log is round to oval; wood has faded to light yellow or gray; all of the log on the ground.
Decomposition class 5) Bark is absent; twigs are absent; wood texture is soft and powdery; shape of log is oval; wood has faded to light yellow or gray; log fully on ground.

Coarse woody debris response variables-- Density (number $\cdot ha^{-1}$), cumulative log length, mean large end diameter, volume of logs (based on large and small end diameter rather than taper functions by species, and log length), and cover, by species summarized by treatment unit.

Forest floor protocol-- Forest floor composite samples will be collected by vegetation crew. Forest floor organic matter and nutrient capital will be sampled by a single grab sample (soils at Hungry Bob are shallow and poorly developed) consisting of a 225 cm^2 sample of entire forest floor, bagged and labeled, six samples per unit at randomly chosen plot centers. All samples (six per treatment unit X 16 units = 96) will be sent to a commercial lab for analysis for standard analysis for C and N after drying and weighing. Nutrient availability of conifer foliage (not addressed in FFS proposal) will be sampled by collecting 10 kg of fresh needles from live trees after prescribed fire; needles will be oven dried, total nitrogen will be determined for a sample of dried needles, and 3 g of needles placed in bags of two mesh sizes (for mites). A total of 60 mesh bags will be placed in each experimental unit, with 12 bags in a cluster at grid points 2, 4, 6, 8, and 10. At each of three sampling occasions (year 1, 2 and 3) two bags from each of the two mesh sizes in each cluster will be removed from the field for analysis.

Forest floor response variables-- Forest floor mass, forest floor C, forest floor N summarized by treatment unit. N-mineralization of forest floor determined by difference between year 0, and 1, 2, 3 for two mesh bag sizes, summarized across the treatment unit.

Forest soil ectomycorrhizal protocol– This work is not addressed by the FFS program. Samples will be taken in spring (May-June) to coincide with the active root growing period. In each treatment unit, ectomycorrhizal (EM) diversity and dominance will be determined at 3 grid points. At each grid point, soil cores (5 cm in diameter and 10 cm deep) will be divided into two depths (0-5 cm and 5-10 cm). Samples will be placed in plastic bags, stored in iced coolers, transported back to the Corvallis lab, and stored at 4°C until EM root tips are morphotyped. EM root tips will be separated by morphotype using dissecting microscopes, lyophilized, and weighed. EM diversity will be verified by PCR/RFLP analysis.

Forest soil ectomycorrhizal response variables– EM diversity and dominance by experimental unit and treatment determined by difference between year 0 and year 2.

Soils protocol-- Soil organic matter and nutrient capital (at 5 cm and 10 cm depth) will be sampled as per FFS protocols. At the same six plot centers as forest floor sampling, a total of 100 cm^3 of mineral soil at 5 cm and 10 cm depths will be collected from three equally spaced points around the grid point (radius 2 m). The composite (three sub-samples) from each depth will be weighed, oven dried, weighed again in lab, and sent to a commercial lab for processing (two sample depths X six per treatment unit X 16 units = 192). Analysis for soil C, N, pH, macronutrients (P, S, K, Ca, Mg, PO_4, SO_4, NH_4, NO_3) will be by standard automated procedures.

Soil nutrient availability will be assessed each spring post-treatment by N-mineralization and nitrification in the soil. At each soil chemistry sampling plot (six per unit), a collected sample of 100 cm^3 of mineral soil will be divided into two equal portions, one portion will be placed into a double polyethylene bag and returned to the field for 20 to 30 days of *in situ* incubation. The location of this sample will be indicated with numbered pin flags. The second portion will be held in the lab until the field incubation is completed, recovered, and then both portions will be sent to the Texas A&M soils lab for analysis. NH_4 and NO_3 (inorganic) N levels will be extracted by KCl.

Soils response variables-- Soil C, N, pH, macronutrients (P, S, K, Ca, Mg, PO_4, SO_4, NH_4, NO_3) summarized by treatment unit. Net N-mineralization is difference in total inorganic between start of incubation and finish, summarized by treatment unit. Nitrification is NO_3 difference between start and finish/ initial NH_4 + net N mineralization summarized by treatment unit.

