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

Andrea S. Thorpe
Institute for Applied Ecology

A Cooperative Challenge Cost Share Project funded jointly by
Bureau of Land Management, Medford District, ***and***
Institute for Applied Ecology

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.

Questions regarding this report or IAE should be directed to:

Andrea S. Thorpe
Institute for Applied Ecology
P.O. Box 2855
Corvallis, Oregon 97339
phone: 541-753-3099, ext. 401
fax: 541-753-3098
e-mail: andrea@appliedeco.org
Internet: www.appliedeco.org

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the contributions and cooperation by the Medford District BLM, especially Mark Mousseaux, Susan Fritts, Armand Rebischke, and Marcia Wineteer. Work was also supported by IAE staff John Grotefend, Tom Kaye, and Shell Whittington.

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).

REFERENCE

Thorpe, A.S. 2010. Botanical implementation and validation monitoring of project buffers: Third year report. Prepared by Institute for Applied Ecology for Medford District BLM. iv + 22 pp.

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.

In previous studies, I found that the depth to which micro-climate variables were affected by edge effects depended on both the variables and time-scale under consideration (Thorpe 2008, 2009). 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. 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. These data suggest that while differences between the positions may be relatively small, the cumulative effects are significant. However, both of our previous studies were limited in that they sampled more frequently, but for shorter portions of the growing season. 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.

The objective of this study was to repeat sampling to determine the appropriateness of using buffers with a 100 ft. radius to protect Sensitive Species. In previous years, we sampled climatic variables more frequently in first (2008) and second (2007) halves of the growing season. In this study, we sampled over the majority of the growing season, but with less frequency.

METHODS

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.

I selected eight study sites, four each in the Ashland and Grants Pass Resource Areas in the Medford District for this study (Table 1). Sites were selected primarily based on the ability to locate obvious buffers.

At each site, I placed four to five monitoring stations, one each in the cut area, on the edge of the cut and buffer, 50 ft into the buffer, 70 – 85 ft, and if possible, 100 ft into the buffer and 150 (Table 1). Distances were determined based on buffer shape and size. The approximate center of the buffers was 70 to 100’ from the edge. When the buffer was on the edge of an uncut area or an uncut area with similar aspect and slope was located nearby, monitoring stations were placed 150’ from the forest edge as an “uncut” reference. For each site, I haphazardly selected a location on the southern edge for the “edge” station then ran a transect into the center of the buffer. I placed the cut stations along the same transect line, approximately 50 ft into the harvest area.

At each station, I 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 placed aboveground (hygrochrons) were programmed to take measurements every hour with 0.5^{o}C accuracy for temperature and 0.63% accuracy for relative humidity. Aboveground iButtons were placed on a fob, then attached to a wooden stake. Stakes were positioned facing north. I stapled a playing card to the top of each stake to shelter the iButton from direct sun and rain (Figure 1). iButtons placed belowground (thermochrons) were programmed to take measurements every 30 minutes with 0.5^{0}C accuracy. Hygrochrons could not be used belowground due to the potential for saturation. 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).

Table 1. Locations of buffer study sites. Distances indicate distances from the cut/buffer edge.

Resource Area	Buffer type*	UTM or Lat./Long.	TRS	Monitoring station locations
Ashland				
Landing N	circular	42.23763N, 122.59568W	T37S R3E S19	cut, edge, 50 ft., 100 ft.
Landing S	circular		T37S R3E S19	cut, edge, 50 ft., 85 ft.
Yellow Gate N	circular	42.34374N, 122.50718W	T37S R3E S19	cut, edge, 50 ft., 100 ft., 150 ft.
Yellow Gate S	circular	42.34160N, 122.50850W	T37S R3E S19	cut, edge, 50 ft., 85 ft.
Grants Pass				
GP3	edge	42°33’58”, 123°29’35”	T34S R7W S35	cut, edge, 50 ft., 70 ft.
GP4	edge	10T463639N, 4705620W	T35S R6W S29	cut, edge, 50 ft., 70 ft.
GP8	circular	10T457440N, 4716380W	T34S R7W S27	cut, edge, 50 ft., 100 ft., 150 ft.
GP13	edge	10T459672N, 4710165W	T35S R7W S11	cut, edge, 50 ft., 100 ft., 150 ft.

*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 up to 100 ft was left surrounding a sensitive species located near the center of the buffer.

Monitoring stations recorded data from 04/13/2009 to 09/13/2009 for aboveground temperature and relative humidity. From the pooled data, I determined which day was the coldest (04/16/2009) and hottest (07/27/2009) aboveground. As there was little difference in the data from 70' and 85', these sites were combined to increase replications for analyses. For each of these dates, I calculated the daily minimum, maximum, average, and variance in aboveground temperature, relative humidity, and belowground temperature. I also calculated the variance for each variable over the entire monitoring period. Variance was calculated as $\sum(x-\bar{x})$. When appropriate, differences between positions were determined using a Bonferonni test for multiple comparisons. I used linear regression to test the hypothesis was that there is a linear relationship between position and each response variable. As the two Resource Areas had different levels of canopy cover and several of the ANOVAs showed a significant difference between the Resources Areas, I conducted separated regressions for each Resource Area. All tests were conducted using SPSS 17.0 (2008).

RESULTS

In both Resource Areas, there was a trend for increasing canopy cover from the cut area to 50' within buffers, then a slight decrease in cover from 50' to 150'. Differences in canopy cover between positions were only significant for the Ashland Resource Area ($P_{position\ x\ RA} = 0.034$). Here, there was significantly higher cover on the edge, 50', and 70' compared to the harvested area.

On the coldest day in the Ashland RA, there was a decrease in variance in relative humidity (Table 2, Figure 3) and aboveground temperature (Table 2, Figure 4) and minimum and average belowground temperature (Table 2, Figure 5) from the cut area to the interior of the buffer. For all of these variables, the decline was strongest from the cut to 50 ft. In Grants Pass RA, minimum relative humidity increased from the cut to 50 ft., then remained relatively stable through 150 ft (Table 2, Figure 3). Variance in relative humidity (Table 2, Figure 3) and belowground temperature (Table 2, Figure 5) decreased from the cut to the interior of the buffer. The mean maximum aboveground temperature in Grants Pass RA decreased from the cut area to 70 ft. in Grants Pass RA, then increased slightly beyond this positions (Table 2, Figure 4). There was no effect of position on any other variable on the coldest day (Table 2, Appendix A Table 1).

