Operational fertilization effects on under-story vegetation

A Thesis

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Degree of Master of Science

with a

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by

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ABSTRACT

This research was designed to investigate fertilization's effects on understory vegetation in conifer stands in the inland Northwest. Results of this study are presented in three sections with these main objectives: 1) determine if fertilization increased annual production and nutrient concentration and contents in understory vegetation; 2) determine if multi-nutrient fertilization changed understory vegetation diversity in understory vegetation; 3) create a model to estimate understory annual production in relation to overstory tree density as measured by basal area and multi-nutrient fertilization.

Experimental designs and statistical analyses differed between the three sections. Transects were established at sites located throughout the inland Northwest. The transect was the sampling unit for this study. Overstory density as measured by basal area and crown competition factor were assumed to be similar between treatments. Annual production was estimated by use of the comparative yield method based on Haydock and Shaw (1975). This part of the study consisted of four treatments: multi-nutrient, Nitrogen only, and Nitrogen + Potassium treatments, and control. These estimates were used to determine if fertilization increased understory annual production and to predict understory annual production following multi-nutrient fertilization. Analysis of variance and t-tests were used to determine if fertilization increased understory vegetation annual production. However, overstory density on some sites differed between treatments and Analysis of Covariance was used. Non-linear regression was used to create a statistical model to predict understory vegetation annual production following multi-nutrient fertilization. Nutrient analysis was conducted on vegetation clipped in the comparative yield method plots as well as additional vegetation collected along the transects. Only vegetation in the multi-nutrient fertilized units was

analyzed by use of t-tests. Percent cover data on understory vegetation was used to determine if fertilization changed diversity. T-tests and Analysis of Covariace (if overstory density differed between treatments) were used to determine if diversity changed.

Results of this study show that fertilization can change understory vegetation dynamics. The statistical model created to predict understory vegetation annual production explained variation while still being field practical. Fertilization produced variable results to increase understory vegetation annual production, diversity, and to change nutrient concentrations. This study showed that several factors may influence understory vegetation response to fertilization such as overstory tree density, overstory tree species, and present understory species composition.

et al. 1986). Fertilization combined with proper harvesting techniques could be used to increase overstory growth, support grazing, and provide wildlife habitat.

There are many environmental variables and species interactions that may not allow for causal effects of fertilization to be measured (Persson 1981). Understory vegetation may show more response immediately after fertilization or more response several years after fertilization. It is important to accurately quantify fertilization response so that resource managers can better manipulate understory vegetation, thereby allowing them to best meet management objectives. Therefore our study had two primary objectives: first, to determine if fertilization increases understory vegetation production in conifer stands in the inland Northwest; and second determine if fertilization increases understory nutrient content. A secondary objective was to determine if fertilization increases wildlife habitat through increases in the aforementioned understory vegetation growth and nutrient contents.

METHODS

Site Description

40N04W01~ General Basalt Hill Area

There were five study sites located near Potlatch, Bovill, and New Meadows in Idaho, Goldendale, Wa. and Wallowa, Oregon. A wide range of habitat types (Steele et al. 1981, Gifford Pinchot National Forest 1989, Johnson Jr. and Clausnitzer et al. 1992), soil parent materials, and overstory species were fertilized and subsequently sampled (Tables 1 and 2). Site descriptives and fertilization treatments are also provided in Tables 1 and 2. Precipitation amounts for 1997 and 1998 are provided in Table 3.

Overstory tree species composition included mixed conifers as well as plantations composed of Douglas-fir and ponderosa pine (Table 1). Goldendale was a Pseuodtsuga menziesii vegetation series and New Meadows was a Abies grandis vegetation series. The Bovill locale was comprised of a Thuja plicata vegetation series. Wallowa was comprised of two different sites, both Abies grandis vegetation series. Potlatch consisted of three different sites all located on Thuja plicata vegetation series.