Soil disturbance protocol– Soil disturbance sampling protocol is adapted from established guidelines. The study site offers significant challenges to measuring soil impacts: the area has been entered repeatedly over the past 80 years, manifested by residual skid trails, berms, ditches, pits, and tire marks; and soils throughout the study area are highly variable in natural depth and most stands contain extremely rocky profiles. Hence, any sampling protocol must account for existing levels of residual soil impact and distinguish past activities from current treatments, and existing methodologies for assessing compaction with core sampling, nuclear gauge, or penetrometer will be limited in the rocky soils. Methods involve both a qualitative (for potential monitoring) and quantitative component. Pretreatment soil samples were collected in the spring of 1998 for all 16 units. Post-treatment sampling of thinning units will occur in 2000. Upon entering an experimental unit, a quick cruise will be taken to assess conspicuous soil disturbance features. Areas of visually undisturbed soils will be assessed with the tile spade to guage standard amounts of soil resistance for that unit. After the cruise, a 30-m transect established at a random bearing at each plot center will be established, and both surface disturbance and compaction will be assessed at 2-m intervals along the transect line. Surface disturbance will be assessed in reference to six disturbance classes derived from Howes (1998) (Table 4), and includes physical evidence of soil displacement or exposure such as cleat marks, forest floor removal, or berming. To assess compaction, resistance to penetration of the tile spade will be compared subjectively against resistance encountered in a standard area within the unit boundary that is assumed to be undisturbed (such as between two closely spaced trees). Unusual resistance to penetration of the spade will be noted and integrated with visible inspection of below-ground physical properties within the top 20 cm of mineral soil such as fine root growth inhibition and plating. Since compaction and displacement vary independently, any point along the transect may be placed in a different class with respect to these two types of soil disturbance. The letter “c” will denote that compaction was responsible for the class value, and a letter “d” will denote that displacement was responsible. At three random locations along the 30 m transect, 100 cm^3 core samples will be collected and sent to a commercial lab to be dried and weighed for estimating bulk density. A sample is considered compacted if bulk density is greater than 120% of a baseline undisturbed conditions for that unit as derived from the soil characterization contract. At the same 15 points along transects, penetrometer readings will be taken and later correlated with both qualitative and quantitative assessments of compaction. Soil exposure estimates using this transect method will also be compared to exposure estimates taken within reconnaissance plots for development of monitoring protocols.

Table 4. Surface disturbance classes used to assess physical soil disturbance at Hungry Bob

Class	Category	Description
0	Undisturbed	Soils undisturbed and considered to be in a natural state. Vegetation present with well-established root systems. No evidence of past equipment operation.
1	Slight	Site in virtually undisturbed. Vegetation present or redeveloping with well-established root systems. Organic layers intact. Surface soil intact and uncompacted. Impressions of wheel tracks may be present.
3	Moderate	Vegetation present or redeveloping. Old organic layers partially intact or missing; new litter layer developing. Surface soil intact but puddled and/or compacted. Wheel tracks or cleat marks evident.
4	High	Vegetation shows signs of stress. Organic layer removed. Surface soils partially or totally removed, or may be mixed with subsoil. Some evidence of blading, gouging, or turning.
5	Severe	Vegetation restricted or severely stunted. Organic layer removed. New litter layer redeveloping or absent. Surface soil absent. Subsoil exposed, compacted, or removed. Evidence of excessive blading and gouging. Hydrology affected.

Soils response variables-- Soil exposure is the proportion of area disturbed which equals the number of transect points classified 3 or higher divided by the total number of points per unit. Soil compaction is the proportion of area compacted which equals the number of transect points classified 3 or higher divided by the total number of points per unit. Total soil disturbance (%area disturbed) is the number of exposed plus compacted points minus points in which both disturbances have occurred, divided by the total number of assessed points per unit.

Soil microorganism diversify protocol-- Forest floor microarthropods will be sampled at each soil chemistry sampling plot by collecting a 625 cm^2 square of forest floor in a plastic bag. The sample will be refrigerated and transported to the Corvallis FSL for Berlese extraction by Chris Niwa. After extraction, microarthropods will be identified to the lowest possible taxonomic unit, and counted (additional protocols per Andy Moldenke). At each soil chemistry sampling plot (6 X 16 = 96), 100 cm^3 cores of soil at the surface will be collected, bagged, and labeled for extracting soil fungi, bacteria, and nematodes (detailed protocols as per Elaine Ingham, pers. comm.).

Soils response variables-- Forest floor microarthropods and soil decomposer response variables are counts of each major microarthropod fungi, bacteria, and nematode functional group summarized by treatment unit.

