Botanical implementation and validation monitoring of project buffers; second year report

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PREFACE

This report is the result of a cooperative Challenge Cost Share project between the Institute for Applied Ecology (IAE) and a federal agency. IAE is a non-profit organization dedicated to natural resource conservation, research, and education. Our aim is to provide a service to public and private agencies and individuals by developing and communicating information on ecosystems, species, and effective management strategies and by conducting research, monitoring, and experiments. IAE offers educational opportunities through 3-4 month internships. Our current activities are concentrated on rare and endangered plants and invasive species.

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Cover photographs: looking through area towards a rare species buffer (upper right), *Allotropa virgata* at a buffer in the Grants Pass Resource Area (photographs by Andrea S. Thorpe).

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Areas selected for timber harvest often contain rare and threatened species that are known to prefer interior and/or old forest habitats. Because of this, areas of uncut forest are frequently left where these species are known to occur in order to provide refuge habitat. However, because these patches are surrounded by cut forest, the may be subject to edge effects that may have negative impacts on the species of concern.

Edge effects have been observed in a number of species. California red-backed voles (*Clethrionomys californicus*) were found six times more often in the interior of forest remnants than on edge (Mills 1995, but see Tallmon 2004). Distribution of the primary food item of red-backed voles, hypogeous sporocarps of mycorrhizal fungi, followed the same patterns as the voles' distribution, suggesting that that fungus was more abundant in the interior of forest remnants than along the edge (Mills 1995). Growth of two moss species in boreal forests in northern Sweden increased exponentially with distance from the edge to the interior in both north- and south-facing edges (Hylander 2005).

Gradients in microclimate have been found to vary through space and time, and have been found to be affected by the type of timber operation, the variables being measured, topographic relief, and forest type (Chen 1999, Danehy and Kirpes 2000, Meleason and Quinn 2004, and Anderson et al. 2007). For example, in one study, the depth to which the edge-effects penetrated the interior of a forest varied from 16 to 137 m (Chen 1992). The majority of these studies have been conducted in relatively mesic forests (e.g. western Cascade forests dominated by *Pseudotsuga menzeisii*) where the buffered areas have been along riparian zones. There is little information on depth to which edge effects can be observed in more xeric forests, such as those found in southwest Oregon.

In the Medford District of the Bureau of Land Management (BLM), areas of uncut forest (buffers) are left around Sensitive Species during timber operations. These buffers are typically 100 ft. in radius. However, if the buffer is located near a forest edge, the boundary of the timber harvest may be altered so that the buffer is contiguous with the adjacent uncut forest. The assumption guiding these practices has been that 100 ft. is sufficient to ameliorate the effects of the timber cut on environmental variables that would affect the growth of Sensitive Species. ***The objective of this study*** was to determine the appropriateness of using buffers with a 100 ft. radius to protect Sensitive Species. This report summarizes the second year of monitoring. For results of the first year of monitoring, see Thorpe 2008.

METHODS

We selected nine study sites distributed in three resource areas in the Medford District for this study (Table 1). Sites were selected primarily based on the ability to locate obvious buffers.

Table 1. Locations of buffer study sites.

Resource Area	Buffer type*	UTM or Lat./Long.	TRS
Ashland			
Landing N	circular		T37S R3E S19
Landing S	circular		T37S R3E S19
Yellow Gate N	circular		T37S R3E S19
Yellow Gate S	circular		T37S R3E S19
Grants Pass			
GP3	edge	42°33'58", 123°29'35"	T34S R7W S35
GP4	edge	10T463639N, 4705620W	T35S R6W S29
GP8	circular	10T457440N, 4716380W	T34S R7W S27
GP13	edge	10T459672N, 4710165W	T35S R7W S11

*Edge buffers are those where the proposed buffer was located near the boundary of the timber harvest and so the boundary was altered in order to envelope the buffer. Circular buffers are those where the buffer was located in the interior of a designated harvest area and a circular buffer with a radius of 100 ft was left surrounding a sensitive species located near the center of the buffer.