On the hottest day, in general, there was an increase in minimum, maximum, and average relative humidity and decrease in variance in relative humidity from the cut to the interior of the buffer in both RA's (Table 3, Figure 6). There was a trend toward increased minimum aboveground temperature and decreased maximum and variance in aboveground temperature in the Ashland and Grants Pass RA's from the cut to the interior of the buffer (Table 3, Figure 7). Similarly, the minimum, maximum, and average belowground temperatures decreased from the harvest to 50 ft. and 70ft. in the Ashland and Grants Pass RA's, respectively, increased at the next sampling position, and then continued to decrease (Table 3, Figure 8). There was no effect of position on any other variable on the hottest day (Table 3, Appendix A Table 2).

The total variance in relative humidity and aboveground temperature decreased from the cut to 50 ft. and 70 ft. in the Ashland and Grants Pass RA's, respectively, increased at the next position, and then continued to decrease (Figure 8). In contrast, there was no relationship between position and variance in belowground temperature.

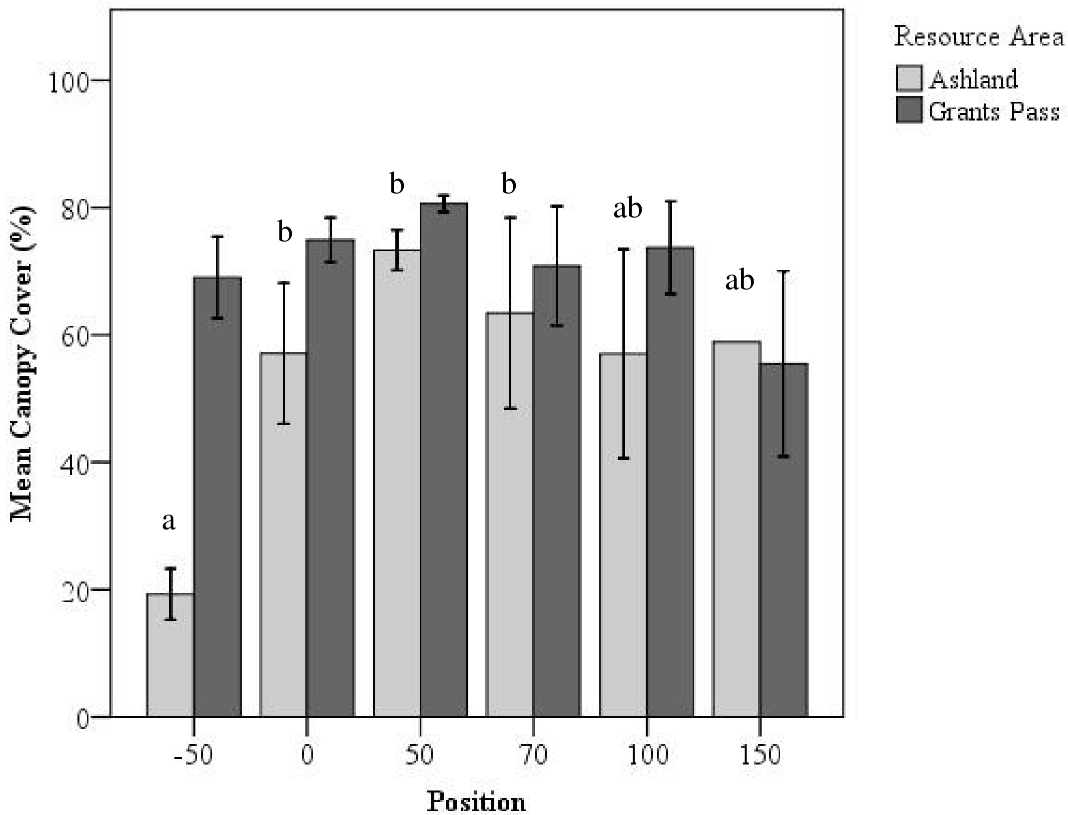


Figure 2. Average canopy cover (%) at five locations along a transaction from a cut area (-100) into the interior of a forest (150) measured at eight sites in the Medford District, BLM on 09/16/2009. Bars are means + 1 S.E. Different letters indicate $P \leq 0.084$.

Table 2. Variation in climatic variables at different positions relative to the edge of a rare species buffer and a timber harvest on 16 April, 2009 (the **coldest day** of the study period). *P < 0.10* is in *italics*. **P < 0.05** is in **bold.**

Analysis of Variance	Min.	Max.	Ave.	Var.
Relative Humidity				
Resource Area	*0.010*	0.111	**0.002**	**0.002**
Position	0.161	0.213	0.461	*0.087*
RA * Position	0.699	0.749	0.872	0.868
Aboveground Temperature				
Resource Area	**<0.0005**	0.811	**<0.0005**	0.250
Position	0.178	**0.044**	0.771	*0.082*
RA * Position	0.837	0.241	0.700	0.462
Belowground Temperature				
Resource Area	**<0.0005**	0.296	**0.007**	0.185
Position	0.710	0.287	0.425	0.316
RA * Position	0.348	0.491	0.344	0.520

Regression, Ashland	Min.	Max.	Ave.	Var.
Relative Humidity	P=0.302 (0.076)	P=0.119 (0.165)	P=0.688 (0.012)	*P=0.054 (0.239)*
Aboveground Temperature	P=0.012 (0.332)	P=0.114 (0.109)	P=0.331 (0.068)	**P=0.019 (0.334)**
Belowground Temperature	**P=0.043 (0.261)**	P=0.230 (0.101)	*P=0.058 (0.234)*	P=0.801 (0.005)

Regression, Grants Pass	Min.	Max.	Ave.	Var.
Relative Humidity	**P=0.0.030 (0.263)**	P=0.688 (0.010)	P=0.122 (0.143)	**P=0.044 (0.181)**
Aboveground Temperature	P=0.963 (0.000)	**P=0.025 (0.233)**	P=0.252 (0.081)	P=0.444 (0.037)
Belowground Temperature	P=0.243 (0.090)	P=0.214 (0.101)	P=0.914 (0.001)	**P=0.045 (0.242)**