Site layout

One hundred meter transects were situated in each treatment unit, with quadrats located every 10 meters for a total of 11 quadrats. Transects were oriented to minimize site (slope, aspect, etc.) and vegetation variation across the treatment unit. The transect is the sample unit in this study for both understory vegetation and overstory density (basal area). Vegetation sampling plot centers were established every 10 meters along the transects and plot centers were marked with a blue painted PVC pipe to facilitate measurement. The areal extent and physical arrangement of the various study locations differed (Table 1) resulting in variable numbers of transects per location. Goldendale had eight transects (4 per treatment), New Meadows had 6 transects (three per treatment), Bovill had eight transects (two per treatment). Wallowa consisted of two stands, a ponderosa pine plantation with 5 transects per treatment and a mixed conifer site with 4 transects per treatment for a total of 8. Potlatch consisted of 3 stands, a Douglas-fir plantation, a western redcedar (Thuja plicata)/grand fir (Abies grandis) site with four transects per treatment, a total of 8 in each stand, and a ponderosa pine plantation with four transects in the control, and five transects in the fertilized unit. By design, different over-story tree species compositions were included in the study as follows: Bovill – mixed conifer (grand fir, Douglas-fir, western redcedar, western larch (Larix occidentalis), and western white pine (Pinus monticola). New Meadows – ponderosa

METHODS

Site Description

There are five locations included in this study; three are located in Idaho, with one each in Oregon and Washington. A wide range of sites, vegetation series, habitat types (Steele et al. 1981, Gifford Pinchot National Forest 1989, Johnson Jr. and Clausnitzer et al. 1992), soil parent materials, and overstory species were sampled (Table 1). Overstory tree species composition included mixed conifers as well as plantations composed of Douglas-fir and ponderosa pine (Table 1).

Site layout

One hundred meter transects were layed out with 1/300th of an acre quadrats located every 10 meters for a total of 11 quadrats. Transects were placed to minimize variability within a transect as well as capture variation across the treatment unit. The transect is the sample unit in this study. The areal extent and physical arrangement of the various study locations differed (Table 1) resulting in variable numbers of transects per location.

Treatments

We assume that the small differences in the micro-nutrient component of the fertilizer blends had no significant effect on understory response or diversity. All sites had control and multi-nutrient treatments. The multi-nutrient blend at both Bovill and Potlatch locations was 200 pounds of N, 100 pounds of K, 80 pounds of S, 10 pounds of copper (Cu) and 5 pounds of boron (B) per acre. Application at both Bovill and Potlatch locations was conducted in the

Table 1. Slope (in degrees) (S), aspect (A), elevation (in feet) (E), and parent material (P), for five study sites located throughout the inland Northwest.

Site	S	A	E	P
Bovill, ID	16	S	3500	Gneiss/schist
Goldendale, WA	5	S	2200	Basalt
New Meadows, ID	11	SW	4100	Basalt
Potlatch, ID	11	NE	3150	Granite
	20	NW	3050	Granite
	3.5	W	3050	Granite
Wallowa, OR	15	NE	4000	Basalt
	12	NW	3700	Basalt

redcedar/grand fir sites. ANCOVA (basal area or CCF as a covariate) was used to analyze the data for the sites where a significant difference was found between transect densities. Covariate selections (basal area or CCF) for the Potlatch Douglas-fir plantation was based on overall model significance and covariate significance. T-tests were used at all other sites to test the hypothesis that fertilization changed diversity. ANCOVA and t-tests were conducted using PROC GLM of the Statistical Analysis System (SAS Institute Inc. 1985). The alpha level chosen for significance was 0.10 which was consistent with Sullivan et al. 1998.

RESULTS

Multi-nutrient fertilization showed mixed results in significantly changing overall diversity for the different study sites. Diversity changes due to fertilization were also variable within lifeforms. Most analyses showed no significant change in diversity for the Shannon-Weiner index (SWI) or the Simpson Index (SI) (Table 3).

Multi-nutrient fertilization was found to increase diversity using the SWI. Increases in overall lifeform diversity for the SWI were seen at the New Meadows ponderosa pine site for mid-summer and late-summer in 1997, and at the Douglas-fir plantation site at Potlatch for mid-summer and New Meadows for late-summer in 1998 (Table 3). The only increase in shrub diversity for the SWI occurred at the western redcedar/grand fir site at Potlatch in mid-summer (Table 3). Forbs showed significant increases in diversity for the SWI in both sampling periods at the Douglas-fir plantation site at Potlatch (Table 3). Significant increases in diversity for grasses for mid-summer occurred at the New Meadows ponderosa pine site in 1998 and the Potlatch Douglas-fir plantation site in mid-summer, and for late-summer only at the Douglas-fir plantation site at Potlatch (Table 3).