Western thatch ant protocol– This portion of work is not addressed by the FFS program. Specific objectives are as follows:

1) Estimate the population density of western thatching ant (*Formica obscoripes* Forez) colonies within each experimental unit (a colony is a population of individual ants organized around a reproductive center, usually a single queen; a nest is a constructed living space for the queen, brood, and workers of a given colony)
2) Estimate the number of individual western thatching ant workers within each experimental unit
3) Assess the relative health of the colonies
4) Place the colonies on unit maps.

Sampling will be accomplished by using fully expanded plot centers (each plot sample will thus represent 1963.5 m^2 of area). From each plot center, a wire flag will be placed at the terminus of a 25 m line in each cardinal direction. The area within the 25-m radius circle will then be carefully surveyed for western thatching ant colonies one quadrant at a time. When a colony's nest is found, a wire flag and ribbon will be used to mark the nest location, a sample of at least 25 worker ants will be collected and placed in a vial with prepared label, and the following information will be noted:

1) A sequential number will be assigned to the colony in order of discovery
2) The distance and bearing from the nest site to the nearest plot center (locate on plot map)
3) Nest condition, assessed as follows: 0=abandoned; 1=apparently declining (thatch poorly organized, low worker density); 2=healthy (thatch well organized, moderate worker density); 3=thriving (thatch well organized, high worker density on nest and trails)
4) Tending activity, assessed as follows: 0=none; 1=one thriving honeydew source; 2=two thriving honeydew sources; 3=three or more thriving honeydew sources

5) Above-ground nest dimensions, measured by height, N-S basal diameter, E-W basal diameter, of both thatched portion and entire mound portion

6) Presence or absence of reproductives

7) A photograph of the nest will be taken with the camera and 50mm lens mounted on a tripod, 120 cm above the ground and 2 m distance from the nest, and facing due north.

8) Any special conditions about the location of the nest, e.g., proximity to old skid trails, pits, campgrounds, etc.

Western thatch ant response variables– The relationship between nest size and worker numbers will be determined by excavating at least 20 nests in the same forest type outside the study area, estimating the number of workers in nests having a wide range of sizes, and then correlating nest size with worker numbers.

Fuel-- FFS response variables and protocols per Sally Haase (PSW) to be used by Ottmar crews. The primary goals of the fuel and fire behavior analyses are to characterize the changes in fuel loading resulting from fire and fire-surrogate treatments, and to document fire behavior during the fire treatment applications. Ground, surface, understory, and overstory fuels will be measured before and after treatment. In addition, fuel moisture content, fire behavior measurements, and fire weather data will be collected at the fire treatment application sites. Other variables, such as smoke emissions and soil heating, are of value in assessing effects of treatments that include prescribed fire. These are not included as core variables in this study, however, because of their cost and/or complexity. Smoke emissions models may be available for the Hungry Bob study area, and can be used to estimate the smoke factor. The specific fuel variables to be measured are tabulated below:

Ground fuels	L-layer (newly cast litter), F-layer (litter beginning to break down yet still identifiable) H-layer (humus consisting of unidentifiable organic material)
Surface Fuels	Coarse woody debris Ground-level plant biomass
Understory Fuels	Live and dead shrub and sapling biomass
Overstory Fuels	Standing live and dead biomass of trees and tall shrubs Vertical and horizontal distribution of overstory fuels
Fire Behavior	Fuel moisture Fire weather Flame length Rate of spread Smoldering duration

The L- and F-layers contribute significantly to fire behavior in the fire treatments, whereas changes in the H-layer are more important in affecting the severity and below ground consequences of the fire. Thus, the mass of the ground fuel component must be measured or accounted for on each treatment plot.

The amount of forest floor material can be determined by destructively sampling the forest floor material or by estimating the weight by developing a regression equation relating forest floor mass to forest floor depth. In order to develop a forest floor prediction equation, the site needs to have an undisturbed, well-developed forest floor, whereas a forest floor with mostly L- and F- and little H-layer material will not usually produce a reliable prediction equation. However, being able to use this indirect method of predicting forest floor weight allows the use of duff spikes to estimate forest floor mass in the burn treatment plots both before and after a fire with less disturbance in sensitive areas where such disturbance may affect fire behavior.