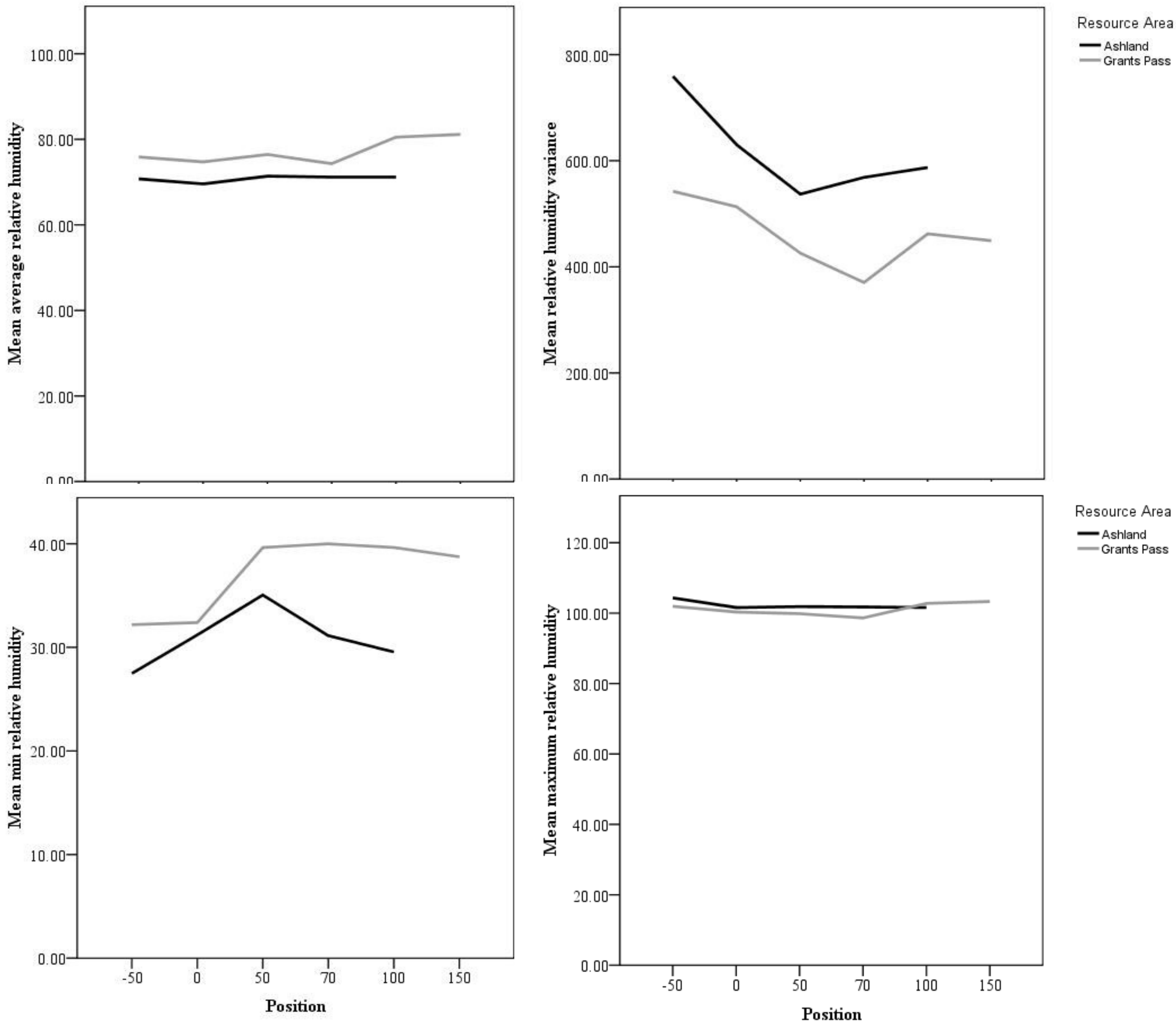


Figure 3. The relationship between position and relative humidity on the coldest day (04/16/2009). See Table 2 for statistical analysis. Position ranges from in the cut at -50 to 150 to the buffer.