At each site, we placed five monitoring stations, one each in the cut area, on the edge of the cut and buffer, 50 ft into the buffer, approximately 100 ft into the buffer, and 125-150 within the buffer. We determined the locations for each monitoring station by haphazardly selecting a location on the southern edge for the "edge" ibutton station then running a transect into the center of the buffer. We placed the cut stations along the same transect line, approximately 100 ft into the harvest area. When a buffer was not large enough for a station greater than 100 ft. to the interior (e.g. most circular buffers), we placed the station in an adjacent uncut forest with approximately the same elevation and aspect.

At each station, we used a densiometer to determine canopy cover and placed iButtons (Maxim/Dallas Semiconductor, Dallas, Texas; http://www.ibutton.com) to measure the relative humidity, aboveground temperature, and belowground temperature,. iButtons were programmed to take measurements every 20 minutes. Belowground iButtons were placed on a fob, attached to a tag and wire and buried approximately 18 cm below ground. The wire was looped through a large nail with a washer at the top in order to aid in locating the iButton at the end of the monitoring period (Figure 1). The aboveground iButtons were placed on a fob, then attached to a wooden stake. Stakes were positioned facing north. We stapled a playing card to the top of each stake to shelter the iButton from direct sun and rain (Figure 1).

Monitoring stations recorded data from 04/22/2008 to 06/28/2008 for aboveground temperature and relative humidity. Belowground temperature was recorded from 04/22/2008 to 09/25/2008. From the pooled data, I determined which day was the coolest and wettest (04/30/2008) and hottest and driest (05/16/2008) aboveground. For each of these dates, I calculated the daily minimum, maximum, average, and variance aboveground temperature, relative humidity, and belowground temperature. Variance was calculated as $\sum(x-\bar{x})$. For each variable, I tested for the effect of Resource Area and landscape position using an Analysis of Variance (NCSS 2001). When appropriate, differences between positions were determined using Fisher's LSD. I also calculated the variance for each variable over the entire monitoring period. The relationship between position and variance was tested using a linear regression (NCSS 2001).

Figure 1. A monitoring station to measure aboveground temperature and relative humidity. On the surface of the ground to the right of the stake you can see the washer and tag for a belowground iButton.

RESULTS

Contrary to expectations, canopy cover was lowest on the edge of the buffers, not in the cut (Figure 2). Cover was approximately the same in the cut and at 50 ft., then increased slightly towards the interior of the buffer.

On the coldest, wettest day, the cut area tended to have the lowest minimum temperature and average relative humidity (Table 2). It also had the highest variance in aboveground temperature and relative humidity. There were few significant differences between interior buffer positions (50 ft, 100 ft, and 150 ft), though as a group they were usually different from the edge (0) and cut (-100 ft).

On the hottest, driest day, we observed significant differences between positions for only the variance in relative humidity and minimum belowground temperature (Table 3). Similar to on the coldest, wettest day, there were few significant differences between interior buffer positions (50 ft, 100 ft, and 150 ft), though as a group they differed from the edge (0) and cut (-100 ft).

Total variance in both relative humidity and aboveground temperature increased along the gradient from the most interior buffer position to the harvest area (Figure 3; P = 0.0054, R^2 = 0.22 and P < 0.0005, R^2 = 0.52, respectively). There was no effect of position on total variance in belowground temperature.