Samples used to develop the prediction equation are randomly selected in areas that have the full range of forest floor depth on the plot. If blocks are used in the design of the study site, a different predictive equation may be necessary for each block if there appears to be significant differences. Fifty samples (each 1.0 ft^2 = 930 cm^2) is the minimum number of samples needed to produce the predictive equation. Each sample is collected by layer (L, F, and H) and bagged separately. A depth for each layer is measured in the center of each side of the square foot sample and the depths are then averaged for that sample.

The amount of forest floor material removed by prescribed burning is critical for defining vegetation and soil responses as well as smoke production potential. A series of eight duff pins will be used to determine the amount of forest floor material removed. The eight steel pins will be located on two perpendicular axes located at each grid point and marked with pin flags to aid in relocating. Each pin will be pushed into the forest floor and mineral soil until the head of the pin is flush with the top of the litter layer. The location of the pins will have to be determined once other activities around the grid points are defined so that they are located in undisturbed areas. After the fire, each pin is relocated and the distance from the top of the pin to the top of the remaining forest floor is measured and recorded. The total distance from the top of the pin to mineral soil is also recorded for each pin. These measured depths are then applied to the prediction equation to estimate the tons per acre of forest floor material present and what amount is removed by burning.

Destructive sampling will be required to characterize the forest floor on the plots receiving thinning due to the high level of physical disturbance the thinning may produce. It may also be necessary to destructive sample forest floor material on the control plots. The destructive forest floor samples will be taken in conjunction with the woody fuel transects. The down dead woody fuels will be measured using Brown's (1974) planar intercept method. Fuel will be classified by size class (0-1/4"=0-6 mm, 1/4-1/2"=6-12 mm, ½-1"=12-25 mm, 1-3"=25-75 mm, and >3"=>75 mm), decay class condition (sound and rotten), and the number of intercepts and diameters of >3" diameter material by species. This fuel inventory will need to be done prior to treatment application, after thinning activity is completed and after the application of the prescribed fire treatments. It is expected that at least 4,000 ft (1,220m) of transect will be measured on each treatment plot. The recommended number of samples would consist of two 20 m transects randomly placed at each grid points. These transects need to be permanently marked with reinforcement rods so that the same transects are measured for post burn sampling.

The number of pieces of different decay classes than those mentioned previously could be estimated from the information collected from the woody fuel transects if these decay classes are more relevant to some of the treatment effects. They would have to be defined prior to the woody fuel sampling process. Only the diameter at the point of the intersection is recorded. The actual volume (including length) and distribution would not be adequately determined by the transect method.

Biomass estimates of grass will be made because grass may be an important contributor to fire behavior or effects. The grass will be destructively sampled before and after treatment.

The overstory fuels are critical in estimating fire risk and crown fire potential on a site. Species, tree density, diameter at breast height, ladder fuel height, number of canopy layers, height to live crown, total height, and percent canopy closure are critical variables and are needed to calculate fire risk and crown fire potential. These variables will be changing during the applications of the treatments within the study. The collection of these data will be part of the basic vegetation sampling and will be incorporated into the overstory plot descriptions for each plot and subplot.

Samples for the measurement of fuel moisture will be collected just prior to the application of the burn treatments. Forest floor samples will be collected by layer to represent the plot condition. Woody fuel moisture content samples will be collected by size class. Moisture content must also be determined for the live fuel component. This will be done by vegetation class (grass, forb and shrub) and will be sampled to represent the entire plot. The moisture content is determined on an oven dry basis. This information will be collected by the burning crew of the Wallowa-Whitman National Forest.

It will be necessary to document fire behavior at each burn treatment plot to be able to qualify the fire intensity between fire treatment plots. Flame length will be measured as an ocular estimate on the flame front. Rate of spread is estimated by timing the movement of the flaming front to cover a known distance. This will be done for both heading and backing fire fronts. Flaming and smoldering stage duration will be measured during the course of the burn. The flame length and rate of spread will be taken as sets of measurements at regular intervals (i.e., every 15 minutes), throughout the lighting phase at selected grid points. In addition, flaming and smoldering duration will be ocularly estimated at the same selected grid points. Prior to and during the burning operations on the fire treatment plots, ambient temperature, relative humidity, and wind speed and direction will be collected as fire parameters.

Wildlife-- FFS response variables and protocols will be used, and per the national FFS program, a JVA will be used to collaborate with Dr. Steve Zack (Wildlife Conservation Society) that will include his direct oversight and the hiring, training, and supervision of non-Forest Service wildlife crews. Protocols to be uses at Hungry Bob, as listed below, follow those approved for the JFSP FFS national program with minor deviations because pretreatment observations were not made (Table 5). The diversity and abundance of birds in response to the vegetation treatments will be assessed through the use of point count censuses. Nest productivity (number of young fledged per nest initiated) of nesting birds will be monitored in a subset of sites. Finally, the functional response of foraging woodpeckers and other bark-gleaners to the treatments will be evaluated.