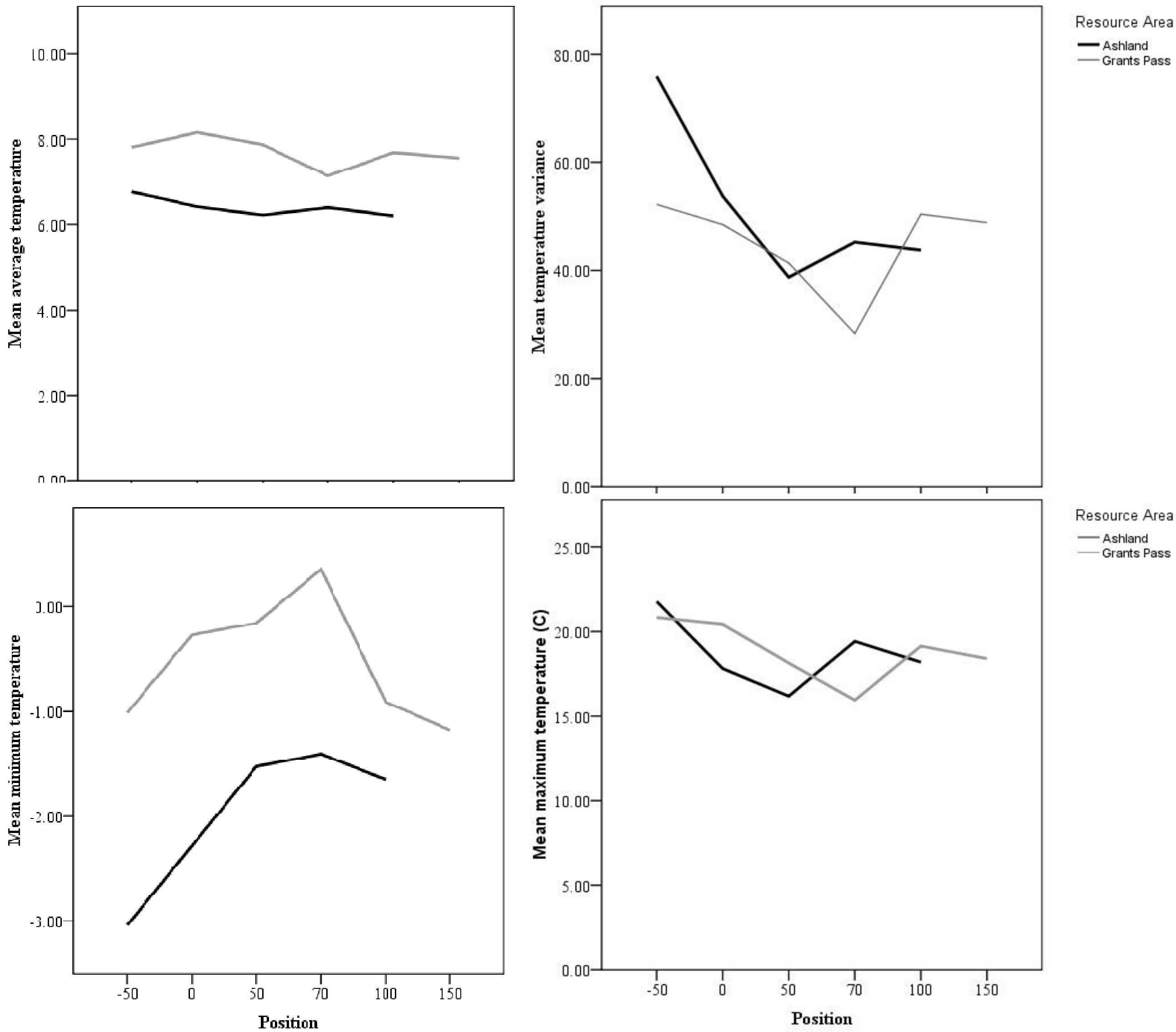


Figure 4. The relationship between position and aboveground temperature on the coldest day (04/16/2009). See Table 2 for statistical analysis. Position ranges from in the cut at -50 to 150 to the buffer.

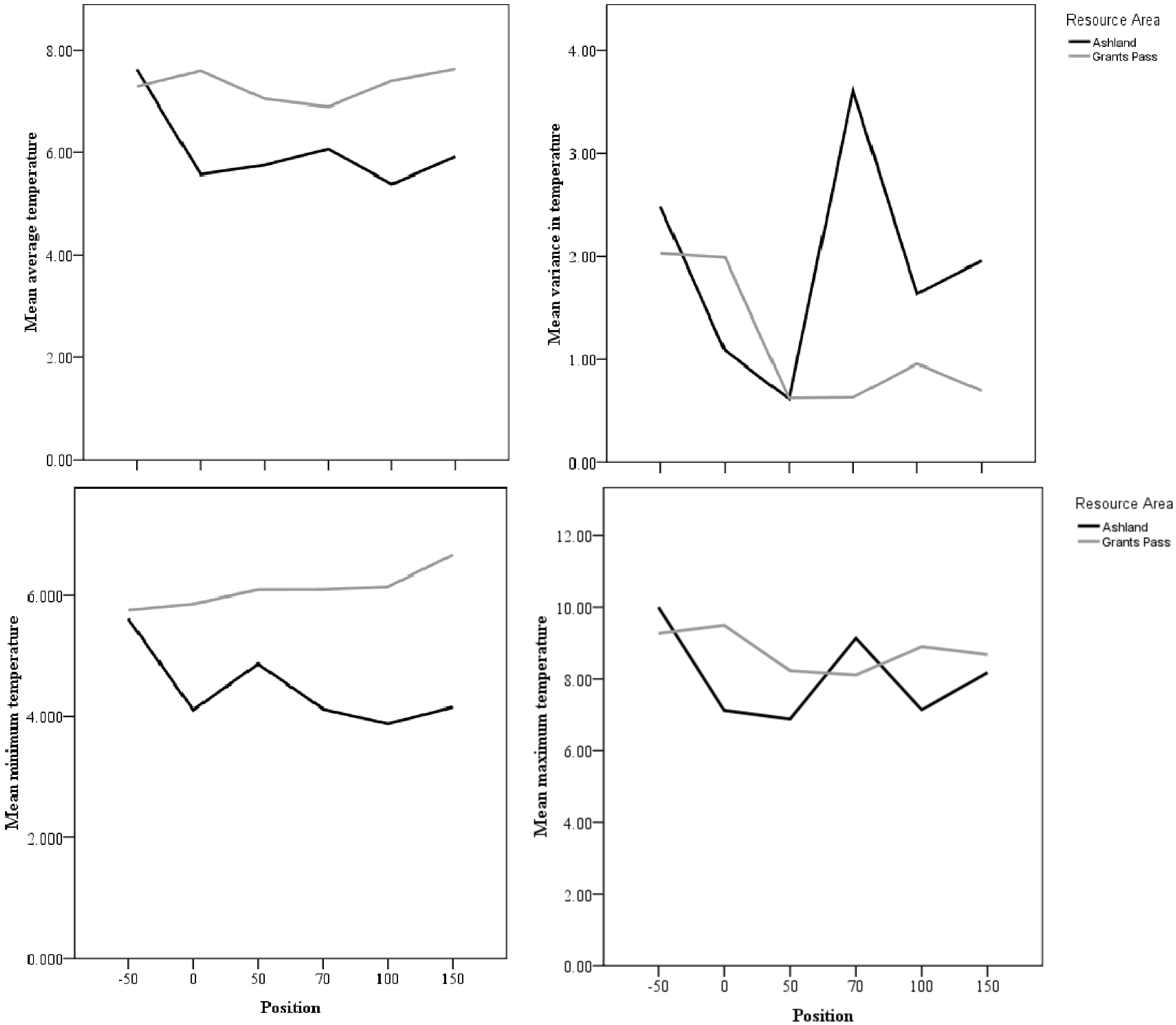


Figure 5. The relationship between position and belowground temperature on the coldest day (04/16/2009). See Table 2 for statistical analysis. Position ranges from in the cut at -50 to 150 to the buffer.

Table 3. Variation in climatic variables at different positions relative to the edge of a rare species buffer and a timber harvest on 27 July, 2009 (the **hottest day** of the study period).

Analysis of Variance	Min.	Max.	Ave.	Var.
Relative Humidity				
Resource Area	**<0.0005**	**0.001**	**<0.0005**	0.444
Position	0.106	0.116	.205	0.168
RA * Position	0.668	0.512	.547	0.493
Aboveground Temperature				
Resource Area	**<0.0005**	0.811	**<0.0005**	0.250
Position	0.178	**0.044**	0.771	*0.082*
RA* Position	0.837	0.241	0.700	0.462
Belowground Temperature				
Resource Area	0.056	0.716	0.128	0.713
Position	**0.039**	0.407	**0.011**	0.735
RA * Position	0.666	0.303	*0.060*	0.645

Regression, Ashland	Min.	Max.	Ave.	Var.
Relative Humidity				
P	P=0.147 (0.144)	**P=0.09 (0.296)**	*P=0.081 (0.202)*	**P=0.028 (0.301)**
Aboveground Temperature				
P	**P=0.012 (0.376)**	P=0.114 (0.169)	P=0.331 (0.068)	**P=0.019 (0.334)**
Belowground Temperature				
P	*P=0.051 (0.231)*	0.174 (0.119)	*P=0.060 (0.217)*	P=0.593 (0.019)