Increases in diversity following multi-nutrient fertilization were observed for the SI. Overall lifeform increases in diversity for the SI were seen in 1997 for mid-summer at the New Meadows ponderosa pine site (Table 3). Increases in overall lifeform diversity for 1998 were observed at the Douglas-fir plantation site at Potlatch for mid-summer, and at the New Meadows ponderosa pine site for the late-summer sampling period. Shrub diversity increases using the SI only occurred at the western redcedar/grand fir site at Potlatch in mid-summer (Table 3). Forbs only showed significant increases in forb diversity at the Potlatch Douglas-fir plantation for both sampling periods (Table 3). Significant increases in grass diversity were observed at the New Meadows ponderosa pine site in mid-summer for 1998 and at the Douglas-fir plantation site for both sampling periods (Table 3).

Decreases were generally observed for the SWI across all lifeforms due to multi-nutrient fertilization. Decreases in overall lifeforms were observed for 1997 in the late-summer sampling period and for 1998 in mid-summer at the Goldendale mixed-conifer site (Table 3). Shrubs showed significant decreases in diversity for the SWI in 1997 for late-summer at the Goldendale mixed-conifer site and in 1998 for both sampling periods at the Goldendale mixed-conifer site and late-summer at the ponderosa pine plantation at Potlatch (Table 3). Forbs showed a significant decrease in diversity at the Goldendale mixed-conifer site for all three sampling periods (Table 3). Grasses showed no significant changes in the SWI due to multi-nutrient fertilization.

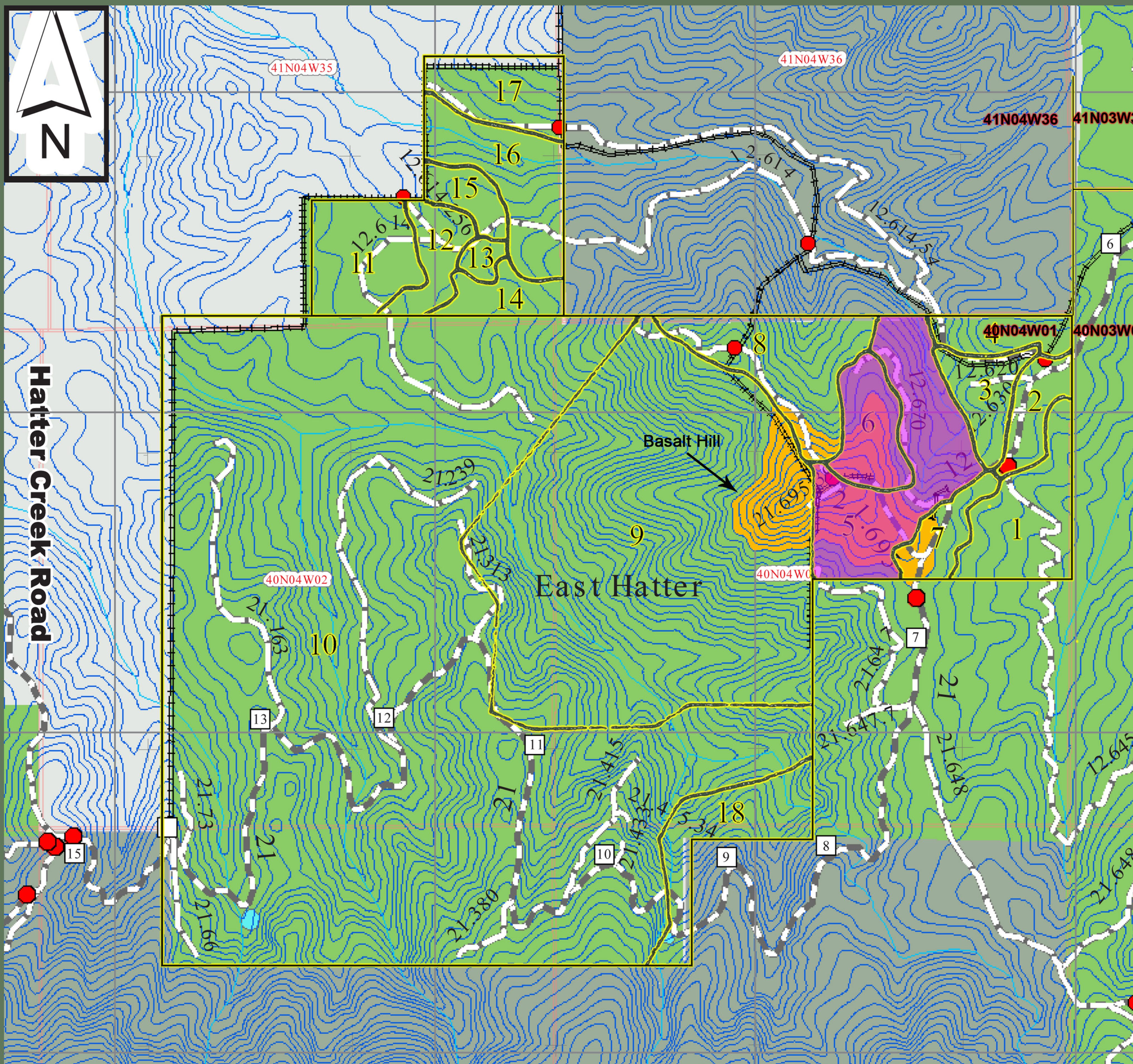
The SI showed decreases in diversity following multi-nutrient treatments. Overall lifeform diversity decreased at the Goldendale mixed-conifer site in 1997 for the late-summer sampling period, and in 1998 for mid-summer at Goldendale mixed-conifer site and for both sampling periods at the ponderosa pine plantation at Potlatch (Table 3). Shrubs showed a significant decrease in diversity for the SI in 1997 for late-summer, and 1998 at the Goldendale mixed-conifer site for mid-summer and the ponderosa pine plantation for late-summer (Table 3). Significant decreases in diversity for forbs were observed at the Goldendale mixed-conifer site for both years in late-summer (Table 3). Grasses showed no decreases in diversity for the SI following multi-nutrient fertilization (Table 3).