Point counts are a standardized method (Ralph and others 1993) of assessing the diversity and abundance of birds by counting individuals (detected by hearing and by sight) at points. As the treatment units will have grid points at every 50m, wildlife teams will assess birds at every 200 m, with 50 m radii of detection. Depending on the shape of each treatment unit four to five points per unit will be assessed for five minutes per point. Each treatment (the four replicates of control, fire-only, fire plus mechanical harvest, and mechanical harvest-only) will be assessed six times (six replicates per treatment unit) during the two-month spring-summer breeding season. The main output of this method will be an assessment of the kind (diversity) and number (abundance) of birds detected as a function of controls and treatments.

Nest productivity (i.e., assessment of the production of young/nest of a given species) will be assessed by standardized methods (Ralph et al., 1993). Wildlife crews will randomly assign two replicates of each treatment (including controls) to be thoroughly searched for bird nests and monitored until the fate (fledging young or failure) has been determined. The data will be analyzed in terms of overall productivity, and analyzed by categories (cavity vs. cup-nesters vs. ground nesters) and by species.

Evaluating the “functional” response of woodpeckers and other bark-gleaning birds (e.g., chickadees, titmice, nuthatches, creepers) will involve observing their foraging patterns on trees in each site, emphasizing tree condition (including “risk rating”), dbh, and a measure of fire-scarring. As woodpeckers forage on larval bark beetles and other insects infecting tree tissue, and ultimately create cavities essential for wildlife from several taxa, the response of woodpeckers to the proposed treatments will be emphasized. The wildlife team will evaluate woodpecker response by quantifying foraging excavations on bark-beetle infested trees during each year of the study and looking for evidence of cavity excavation in these and other snags. Microhabitat measurements will be made near each nest (e.g., substrate measures, cover) and each woodpecker or bark-gleaner tree chosen for foraging. These data will be correlated with the plot data taken by the vegetation team so that both teams can collect data in a comparable manner. All of the foraging and microhabitat observations will be referenced to the nearest grid point.

Table 5. Outline of wildlife measurements, timing, scale and intensity for Hungry Bob

Measurement	Season	Scale	Effort	Output
Bird point counts	June-August	Every 200 m	All plotssix repeat visits	Abundance and diversity
Bird nest productivity	June-August	Where found on sampled plots	Two plots each treatment (= 8 plots total)	Young/nest per nesting species
Bird “functional response”	June-August	Sampling foraging “bark gleaners”	Two plots each treatment (= 8 plots total)	Foraging response to “treated” trees
Mammal capture-recapture	June-AugustPre- and Post-Treatment	6X6 grid, 40 m apart, with two live traps and, at every other trap, a pitfall trap	All plots, sampled one time/yr (10 day-night periods)	Abundance and diversity
Herpetofauna pitfall trapping	June-AugustPre- and Post-Treatment	Pitfall trap at every other grid point in a 6X6 grid array (above)	All plots, sampled one time/yr (10 day-night periods)	Abundance and diversity

It is generally quite costly and difficult to effectively sample populations of small mammals and the herpetofauna. However, there are methods being developed that may provide better sampling reliability at lesser cost. The wildlife crew under the direction of the FFS program wildlife leader will establish a 6 X 6 grid, with grid points spaced 40 m apart, on each plot with one Sherman XLK and one Tomahawk #201 at each grid point, and a pitfall trap at every other grid point. Traps will be spaced at 25m intervals. Pitfall traps will be kept dry as the objectives are to have a minimum impact on the mammal and herpetofaunal population and population estimates will need to be based on marking and recapturing animals.

Traps will be inspected morning and night for 10 day/night periods at each experimental area. This inspection interval will reduce mortality. It will also ensure that traps are available in both daylight and night hours, thereby affording the greatest potential for capturing specimens of all species present. Trapping will be completed within an approximate one month period after the juvenile mammals appear. These methods should do a reliable job of sampling the ground-dwelling small mammals and herpetofauna; however, these methods will probably not suffice for arboreal or fossorial mammals for which there are no cost-effective methods available.

For the more abundant taxa, estimates of absolute abundance or at least relative abundance will be developed. For less abundant taxa, presence vs. absence information may be the most quantitative analysis possible. Taxa will be aggregated as appropriate to develop analyses of population differences among functional groups.

Microhabitat measurements of vegetation will be made near each trap setting (pitfall trap + Sherman + Tomahawk trap). These will be correlated with those of the plot data taken by the vegetation team. All trap settings will be referenced to the nearest grid point.

The wildlife team will interact on a regular basis the vegetation crew in order to match the status (time since infection, source of infection) of infected trees with woodpecker foraging patterns and drilling patterns. This will allow the correlation of tree mortality with onset of cavity excavation. For woodpeckers and the other bark-gleaners the wildlife team will record the tag number of the individual tree identified during foraging observations so as to later correlate bird utilization patterns with tree characteristics. Interaction with vegetation crew will also ensure that microhabitat variables associated with nest-site choice in birds and small mammal and herp trapping sites can be correlated with the overall habitat features (e.g., tree density, shrub and herbaceous cover) on a per site basis.

VI. Quality Assurance/Quality Control Procedures

This planned research will be conducted as a team effort between the Wallowa-Whitman National Forest, PNW Station scientists, various universities, and the Wildlife Conservation Society, in addition to contracts with individuals. It will require a high degree of cooperation and coordination with the Wallowa Valley Ranger District. Personnel performing data collection functions are responsible for operational maintenance and calibration of any measuring or recording instrument. Accuracy of each instrument will be maintained using manufacture's recommended procedures for daily calibration and annual maintenance. Approximately 10 percent of morphological measures (tree diameters, char height, canopy cover of herbaceous species, soil bulk density, etc.) will be remeasured (blind resampling) to determine precision levels. For computer entry and data reduction, the identified personnel are responsible for verification of data entry, documentation of data completeness, accuracy, precision, and implementation of corrective action.

Data will be stored in log books, computers, and backup disks. Numeric data will be entered and stored in spreadsheet form compatible with QuattroPro. File headers will identify fields, units, experimental conditions, and other relevant information. All files will be readily convertible to ASCII files. Complete pretreatment data currently exists for all treatment units; data resides in LaGrande and Corvallis. Pretreatment data will be used to aid in design and development of the FFS corporate database; all pretreatment data in electronic format at the 50-m grid point scale will be migrated to a corporate database in year 2000, and maintained on the FS network. Hardtop backups and the complete study file, including documentation of methods and equipment used, training and certification of personnel, any notes from field personnel, study plan amendments, copies of manuscripts and technology transfer materials, and safety documentation will be housed in fireproof storage at LaGrande.

VII. Application of Research Results

The common sampling grid will allow the use of both ANOVA and regression to identify linkages among variables at the treatment unit scale. For example, while fuel reduction may lower fire hazard and risk, removing down woody material may also reduce foraging habitat for birds and numerous macroinvertebrate species. Measuring both the extent of fuel reduction and its effect on components of biodiversity may help to identify thresholds that would be useful for fine-tuning management to achieve more holistic objectives. Measuring belowground variables in a fuel reduction context should help to better understand the interplay between rotting wood and the soil environment. Because decomposing wood plays an important role in nutrient cycling, measuring the extent of fuel reduction, as well as soil chemistry and plant growth, should help identify ecological tradeoffs inherent in the application of management activities. Finally, since the Hungry Bob project will collect both ecological and economic data on common sites under similar conditions, managers will be able to assess tradeoffs between these two broad classes of information.

The JFSP FFS network, of which Hungry Bob is one of eleven sites, is in response to the perception among managers, scientists and policy makers that seasonally dry forests nationwide are at increased risk to stand-replacement disturbances. Each participating site will apply the same four treatments (control, burn, thin and burn, thin) replicated at least three times, measure the same set of core response variables with a common plot design and over the same relative time period. Common experimental design between sites and sampling design within sites will allow three distinct and useful types of analysis in addition to the typical non-integrated, single discipline analysis: 1) integrated, multidisciplinary analyses among disciplines at the site scale (ANOVA, Regression); 2) integrated, single disciplinary analyses among sites (ANOVA); and 3) summary comparison of multidisciplinary results among sites (descriptive statistics). Because communication among sites will be facilitated by a network structure, participating scientists will gain perspective from other sites as they carry out their own site-specific work, and will be able to analyze their data within a richer context. Managers will also benefit, especially if repeatable patterns of results are observed where fire and fire surrogate treatments are applied nationwide.