Regression, Grants Pass	Min.	Max.	Ave.	Var.
Relative Humidity				
P	**P=0.004 (0.408)**	P=0.682 (0.011)	P=0.172 (0.113)	P=0.737 (0.007)
Aboveground Temperature				
P	P=0.113 (0.000)	**P=0.025 (0.278)**	P=0.252 (0.081)	P=0.444 (0.037)
Belowground Temperature				
P	*P=0.093 (0.166)*	0.298 (0.067)	*P=0.064 (0.198)*	P=0.561 (0.022)

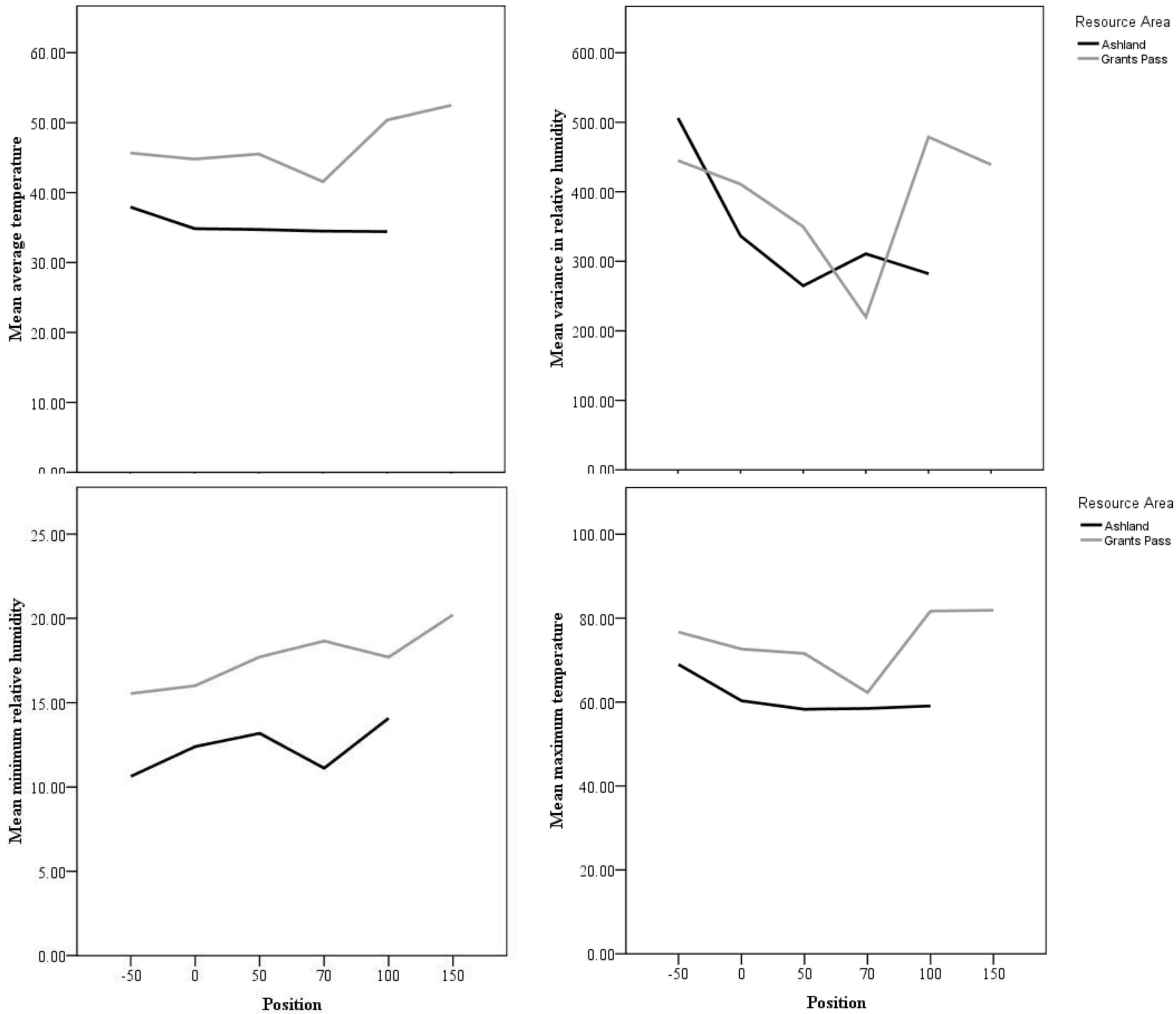


Figure 6. The relationship between position and relative humidity on the hottest day (07/27/2009). See Table 3 for statistical analysis. Position ranges from in the cut at -50 to 150 interior to the buffer.