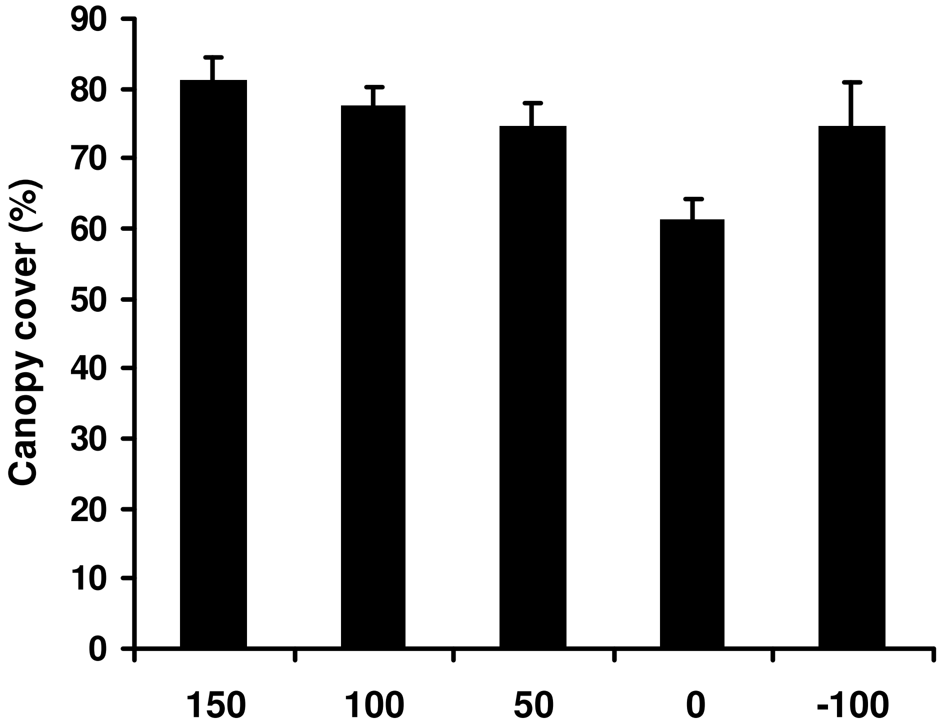

Figure 2. Average canopy cover (%) at five locations along a transaction from a cut area (-100) into the interior of a forest (150) measured at nine sites in the Medford District, BLM. Bars are means + 1 S.E.

Table 2. Variation in climatic variables at different positions relative to the edge of a rare species buffer and a timber harvest on 30 April, 2008 (the **coldest, wettest day** of the study period). Positions are "150" feet interior to the buffer, "100" feet interior to the buffer, "50" feet interior to the buffer, on the edge, and approximately 100 feet into the harvested area. The effect of treatment was tested using an ANOVA. When $p < 0.05$. Fisher's LSD was used to test for differences between positions; positions that differed significantly are indicated by different letters.

	Mean (SE) for each position				
	150	100	50	edge (0)	harvest (-100)
Relative Humidity					
Min.	64.42 (5.96)^{ab}	67.27 (4.34)^{ab}	65.87 (3.16)^{ab}	58.50 (4.00)^{bc}	53.70 (3.89)^{c}
Max.	103.27 (1.98)	103.60 (.086)	104.30 (1.06)	103.76 (1.27)	104.49 (1.00)
Ave.	92.28 (2.78)	92.96 (2.38)	93.63 (2.19)	91.07 (2.46)	89.93 (2.14)
Var.	114.59 (24.77)^{a}	118.95 (30.70)^{a}	115.88 (23.11)^{a}	157.37 (25.28)^{ab}	218.95 (36.17)^{b}
Aboveground Temperature					
Min.	0.91 (0.48)	0.72 (0.33)	0.62 (0.33)	0.52 (0.35)	0.43 (0.31)
Max.	15.1 (1.46)	13.2 (0.91)	11.1 (1.45)	8.84 (1.07)	11.4 (1.65)
Ave.	4.24 (0.87)	3.84 (0.67)	3.80 (0.63)	4.37 (0.58)	4.84 (0.64)
Var.	8.24 (1.69)	8.10 (1.63)	7.92 (1.04)	11.78 (1.20)	15.53 (1.68)
Belowground Temperature					
Min.	7.11 (0.74)^{ae}	5.33 (0.86)^{a}	6.50 (0.50)^{ac}	7.42 (0.61)^{bce}	8.50 (0.0)^{be}
Max.	7.92 (0.68)^{a}	7.70 (0.68)^{a}	7.63 (0.48)^{a}	9.50 (0.53)^{b}	10.63 (0.42)^{c}
Ave.	7.43 (0.69)^{a}	6.30 (0.59)^{ab}	7.11 (0.49)^{ab}	8.41 (0.47)^{ac}	9.41 (.57)^{c}
Var.	0.080 (0.019)	1.01 (0.82)	0.14 (0.023)	1.08 (0.76)	0.71 (0.36)

Table 3. Variation in climatic variables at different positions relative to the edge of a rare species buffer and a timber harvest on 16 May, 2008 (the **hottest, driest day** of the study period). Positions are "150" feet interior to the buffer, "100" feet interior to the buffer, "50" feet interior to the buffer, on the edge, and approximately 100 feet into the harvested area. The effect of treatment was tested using an ANOVA. When $p < 0.05$. Fisher's LSD was used to test for differences between positions; positions that differed significantly are indicated by different letters.

	Mean (SE) for each position				
	150	100	50	edge (0)	harvest (-100)
Relative Humidity					
Min.	20.6 (2.5)	17.6 (1.0)	17.7 (1.2)	18.6 (2.3)	16.6 (1.9)
Max.	78.5 (6.8)	72.1 (5.1)	74.5 (4.8)	78.6 (4.8)	86.7 (3.9)
Ave.	51.5 (6.9)	45.6 (4.3)	46.1 (3.9)	48.9 (4.3)	55.0 (4.2)
Var.	322.6 (96.5)^{a}	300.1 (59.9)^{a}	320.8 (63.8)^{a}	373.3 (78.0)^{a}	577.1 (97.4)^{b}
Aboveground Temperature					
Min.	15.1 (1.39)	16.2 (0.98)	15.9 (0.93)	15.2 (0.99)	13.2 (1.01)
Max.	37.1 (0.69)	38.6 (0.90)	38.3 (0.82)	40.8 (0.88)	43.2 (1.25)
Ave.	24.5 (0.95)	25.6 (0.55)	25.6 (0.51)	25.5 (0.63)	25.0 (0.74)
Var.	42.5 (7.7)	46.6 (6.3)	47.6 (4.9)	60.2 (6.0)	87.6 (9.3)
Belowground Temperature					
Min.	12.7 (0.3)^{a}	14.4 (0.7)^{b}	13.5 (0.4)^{ab}	14.6 (0.5)^{b}	14.9 (0.4)^{b}
Max.	14.7 (0.2)	19.8 (3.0)	17.0 (0.7)	18.4 (0.9)	19.9 (0.8)
Ave.	13.6 (0.3)	16.7 (1.6)	15.0 (0.4)	16.4 (0.6)	17.1 (0.4)
Var.	0.6 (0.1)	4.4 (3.2)	2.2 (0.8)	1.8 (0.5)	3.4 (1.2)