For Hungry Bob, one MS thesis on economics of mechanical thinning was produced in 1999. One Ph.D. dissertation addressing overall economics of all treatments is in progress. Additional papers will address initial change in forest structure and composition, initial changes in soil ectomycorrhizae, initial changes in microarthropod and western thatch ant populations, and fuel reduction pending complete post-treatment observations. One integrating paper will address first year post-treatment response. Additional papers will describe the results after the fourth-year post-treatment assessment. At this point, we will begin to integrate and synthesize results from across the FFS network.

VIII. Safety and Health

PNW and R6 personnel will be conducting much of the fieldwork under normal field conditions of spring, summer and fall. All Federal personnel will be informed of and operate under approved safety procedures as detailed in FSH 6709.11– Health and Safety Code Handbook. Supervisors will ensure appropriate Job Hazard Analyses are completed before work begins. Safety and health issues for those operating under contract, cooperative agreement, or joint venture agreement are not addressed here.

IX. Environmental Analysis Considerations

All NEPA issues have been addressed by the Wallowa Valley Ranger District.

X. Personnel Assignment, Time of Completion, and Cost

Pretreatment personnel requirements-- A two-person crew established the unit boundaries and 50-m grid points for all 16 units (400 points total) in two weeks. A three-person crew collected all baseline pretreatment vegetation, entomology, and pathology measurements in five weeks. Soils took about 10 weeks for a single person, fuels about three weeks with four-person crew. No pretreatment wildlife data were collected.

Post-treatment personnel requirements-- A four-person post-treatment crew will collect vegetation, entomology, pathology, soils and forest floor data and CWD measurements. Wildlife data will be collected as per the national protocol with network crews. Fire behavior and first-order fire effects data will be collected by Roger Ottmar’s crew and personnel from the Wallowa-Whitman National Forest. Post-fire fuels data will be collected by Roger Ottmar’s field crew. Some work outside of FFS is funded by the NRI grant.

Budget items approved by the JFSP are listed in table 6.

Table 6. Site budget for Hungry Bob, a site in the national FFS network

	FY00	FY01	FY02	FY03	FY04
Salaries and Benefits					
Site Manager (USFS Term-1 position)	33,000	33,990	35,010	36,060	37,142
Site Integration Analysis (USFS Term)	0	0	0	36,060	37,142
Technical Assistants (USFS Seasonal)					
Vegetation	6,000	10,800	0	0	10,800
Entomology	7,000	7,000	0	0	7,000
Pathology	2,000	2,000	0	0	2,000
Soils	5,000	5,000	0	0	6,000
Fuels	3,840	12,800	0	0	0
Wildlife (costs as per national protocol)	21,350	21,350	8,000	8,000	8,000
Total Salaries and Benefits	**78,190**	**92,940**	**43,010**	**80,120**	**108,084**
Travel					
Vegetation	0	8,700	0	0	8,700
Entomology	0	0	0	0	0
Pathology	0	0	0	0	0
Fuels	3,520	5,080	0	0	200
Soils	200	200	0	0	200
Wildlife	19,500	19,500	6,500	6,500	6,500
Total Travel	**23,220**	**33,480**	**6,500**	**6,500**	**15,600**
Equipment and Supplies					
Vegetation	0	0	0	0	5,000
Entomology	0	0	0	0	0
Pathology	0	0	0	0	0
Fuels	200	0	0	0	0
Soils	4,000	0	0	0	0
Wildlife	15,000	15,000	5,000	5,000	5,000
Total Equipment and Supplies	**19,200**	**15,000**	**5,000**	**5,000**	**10,000**
Contracts					
Fuel Analysis	0	1,200	0	0	0

Soil characterization	9,600	0	0	0	0
Soil analysis	12,560	22,320	0	0	35,120
Total Contracts	**22,160**	**23,520**	0	**0**	**35,120**
Publications & technology transfer	**0**	**0**	**10,000**	**5,000**	**2,000**
Direct Costs Total	**142,770**	**164,940**	**64,510**	**96,620**	**170,804**
Indirect costs PNW Station (15%)	**21,416**	**24,741**	**9,676**	**14,493**	**25,621**
Annual Funding Requested	**164,186**	**189,681**	**74,186**	**111,113**	**196,424**

Total funding allocated from JFSP: $735,590.

XI. References

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