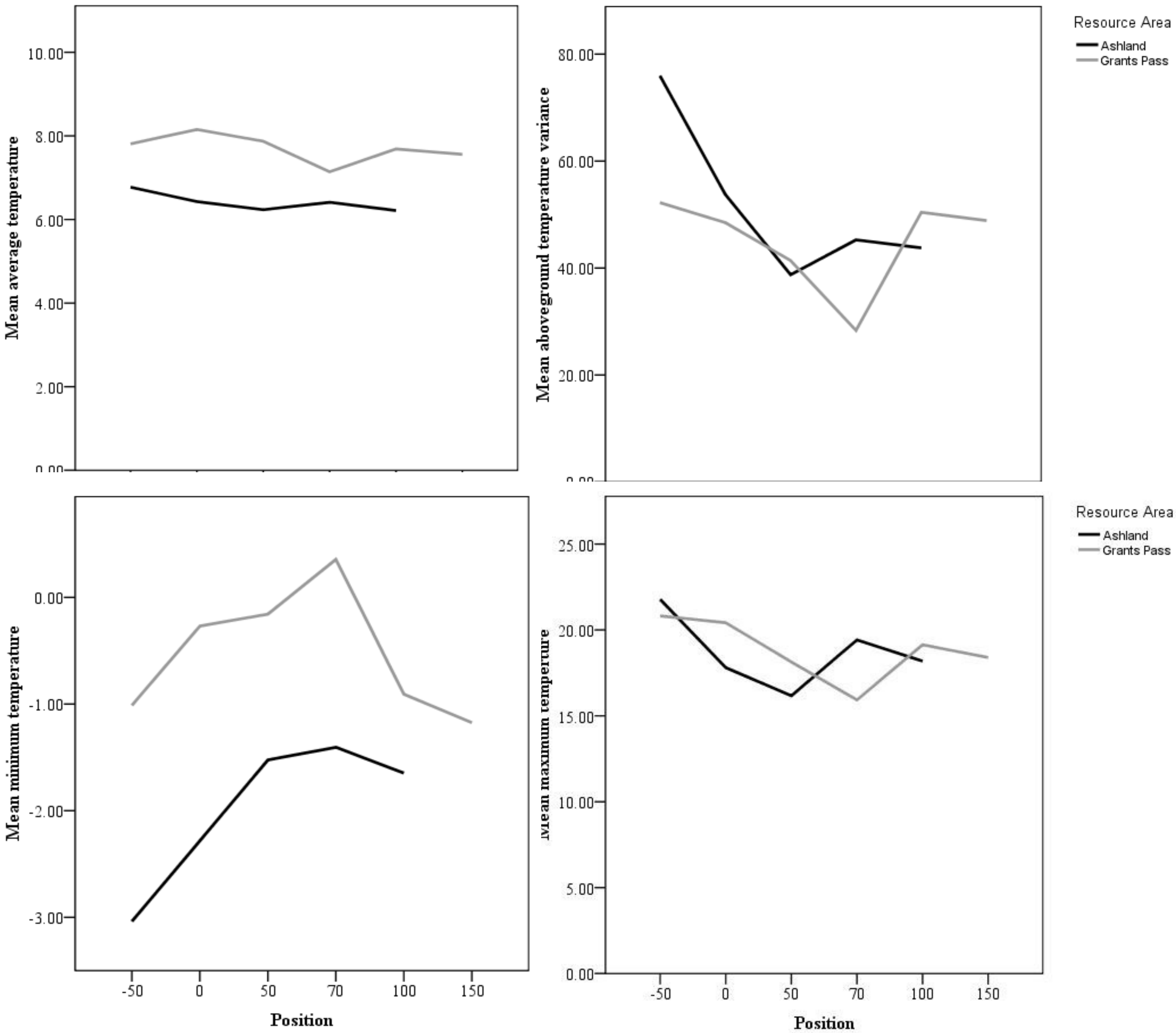


Figure 7. The relationship between position and aboveground temperature on the hottest day (07/27/2009). See Table 3 for statistical analysis. Position ranges from in the cut at -50 to 150 to the buffer.

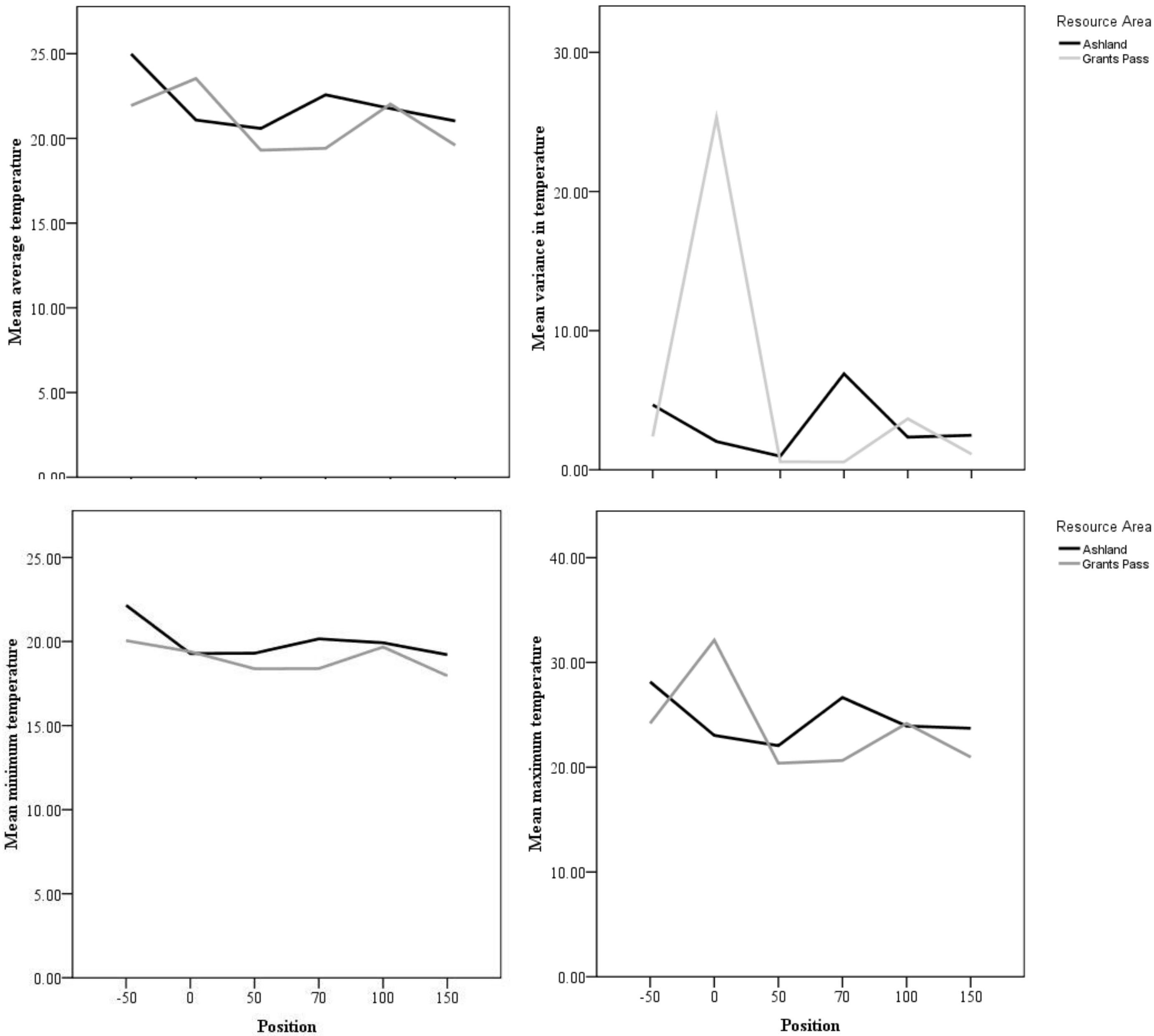
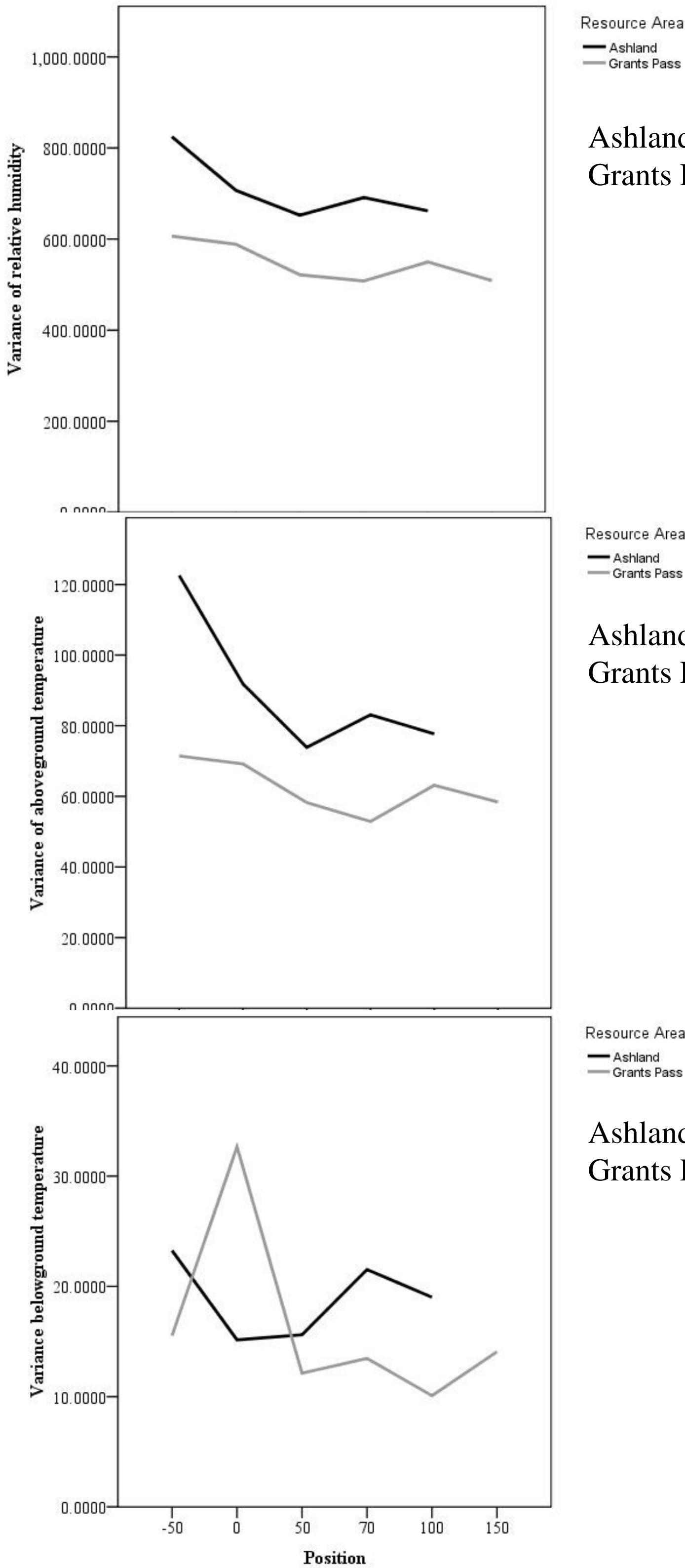