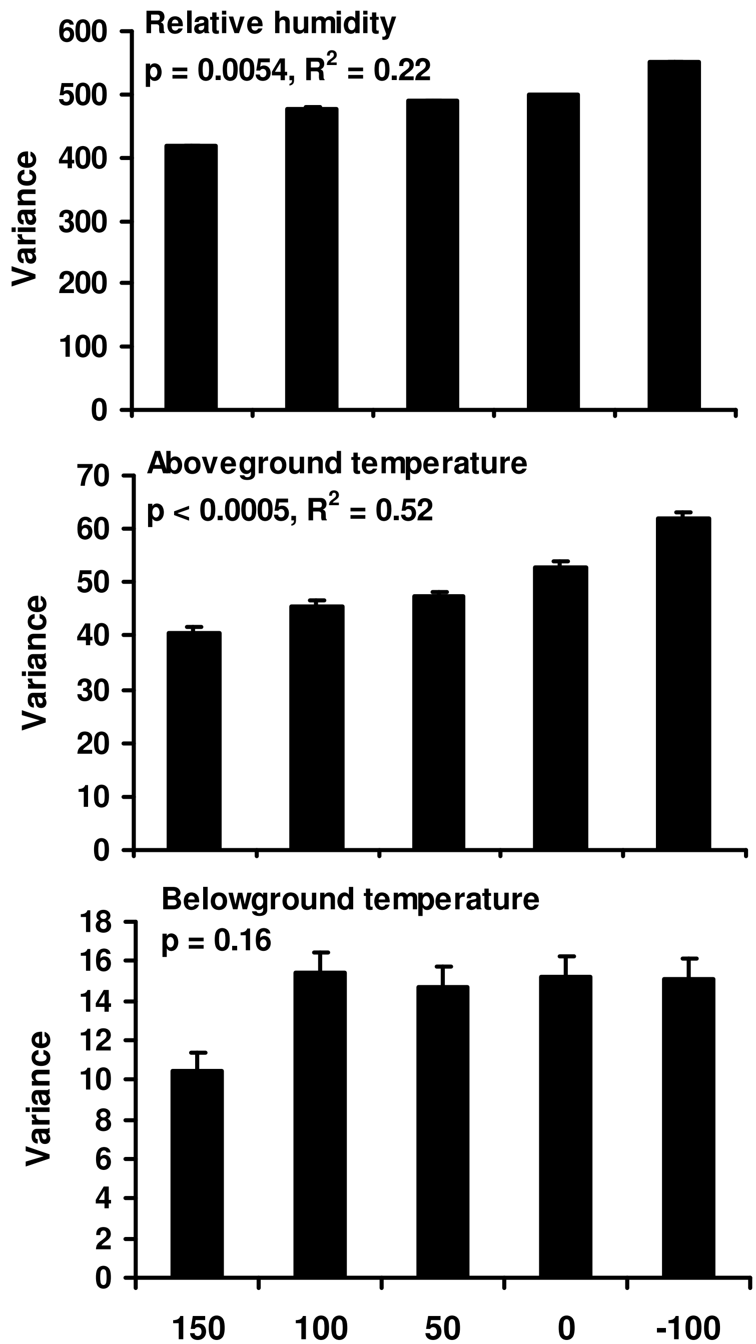

Figure 3. Variance in climatic variables at different positions relative to the edge of a rare species buffer and a timber harvest. The study period was from 04/22/2008 to 06/28/2008 (aboveground variables) or 09/25/2008 (belowground temperature). Positions are "150" feet interior to the buffer, "100" feet interior to the buffer, "50" feet interior to the buffer, on the edge, and approximately 100 feet into the harvested area. The relationship between position and variance was tested using a linear regression.

DISCUSSION

We found that the depth to which micro-climate variables were affected by edge effects depended on both the variables and time-scale under consideration. On both the coldest, wettest and hottest, driest days, we found that while the harvest and edge positions generally differed from the positions within the buffer, there was generally no effect of distance from the edge within the buffer (Table 2, 3). However, when analyzed over the entire time series, both the variance in relative humidity and aboveground temperature increased from the most interior position within the buffer outside to the harvested area (Figure 3). These data suggest that while differences between the positions may be relatively small, the cumulative effects are significant. Anderson et al. (2007) also reported finding small (1-4^{o}C), but significant edge effects on microclimate when comparing thinned stands to unthinned stands.

One of the factors that is likely having a strong influence on our results is the relatively high canopy cover in the harvested areas (Figure 2). The timber harvests at these sites occurred more than three years prior to monitoring and since then, there has been significant shrub growth. Greater edge effects might have been observed the first year after timber harvest.

Our results suggest that there is a small effect of edge on relative humidity, aboveground temperature, and belowground temperature a few years after selective timber harvest, but that a buffer with a radius of 50 – 100’ may be sufficient to minimize changes in microclimate. However, we recommend caution in interpreting these results as we do not know what the edge effects were the first year after harvesting. Even if changes in microclimate are transitory, one year of unsuitable abiotic conditions may cause substantial death in a population. These conclusions are also limited to harvesting methods that maintain some canopy cover. We hypothesize that edge effects would be more apparent if these sites had been clearcut. As it is possible that yearly climatic regime might also affect these results, we will repeat this study in 2009. We also recommend that future studies include data on populations size, plant size, and reproductive output for the species being buffered.

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