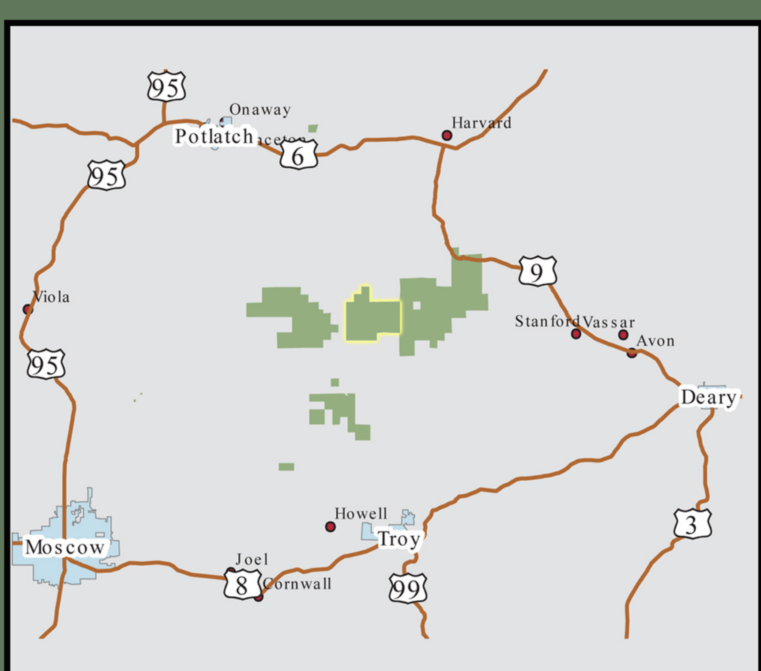
Most results were consistent between 1997 and 1998 sampling years and for both sampling periods for the SWI within sites and lifeforms. However, different results were observed for overall lifeforms at the New Meadows ponderosa pine site for mid-summer and the Goldendale mixed-conifer site for late-summer (Table 3). All results observed for shrubs and forbs in 1997 were consistent with findings in 1998 for the SWI (Table 3). Grasses showed different results for the SWI in mid-summer at the New Meadows ponderosa pine site (Table 3).