Figure 8. The relationship between position and belowground temperature on the hottest day (07/27/2009). See Table 3 for statistical analysis. Position ranges from in the cut at -50 to 150 to the buffer.



Ashland, *P=0.017*, R^2=0.586
Grants Pass, *P=0.005*, R^2=0.394

Ashland, *P=0.008*, R^2=0.405
Grants Pass, *P=0.012*, R^2=0.336

Ashland, *P=0.300*, R^2=0.077
Grants Pass, *P=0.375*, R^2=0.049

Figure 9. Variance in climatic variables at positions relative to the edge of a rare species buffer and timber harvest, from 04/13/2009 to 09/13/2009. Positions relate to distance from the harvested and buffer edge, from -50 being in the harvest area, 0 on the edge, and up to 150 feet interior to the buffer edge.

DISCUSSION

For most of the variables that I explored on the coldest and hottest days, there was a relationship with distance from the cut/buffer edge. These relationships were generally strongest to 50 ft. in the Ashland RA and 70 ft. in the Grants Pass RA. In previous years, I 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). Although I intended to not place stations beyond the center of the buffer areas. The edges of the buffer areas were often unclear and undulated, so the inflections in the data may be indicative of moving closer to another cut/buffer edge. In some cases, trails and treefall also created openings in the canopy in the interior of the buffer areas.

In every year of this study, I have found that when analyzed over the entire time series, both the variance in relative humidity and aboveground temperature decreased from the cut area to the most interior position within the buffer (Figure 3). These data suggest that even when differences between the positions may be relatively small, the cumulative effects are significant. Anderson et al. (2007) also reported finding small (1-4oC), 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 in the Grants Pass RA is the relatively high canopy cover in the harvested area (Figure 2). In fact, it is somewhat surprising that there were significant edge effects on climatic variables when there was so little difference in canopy cover between the monitoring positions. The harvests in the Grants Pass RA were generally selective thins and a significant number of larger trees remained. Also, 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, but significant effect of edge on relative humidity, aboveground temperature, and belowground temperature a few years after selective timber harvest in the Medford District of the Bureau of Land Management. A buffer with a radius of 50 ft. (Ashland RA) or 70 ft. (Grants Pass RA) may be sufficient to minimize changes in microclimate. However, these results should be interpreted with caution as I 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. I hypothesize that edge effects would be more apparent if these sites had been clearcut. As there were significant differences in the distance of edge effects between the Ashland and Grants Pass RA's, I recommend that extreme caution should be used when trying to apply these results to different geographic regions. Finally, I recommend that future studies include data on population size, individual size, and reproductive output for the species being buffered.

LITERATURE CITED

Anderson, P.D., D.J. Larson, and S.S. Chan. 2007. Riparian buffer and density management influences on microclimate of young headwater forests of western Oregon. Forest Science **53**:254-269.

Chen, J., J.F. Franklin, T.A. Spies. 1992. Vegetation responses to edge environments in old-growth Douglas-fir forests. Ecological Applications **2**:387-396.

Chen, J., S.C. Saunders, T.R. Crow, R.J. Naiman, K.D. Brosofske, G.D. Mroz, B.L. Brookshire, and J.F. Franklin. 1999. Microclimate

Danehy, R.J., and B.J. Kirpes. 2000. Relative humidity gradients across riparian areas in eastern Oregon and Washington forests. Northwest Science **74**:224-233.

Hylander, K. 2005. Aspect modifies the magnitude of edge effects on bryophyte growth in boreal forests. Journal of Applied Ecology **42**:518-525.

Meleason, M.A., and J.M. Quinn. 2004. Influence of riparian buffer width on air temperature at Whangapoua Forest, Coromandel Peninsula, New Zealand. Forest Ecology Management **191**:365-371

Mills, L.S. 1995. Edge effects and isolation: red-backed voles on forest fragments. Conservation Biology **9**:395-403.

Tallmon, D.A., E.S. Jules, N.J. Radke, L.S. Mills. 2003. Of mice and men and trillium: cascading effects of forest fragmentation. Ecological Applications **13**:1193-1203.

Tallmon, D.A., and L.S. Mills. 2004. Edge effects and isolation: red-backed voles revisited. Conservation Biology **18**:1658-1664.

Thorpe, A.S. 2008. Botanical implementation and validation monitoring of project buffers: first year report. Prepared by Institute for Applied Ecology for Medford District BLM. v + 37 pp.

Thorpe, A.S. 2009. Botanical implementation and validation monitoring of project buffers: Second year report. Prepared by Institute for Applied Ecology for Medford District BLM. iii + 11 pp.

APPENDIX A. MEANS FOR CLIMATIC VARIABLES ON THE COLDEST AND HOTTEST DAYS DURING THE 2009 SAMPLING PERIOD.

Table A1. Variation in climatic variables at different positions relative to the edge of a rare species buffer and a timber harvest on 16 April, 2009 (the **coldest day** of the study period). Positions were -50 (harvested area), 0 (harvest/buffer edge), and 50, 70/85, 100, and 150 feet interior to the buffer. Data from stations at 70 and 85 feet were combined to so similarity and in order to increase replication at this distance. Data were not taken at 150' stations in the Ashland Resource Area.

	Mean (SE) for each position					
	-50	0 (edge)	50	70/85	100	150
Ashland Resource Area						
Relative Humidity						
Min.	20.2	28.1	30.7	29.6	21.1	N/A
Max.	105.0	106.5	103.9	103.6	101.7	N/A
Ave.	70.8	69.6	71.4	71.2	71.2	N/A
Var.	744.9	623.2	530.2	561.7	579.1	N/A
Aboveground Temperature						
Min.	-4.4	-4.0	-2.4	-1.9	-1.9	N/A
Max.	26.1	21.2	17.7	22.2	21.4	N/A
Ave.	6.7	6.4	6.2	6.4	6.2	N/A
Var.	74.1	52.3	37.8	44.3	43.6	N/A
Belowground Temperature						
Min.	5.1	3.1	4.1	3.1	3.6	4.2
Max.	10.7	8.6	7.6	13.1	8.7	8.2
Ave.	7.6	5.6	5.7	6.1	5.4	5.9
Var.	2.7	2.1	0.9	7.3	2.7	2.0
Grants Pass Resource Area						
Relative Humidity						
Min.	28.7	28.7	32.3	33.2	35.6	32.7
Max.	103.7	107.8	102.2	99.7	103.1	103.7
Ave.	75.9	74.7	76.5	74.3	80.5	81.2
Var.	534.3	519.4	426.8	368.5	460.4	461.6
Aboveground Temperature						
Min.	-2.4	-1.9	-1.9	0.09	-1.9	-1.9
Max.	22.7	22.4	19.6	17.2	19.1	19.7
Ave.	7.8	8.2	7.9	7.1	7.7	7.6
Var.	50.7	47.1	40.2	28.4	49.5	47.9
Belowground Temperature						
Min.	3.6	5.1	4.6	6.1	5.6	6.7
Max.	9.7	10.6	9.1	8.1	9.1	9.2
Ave.	7.3	7.6	7.0	6.9	7.4	7.6
Var.	2.7	2.6	1.6	0.6	1.0	0.7

Table A2. Variation in climatic variables at different positions relative to the edge of a rare species buffer and a timber harvest on 27 July, 2009 (the **hottest day** of the study period). Positions were -50 (harvested area), 0 (harvest/buffer edge), and 50, 70/85, 100, and 150 feet interior to the buffer. Data from stations at 70 and 85 feet were combined to so similarity and in order to increase replication at this distance. Data were not taken at 150' stations in the Ashland Resource Area.

	Mean (SE) for each position					
	-50	0 (edge)	50	70/85	100	150
Ashland Resource Area						
Relative Humidity						
Min.	8.5	8.4	12.3	9.7	11.7	N/A
Max.	76.8	71.5	63.8	64.1	62.4	N/A
Ave.	37.9	34.8	34.7	34.5	34.4	N/A
Var.	495.3	332.2	260.6	314.8	276.5	N/A
Aboveground Temperature						
Min.	13.6	15.2	17.2	17.2	17.7	N/A
Max.	52.1	52.1	45.6	19.6	45.1	N/A
Ave.	29.6	29.3	29.1	29.2	28.9	N/A
Var.	143.8	91.5	63.7	80.5	66.9	N/A
Belowground Temperature						
Min.	21.1	18.1	18.7	19.7	18.7	19.2
Max.	31.1	26.2	22.7	31.6	27.2	23.7
Ave.	25.0	21.1	20.6	22.6	21.8	21.0
Var.	6.7	5.1	1.4	10.9	7.4	2.5
Grants Pass Resource Area						
Relative Humidity						
Min.	13.0	12.4	16.1	16.9	17.4	19.7
Max.	88.0	85.5	85.0	62.6	84.3	83.3
Ave.	45.7	44.8	45.5	41.6	50.4	52.5
Var.	451.9	427.2	267.8	215.7	473.1	429.9
Aboveground Temperature						
Min.	12.7	13.7	13.6	20.7	13.6	13.7
Max.	46.6	45.1	43.6	39.2	43.6	39.1
Ave.	27.9	28.4	27.8	27.8	27.2	26.4
Var.	73.6	71.9	52.2	31.1	75.2	63.6
Belowground Temperature						
Min.	18.7	15.6	18.1	17.6	19.6	17.7
Max.	26.2	55.5	21.1	21.7	26.1	21.2
Ave.	22.0	23.6	19.3	19.4	22.0	19.6
Var.	4.2	29.7	0.9	1.4	4.8	1.1