The SI showed differences in diversity between years within sites and lifeforms. Measurements in diversity were different for overall lifeforms between years at the New Meadows ponderosa pine site for mid-summer and at the Goldendale mixed-conifer site and the New Meadows ponderosa pine site for late-summer (Table 3). Shrubs showed differences in diversity between years at the Goldendale mixed-conifer site in late-summer (Table 3). No differences in diversity were observed for forbs between years (Table 3). However, grasses showed differences in diversity for the SI between years at the New Meadows ponderosa pine site in mid-summer (Table 3).

DISCUSSION

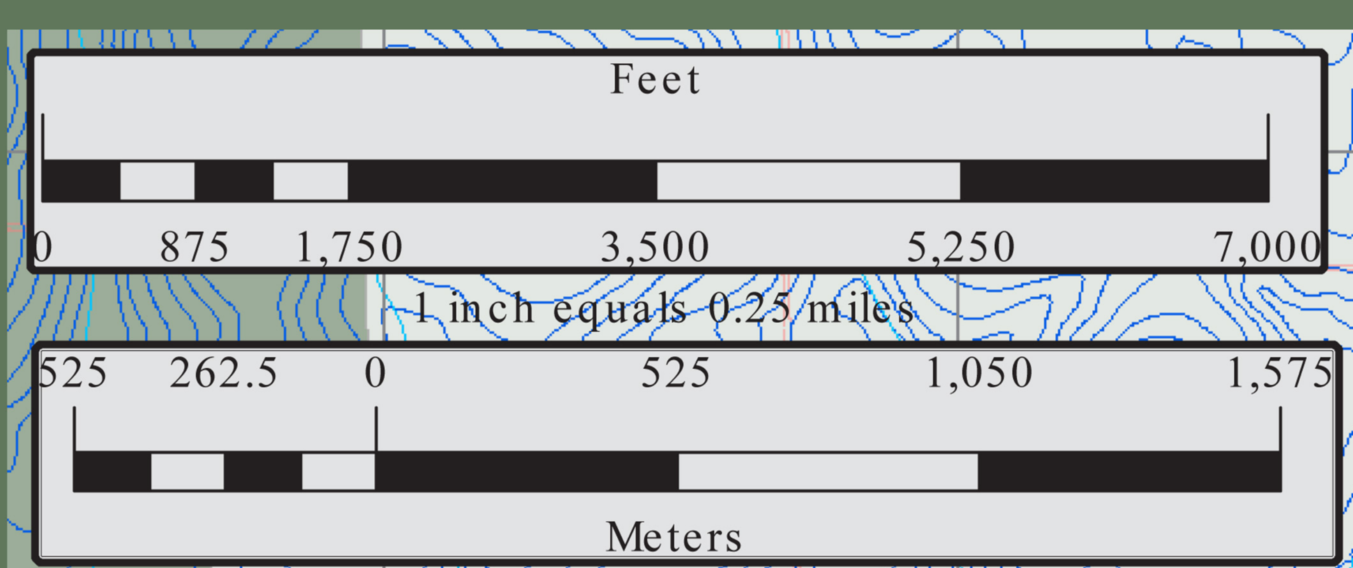
Diversity, as measured by the indices we used, is determined by the weighted





UI Experimental Forest Administrative Map 2004

- 6-Meter Contours
- Running Surface Water
- Fencelines
- Railroad Grade
- Forest Gravel Road
- County Paved Road
- County Gravel Road
- County Dirt Road
- State Road
- Public Land Survey System
- Forest Gates
- CB Mile Markers
- Cattleguards
- Fire Ponds
- University of Idaho Experimental Forest
- Bennett Lumber Products
- Potlatch Corporation
- City of Troy Forest



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Location of Complete Research:

Author & Title: **VanderSchaaf, Curtis**
Operational Fertilization Effects on Under-Story Vegetation (1999)

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Other Sources: