SHORT-TERM EFFECTS OF FUEL TREATMENTS ON VEGETATION IN HEADWATER RIPARIAN CORRIDORS OF THE MIDDLE ROGUE RIVER BASIN IN SOUTHWEST OREGON

By

Jena DeJuilio

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Approved:

_____________ _______________________________________

Date Dr. Charles Welden, Committee Chair

_____________ _______________________________________

Date Dr. Gregory Jones, Committee Member

_____________ _______________________________________

Date Dr. John Sollinger, Committee Member

_____________ _______________________________________

Date Mr. Paul Steinle,
Director of Graduate Studies

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ABSTRACT

Riparian systems proportionally occupy a narrow slice of the landscape, yet provide beneficial resources in excess of their expanse. Riparian buffers are meant to preserve the natural variability and immense ecological value riparian zones provide. Largely based on research conducted in riparian zones subjected to years of fire suppression, guidelines developed for buffers might misrepresent historical or ecologically sustainable conditions.

To gain a better understanding of prescribed fire effects in riparian areas, changes in plant species richness, composition, and cover were examined both in a non-commercial fuel thinning and prescribed fire treatment applied through the riparian area and compared to the typical buffered riparian area treatment in a Before-After-Control-Impact study. Over the course of treatments, unbuffered riparian areas showed significant declines in subcanopy and forest floor plant cover, greater shifts in species composition, and different trends in species richness relative to buffered riparian areas.

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INTRODUCTION

Situated at the terrestrial and aquatic interface, riparian systems represent the most dynamic and biologically complex environments found in forested ecosystems (Sarr et al. 2005; Naiman et al. 2000; Skinner & Chang 1996). Though they occupy a small portion (0.5 - 2%) of the total landscape (Dwire & Kaufmann 2003; Naiman et al. 1993), these ecological zones provide unique habitat and resources to both aquatic and upland species (Naiman and D'ecamps 1997). Encompassing a three dimensional space, down into the saturated hyporheic zone beneath the stream, out to the flood plain and into the surrounding vegetation, the dimensions of this zone vary considerably depending on environmental characteristics such as stream size and position in the drainage network, the hydrological regime, and geomorphology of the region (Naiman and D'ecamps 1997).

Physically, riparian vegetation stabilizes stream banks, dissipates flood energy, structures instream habitat and moderates stream temperature. Vegetation aids in many critical riparian functions, including the maintenance of low stream temperatures (Macdonald et al 2003), stream bank stabilization, (Arno 1996; Benda et al. 1997), nutrient inputs, water filtration, (Naiman & D'ecamps 1997; Arno 1996), flood energy dissipation, and in stream habitat creation. Heterogeneity in landforms, variation in microclimate, and frequency of disturbance continually modify riparian vegetative composition and diversity (Naiman et al. 2000; Sarr et al. 2005). Many riparian species possess adaptations, such as prolific sprouting, water-dispersed propagules, and fire-promoted budding, which enhance the likelihood of establishment following a disturbance (Dwire and Kaufmann 2003). Additionally, many native species of the region have evolved adaptations to fire and depend on periodic episodes of fire for nutrient cycling, regeneration and other ecological processes (Coogle 2002; Frost and Sweeney 2000).

Riparian buffers, created as a management tool for protection of lentic systems, do provide acknowledged benefits, particularly by acting to alleviate impacts from various land management activities (Macdonald et al. 2003). However, concerns surround their blanket implementation. The standards and guidelines developed to define buffers of varying sizes according to stream classification and fish bearing status, such as in the Northwest Forest Plan (1994), may misrepresent ecologically sound conditions, having largely been based on research conducted in forests subjected to years of fire suppression (Skinner 2003). The understanding of small stream ecology, and particularly their function in the whole watershed, relative to knowledge gained by research on large downstream systems, remains incomplete. This lack of knowledge 'fuels' a debate surrounding the necessary levels of buffer retention for riparian vegetation in small streams (Moore and Richardson 2003).

In the Pacific Northwest, specifically the Klamath Mountains, evidence of fire occurrence (charcoal traces in lake sediment) dates to the Holocene period (Mohr et al. 2000; Whitlock et al. 2003), indicating that fire disturbance played an historic role in this region (Aztet 1996; Skinner and Chang 1996; Frost and Sweeney 2000; Hessburg and Agee 2002; Taylor and Skinner 2003; Odion et al. 2004) Interacting with topographical heterogeneity and climatic gradients comparable to the Mediterranean region, this influential ecological process has helped shape the forest structure and species composition of southwest Oregon (Mohr et al. 2000; Frost and Sweeney 2000). A variety of intermingled forest types occur, indicative of the historic low-moderate mixed-severity fire regime attributed to the Klamath region (Skinner and Chang 1996; Taylor and Skinner 1998; Knapp and Keeley 2006; Taylor and Skinner 2003; Frost and Sweeney 2000; Rocca 2004).

Fire is recognized as one among many agents of disturbance (fluvial, wind, herbivory, disease, anthropogenic, etc.) acting to influence riparian area and forests processes (Naiman et al. 2000; Gresswell 1999; Naiman and Decamps1997; Sarr et al. 2005; Halofsky and Hibbs 2005). Previous studies in the southern Oregon Cascades and Klamath Mountains have shown that certain riparian and upland forests have historically burned with comparable frequencies (Olson and Agee 2005; Taylor and Skinner 2003; Dwire and Kaufmann 2003; Skinner 2003). However, relative to fire and upland forest interactions, the relationship of fire to riparian areas remains relatively understudied (Halofsky & Hibbs 2005; Kaufmann 2001; Everett et al. 2003). Regarding the exclusion of fire from riparian zones as potentially detrimental, Kaufmann (2001) and other ecologists suggest that the long-term sustainability of ecologically diverse and viable riparian corridors may necessitate the incorporation of spatially and temporally variable disturbance regimes into management planning (Naiman et al. 1993 & 2000; Everett et al 2003; Reeves et al. 1995; Rieman et al. 2003; Olson and Agee 2005; Bisson et al. 2003; Frost & Sweeney 2000; Arno 1996).

Complexity and variability in the intensity, extent, duration and interval of disturbance may increase heterogeneity and promote diversity in vegetative structure and species assemblages (Sarr et al. 2005, Rocca 2004, Nakamura et. al. 2000). Vegetative diversity and structural complexity are integral to maintaining and supporting the rich productivity associated with riparian ecosystems (Arno 1996). Unnaturally high fuel loadings threaten the maintenance of the rich riparian biological and floristic diversity (Dwire and Kaufmann 2003; Coogle 2002; Aztet 1996) and forest health in general, by potentially promoting wildfires and prescribed fires of higher intensity and uniformity than the region would have historically supported (Everett 2003; Sarr et al. 2005; Coogle 2002; Knapp and Keeley 2006).

Given the critical resource value of riparian zones, we developed an interdisciplinary study to address key issues and data needs regarding the role fire can play in maintaining riparian ecological diversity (Bisson et al.

2003; Kaufmann 2001), and improve management planning and application (Fisk et al. 2004; Rieman et al. 2003).

We asked the following critical questions regarding "how riparian areas respond to non-commercial mechanical fuel thinning and prescribed fire treatments: (1) Can perennial and intermittent streams be treated without compromising riparian function? (2) Will biological diversity of riparian areas be maintained, lessened, or improved through fuels treatment? (3) Will incorporating fuel reductions in riparian corridors significantly reduce the threat of wildfire across the landscape?" (Grant proposal, 2004).

Specifically, this paper addresses the following question regarding the effects of fuels treatments in riparian areas: (*1)* what are the short-term effects of fuels treatments on riparian vegetative characteristics? To answer this question, cover and frequency data were collected by species along point-intercept transects during the growing seasons (May-July) of 2006 through 2008. Changes in species diversity, plant composition and life form cover were examined in riparian areas of first and second order streams before and after fuel treatments.

METHODS

Study Area

Study sites were located in two fifth-field watersheds of the Middle Rogue Basin in the Klamath Mountain Geological Province of southwest Oregon: the Applegate River-McKee Bridge, and the Rogue River/Gold Hill watersheds (Fig. 1). The Klamath Mountains are steep (12-80% slope) and elevations range between 300-1200 meters (1,000-4,000 ft). This area of southwestern Oregon is characterized by moist, cool winters and hot, dry summers. The mean annual precipitation is between 50-100 cm (20-40 in), mostly falling in the winter and spring months. Soils in this region are varied and widely intermixed. Within the study basins they are moderately deep and well drained silt loams and gravelly loams, though areas of excessively drained granitic soils are also present (USDA-NRCS 1993).

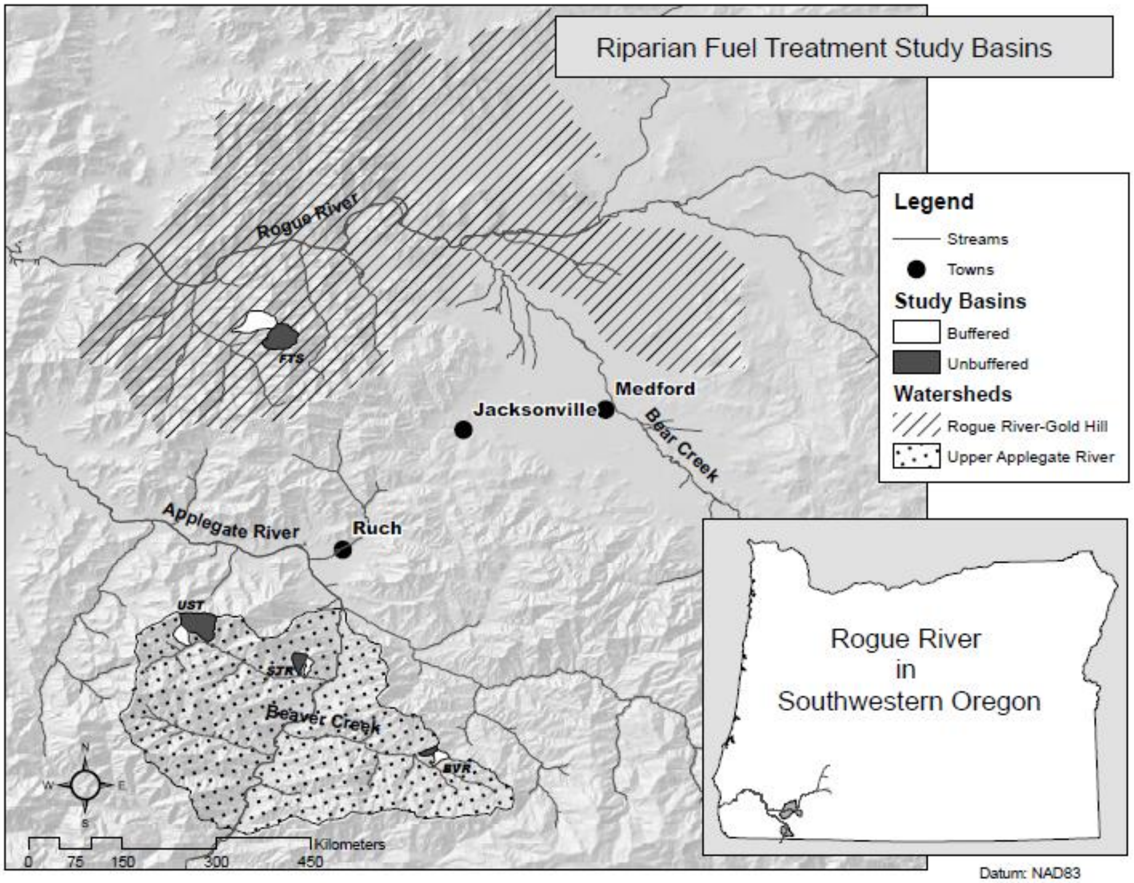

Figure 1. Study area and paired riparian treatment study basins in southwestern Oregon. Map data was acquired from Bureau of Land Management (BLM) Corporate layers.

Vegetation ranges from mixed-conifer forest, to a mixed-conifer/hardwood forest with patches of oak woodland in upland and riparian areas. Dominant conifers in the study area include Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), ponderosa pine (*Pinus ponderosa* C. Lawson), incense-cedar (*Calocedrus decurrens* (Torr.) Florin), and white fir (*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.). Subcanopy hardwoods include the evergreen species Pacific madrone (*Arbutus menziesii* Pursh) and Canyon live oak (*Quercus chrysolepis* Liebm.). Deciduous hardwoods mostly consist of California black oak (*Q. californica* (Torr.) Cooper), Oregon white oak (*Q. garryana* Douglas ex Hook.), and big-leaf maple (*Acer macrophyllum* Pursh). The shrub species mock orange (*Philadelphus lewisii* Pursh), hazelnut (*Corylus cornuta var. californica* Marsh.), and dogwood (*Cornus nuttallii* Audubon ex Torr. & A. Gray) regularly occur in riparian areas. Shrubs common to the upland areas included Manzanita (*Arctostaphylos viscida* Parry), buckbrush (*Ceanothus cuneatus*), and silk tassel (*Garrya buxifolia* A. Gray).

Responsive to subtle differences in topography, soils and moisture availability, these species and forest types often intermingle throughout the landscape, with the oak and upland shrub species growing in some riparian areas, as has been observed by other studies in this region (Alexander et al. 2006; Taylor and Skinner 1998; Taylor and Skinner 2003; Jimerson and Carothers 2002; Hosten et al. 2006).

Sample Design

The sampling design reflects the multi-party collaboration of the study and the needs of the land management objectives and multiple researchers involved. The entire study compares the before and after effects of typical fuels reduction treatments which only treat upland areas (hereafter referred to as buffered), to a treatment which would incorporate fuels treatments (manual thin, pile burn, and underburn) into the riparian area (hereafter referred to as unbuffered), utilizing a paired watershed approach (Fig. 2). Paired study basins are adjacent and include a perennial and intermittent stream reach. Slope, aspect, elevation, geology, annual precipitation and vegetation are similar between adjacent basins, but differ throughout the study area. The history of fire, placer mining and timber activity varies between basins (Table 1).

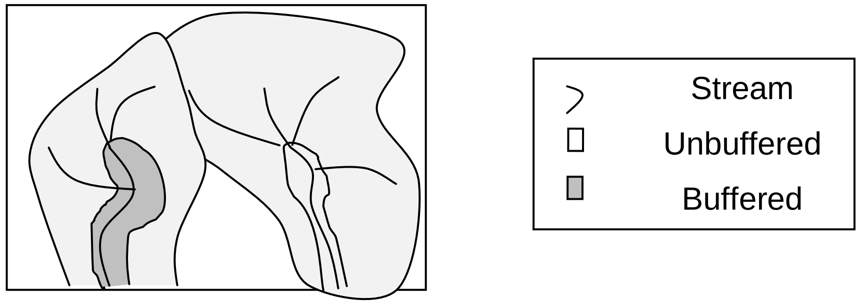

Figure 2. **P**aired watershed study design for buffered and unbuffered riparian treatments. Fuel treatments (manual thin, pile burn, and underburn) occurred in both the upland and riparian areas of the unbuffered treatment stream. For the buffered treatment, only uplands received fuels treatments.

<u>Fuel Treatments</u>

The same fuel hazard reduction prescription was applied to all areas receiving treatments over a two year period. We randomly assigned fuels treatments (buffered vs. unbuffered riparian zone) to study basins. In the four buffered basins the standard riparian buffer of 25ft (7.6m) on each side of an intermittent stream, and 50ft (15m) on each side of a perennial reach applied to all treatments, while the four unbuffered basins received fuels treatments, typical of upland areas, throughout the riparian corridor.

Table 1. Study basin attributes including: Fuel treatment assignment and geographical attributes derived from corporate Bureau of Land Management (BLM) Geographic Information System (GIS) layers (ArcMap 9.2), and field data collection. Annual precipitation data is from PRISM group (2006) climatic raster data for the period of record 1971-2000. Past disturbance record compiled from BLM internal records (USDOI-BLM 1998 and USDOI-BLM 2001); commercial timber harvest (CHT), mechanical mastication (M-M), road bed (RB), placer mining (PM), water withdrawals (WW) and wildland fire (WF) (Volpe in review).

BASIN	Treatment	Aspect	Avg. stream gradient (%)	Avg. bank slope (%)	Basin hectares	Fuel treatment hectares	Perennial length (km)	Intermittent length (km)	Elevation Range (m)	Avg. ann. precip.(cm)	Past Disturbance
BVR 1	Unbuffered	W/ SW	25	23	33	15	0.5	0.3	800-1024	109	CTH, M-M & RB
BVR 2	Buffered	S	32	26	53	22	0.3	2.7	804-1036	109	CTH, M-M & RB
FTS 1	Buffered	W/ SW	17	11	226	113	1.6	4.2	436-988	71	CTH, PM, WW & RB
FTS 2	Unbuffered	W/ SW	18	17	241	159	1	0.6	536-1048	71	CTH & PM
STR 1	Unbuffered	S	16	17	74	40	0.6	0.6	524-878	74	WF, CTH & PM
STR 2	Buffered	S	12	17	39	39	0.2	0.5	518-884	74	WF & PM
UST 1	Buffered	S	15	16	84	45	1	0.3	768-1268	117	CTH & PM
UST 2	Unbuffered	S	20	17	271	175	1.6	0.8	762-1451	117	CTH, PM & RB

The initial year of fuels treatments (2006) consisted of manual fuels reduction (cutting and hand piling) during the winter and spring months according to the following specifications: small conifers (less than 7in (18cm) diameter at breast height) were cut and placed into piles by hand. Small live conifer trees were left at an approximate spacing of 25ft (7.6m) on all sides. In areas dominated by oak woodland or xeric species the brush was cut and hand piled, except where 15 feet (4.5m) diameter brush clumps were left uncut at an approximate spacing of 45ft (14m). In areas where oaks were naturally spaced less than 45ft (14m) all brush was cut and piled. All hand piles were covered with 4 Mil plastic to ensure that each pile was consumed at least 90% when ignited and at least 90% of all hand piles were ignited during the hand pile burn phase (Fig. 3).

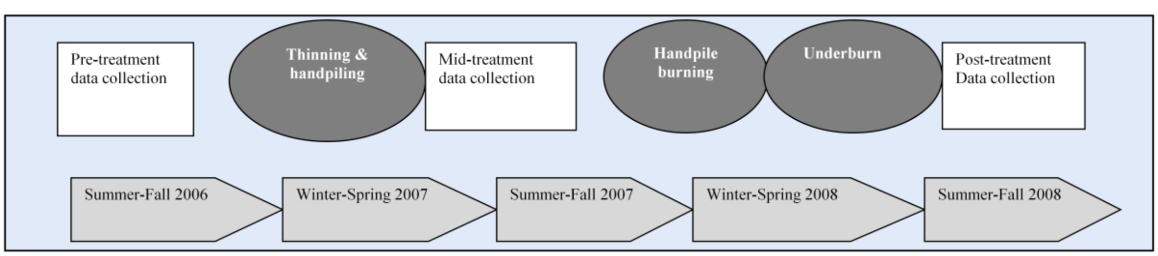

Figure 3. Project timeline for data collection and fuel treatment implementation. (KBO and BLM 2009)

In 2008 spring underburning/ broadcast burning occurred in basins where the environmental prescription conditions favored these management applications (Fig. 3, Table 2). The ignition pattern chosen for all of the treatment basins was a Strip Head pattern. These strips of fire varied in width (e.g. 3-9m (10-30 feet)) depending on conditions and observed fire behavior. Firing was adjusted to maintain an average flame length of less than 1.2m (4 feet). Within unbuffered riparian areas ignition took place in the same manner as the upland areas, while ignition strips did not occur in buffered area. Fire was allowed to back into the buffered areas.

Table 2. Underburn environmental prescription window for environmental parameters established in the prescribed fire burn plan.

Environmental Prescribed Fire Prescription Window				
	LOW	**DESIRED**	**HIGH**	**OUTSIDE AREA AT CRITICAL HOLDING POINT MINIMUM ACCEPTABLE MOISTURE**
TEMPERATURE F°(C°)	**35(2)**	**60 (16)**	**90 (32)**	
RELATIVE HUMITY (%)	**60**	**45**	**20**	
MIDFLAME WIND SPEED (MPH)	**0-10**	**0-8**	**0-6**	
WIND DIRCTION (AZIMUTH°)	**upslope**	**upslope**	**upslope**	
1-HOUR FUEL MOISTURE (%)	**12**	**9**	**7**	**7**
10-HOUR FUEL MOISTURE (%)	**13**	**11**	**9**	**9**
100-HOUR FUEL MOISTURE (%)	**15**	**13**	**11**	**11**
1000-HOUR FUEL MOISTURE(%)	**25**	**22**	**19**	**19**

Factors (air shed smoke restrictions, environmental prescription windows etc.) often complicate the implementation of prescribed fire operations. This study was no exception. Environmental prescription windows (Table 3) and smoke clearance issues thwarted underburning intentions in portions of the riparian areas in FTS2 and BVR1 (Table 1). These plots were included in the unbuffered treatment group for analysis, as this is not outside the realm of typical fuel treatment implementation.

Permanent Transect Establishment

Using a random starting location at each catchment base, points were randomly generated in ArcView 3.2 (ESRI 2003) at 50m (164ft) intervals along both intermittent and perennial streams. To minimize bias in the placement and positioning of sample points (Kaufmann et al. 1999), the first eight points (4 perennial and 4 intermittent) in each basins were selected from the random list of sampling points. These locations were field verified for safety and often overlapped with the data collection of several companion studies.

Data were collected along 16 point-intercept transects in each study basin following standard protocols (FIREMON (PO)/ National Park Service Fire Monitoring Handbook (NPS FMH)) during the growing seasons (May-July) of 2006 through 2008. Point-intercept sampling provides a repeatable, non-biased measure of cover by species (USDI-NPS 2003, Elzinga et al. 1998, McCune and Grace 2002). By taking a sample of the assumed infinite number of points in a one dimensional space (meter tape), cover can then be estimated with the point-intercept method as a ratio of the number of points at which a species occurs, relative to the total number of points in the sample (USDI-NPS 2003). Point-intercept sampling also successfully captures species diversity in heterogeneous communities (McCune and Grace 2002), common to the Applegate Valley and Klamath Province in general, although there may be limitations in representing the cover for species with scant occurrence (USDI-NPS 2003).

Prior to any fuels treatments, the permanent installation of sixteen 20m transects (2 at each sample point) occurred in each basin. At each sample point two transects paralleled and flanked the stream on opposite banks and in opposing directions (Fig. 4). The up/down stream direction for transect 1 was determined randomly. Transects were randomly located in 7m of the channel bank, in both the buffer prescriptions of 50 feet (15m) for perennial streams and 25 feet (7.6m) for intermittent streams. In the Star 1 basin, the length of the perennial reach did not allow for the installation of four sample site to be located at 50m intervals. This required four transects to be installed at each of two sample site locations, maintaining a total of 16 transects in 7m of the stream edge in this basin.

Each 20m transect contained 66 data collection points. Every 0.3m along the meter tape, a sampling pole was vertically dropped on the uphill side, and the species touching the pole recorded. At each sampling point, all species touching or sighted above the sampling pole were recorded, along with corresponding tree size class, if appropriate. For all plants live and dead status was noted. Transect and bank slope percentages and aspect were also recorded. Four digital photos taken from each random sample point facing upstream, downstream, and transect 1 (left stream bank) and transect 2 origins (right stream bank) accompany transects and random sample points. Two photos also accompanied each transect, oriented at transect ends and facing the length of each transect. All photo documentation included a white board with written photo ID for a reference of scale.

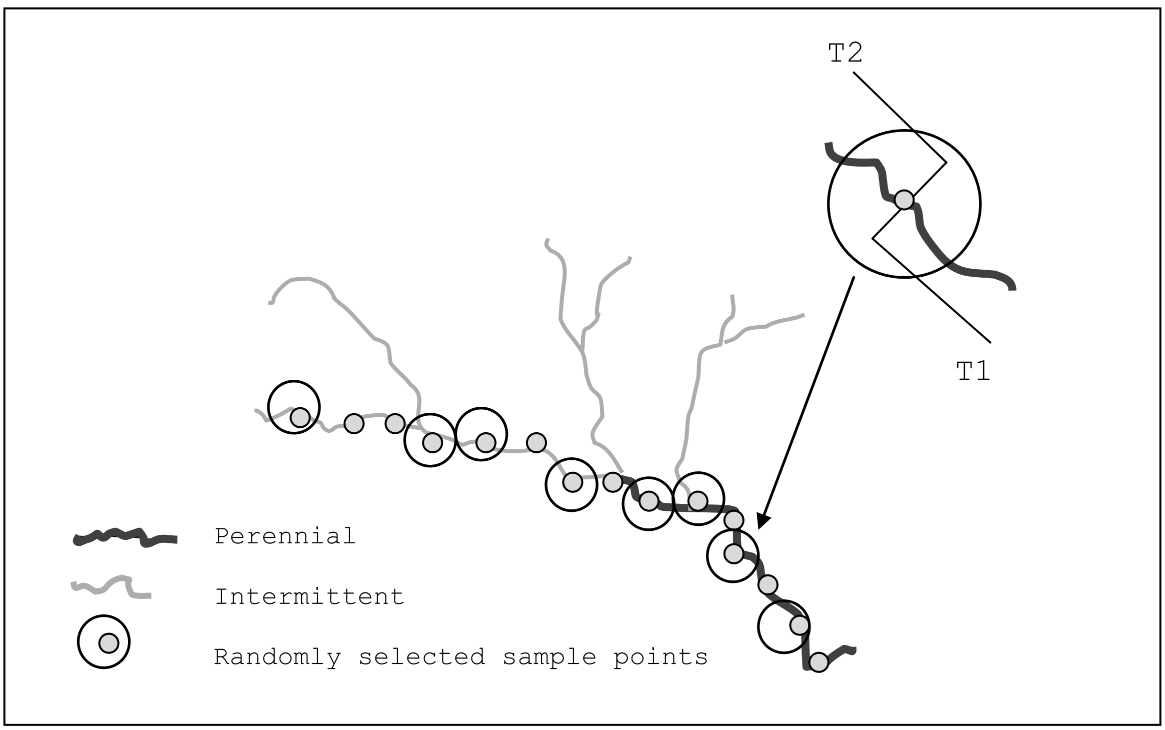

Figure 4. Example of study basin random site selection and point-intercept transect layout along perennial and intermittent stream reaches.

Plants were identified to at minimum to the genus level and species level whenever possible. Due to the scope of the project, some field work occurred prior to the onset of well developed flower parts, which hindered identification to species in some instances, particularly in the case of graminoids.

Analysis

Species Matrix Summary

Species count data were utilized for analysis with PC-ORD software v5.0 (McCune and Mefford 1999). The species matrix was not transformed or relativized. The coefficient of variance (CV %) was small (<50) among transects (samples) and relativization would have had little effect on the analytical outcome (McCune and Grace 2002). Although the CV% was large among species, a relativization by species would have given equal weight to rare and common species, washing out the compositional abundance and potentially introducing more noise into the analysis results. For compositional analysis, some groups of species were clustered at the genus taxonomic level (Appendix B).

Natural Resources Conservation Service (NRCS) PLANTS database definitions were also used to categorize species point-cover data (Appendix B) into life form categories and nativity status.

Alpha, Beta & Gamma Diversity

Many measures and indices of species diversity exist (Kent and Coker 1992). Whitaker's (1972) simple concept of alpha, beta and gamma diversity measures as presented in McCune and Grace (2002) were applied to changes in before and after treatment. This concept envisions species richness spatially from large to small gradients. Gamma diversity refers to the treatment level (buffered vs. unbuffered), while alpha diversity describes the sample, or transect scale, and the habitat or basin level heterogeneity reflects beta richness. PC-ORD row and column summaries were performed with raw species data to calculate average species richness for each sample season among grouped transects in treatments. Changes pre- and post treatment in species richness at the various spatial scales were examined for unbuffered and buffered riparian treatments.

Multi-response permutation procedure

Multi-response permutation procedure (MRPP) was used piece-wise to test differences between species composition in treatment groups and basins before and after treatments. Unlike the parametric equivalent, multivariate analysis of variance (MANOVA), MRPP does not make assumptions of data distribution (McCune and Grace 2002). Wayman and North (2007) used MRPP to test for differences in species composition in treatments before and after application (1999 versus 2003) and Halofsky and Hibbs (2005) used it to test for differences between regenerating plant communities in plots along different stream classes and in different watersheds.

MRPP calculates the distance matrix, then the average distance of each variable in each group, then the weighted within-group mean, and then the probability of this observed mean or one that is smaller. The T test statistic describes the separation between groups, where a more negative value implies a greater distance, while a null value is indicative of equal groups. The *A* statistic indicates the similarity in groups. While an (*A*) value of 1 indicates that all items in groups are identical, a null value denotes differences expected by chance. More differences among within group items than expected by chance result in negative values. Typically community data results in *A* values <0.1 and *p*-values should be considered in the context of the chance-corrected within-group-agreement (*A*) (McCune and Grace 2002).

Indicator Species

Dufrêne and Legendre’s (1997) indicator species analysis was performed with PC-ORD (McCune and Mefford 200X) to detect changes in the abundance and frequency of species between treatment applications. This test pairs well with the MRPP test for differences in species composition in groups by providing information about significant changes to certain species in those same groups. Species Indicator Values *(IV)* are calculated as a product of relative abundance and relative frequency, and expressed as a percent (%) of perfect indication of a species in signifying the respective group. Because IV is a product of relative abundance and relative frequency, both values must be substantial to result in a high *IV* percent. Likewise if either value is low, the resulting low *IV* would indicate that the species in question is a poor determinant of the group in question (McCune and Grace 2002).

Friedman Test

Changes in life form cover were assessed with Friedman tests using SPSS v13, because distributional assumptions among cover data for analysis of variance (ANOVA) of repeated measures were not met. A non-parametric equivalent to ANOVA, the Friedman test makes no assumptions of data distribution and suits repeated measure study designs well (i.e. before, during and after) (Dytham 2003, SPSS 2004). The Friedman chi-square tests a null hypothesis of no difference in the ranked values between repeated measures in each block. Friedman tests were applied at both the treatment group and basin blocking levels and sample values ranked from 1 to *k* (66 for treatment groups and 16 for basins).

The nature of ordinal ranked values complicates the display of the real data in relation to the test of the compared ranking. The results presented here show mean vegetative cover over time, coupled with an indication of a significant Friedman test result concerning the change of ranked distribution among samples. Apparent, but not significant changes in cover are associated with low chi-squared values. This indicates little difference between a variable’s summed ranks in repeated samples than from pretreatment ranks, though a few outliers may influence average cover. Results are presented in three vegetation strata: canopy (> 5 m high), subcanopy (0.5 to 5 m high), and ground cover layers (< 0.5 m high).

Before-After-Control-Impact Paired t-Test

Utilizing a paired Before-After-Control-Impact (BACI) design (Smith 2002), paired t-tests were performed to test a hypothesis of no difference in the mean difference between treatment groups (buffered and unbuffered) from before to after treatments. Only vegetative life forms resulting in statistically significant changes (p <0.05) are presented. Confidence intervals (95%) in the average percent change between treatment groups were also examined to detect significant differences in the magnitude of change between treatments.

RESULTS

Species Diversity

Pretreatment gamma diversity was slightly higher in riparian buffered basins (126) than unbuffered basins (103) and remained so throughout the course of treatments (Table 3). Although changes over the course of treatments in the richness measures were minor, trends in diversity measures differed between treatment groups. While alpha (transect) diversity slightly decreased over the course of treatments among all treatment groups, gamma and beta diversity changed in different ways. Gamma diversity slightly declined over the course of treatments in the buffered riparian areas, with a greater decrease occurring in the second treatment year (prescribed burning). Similarly unbuffered areas displayed a relatively sharp decline in gamma diversity following thinning, with a slight increase after prescribed burning. Beta diversity essentially increased post thinning for both treatment groups, with a greater increase occurring in year three in buffered areas and in year two in unbuffered areas.

Table 3. Species diversity among treatment groups as defined by Whittaker (1972) where alpha diversity is the average species richness within transects, gamma the total number of species in treatment groups and beta (basin) richness, the ratio of total species to unique species among transects. The alpha and gamma values were calculated in PC-ORD Ver 5 with a species matrix of 143 total species and 384 transects.

Treatment groups	**Treatment**	**Alpha (transect)**	**Beta**	**Gamma (total)**
Buffered (n=66)	Pretreatment	16.2	7.8	126
	Post Thin	14.7	8.4	124
	Post Burn	13.8	8.6	119
Unbuffered (n=62)	Pretreatment	13.7	7.5	103
	Post Thin	12	7.3	88
	Post Burn	10.3	8.8	91

<u>Species Composition</u>

Significant differences were found in pretreatment species composition between paired basins and treatment groups (Table 4). Species composition after treatments changed significantly in unbuffered areas compared with before treatments, while species composition did not change significantly in buffered areas (Table 5). In one pair of basins (STR1 and STR2), species composition changed significantly after treatments in both the unbuffered and buffered basins, while no significant change occurred in any other individual or pair of basins (Table 5). There was greater separation between pre and post treatment composition in the buffered basin (Table 5).

Table 4. MRPP pairwise comparisons of species composition before treatments.

Pair-wise Groups Compared	**T**	**A**	***p***
Treatment Groups			
Unbuffered s.Buffered (n=66; n=62)	-2.375	0.003	0.023
Basins			
BVR1 vs. BVR2 (n=16)	-1.95	0.013	0.044
FTS1 vs. FTS2 (n=16)	-6.04	0.041	<0.005
STR1 vs. STR2 (n=16)	-9.41	0.62	<0.005
UST1 vs. UST2 (n=16)	-2.36	0.015	0.023

Table 5. MRPP pairwise before to after treatment comparisons of species composition for 143 total species and 128 repeated point-intercept transects. Only basins with significant differences are presented.

Pre vs. post treatment	**T**	**A**	***p***
Treatment Groups			
Unbufferd (n=66)	-3.515	0.004	0.003
Buffered (n=62)	0.68E-01	0.000	0.48
Basins			
STR1 (n=16)	-2.65	0.016	0.018
STR2 (n=16)	-3.54	0.022	0.004

Indicator Species

Only the species with significant changes in Dufrêne and Legendre’s (1997) species Indicator Value *(IV*, are presented (Table 6). For both treatment groups, all species had higher *IV* values in the pretreatment conditions, with the exception of an exotic herb, spreading hedgeparsley (*Torilis arvensis* (Huds.) Link), which had higher indicator values post treatment.

Forbs and herbs made up nearly all of the species in buffered areas with changed indicator values after treatments (Table 6). Those species with the greatest indicator values in buffered areas were a native geophyte (*Dichelostemma congestum* (Sm. Kunth)) (*IV* 33%) and the exotic herb, spreading hedgeparsley (*Torilis arvensis* (Huds.) Link) (*IV* 34%). All other species were below 14% *IV*, two of which were grass species.

In unbuffered areas significant changes in species Indicator Values occurred among all functional vegetative life forms (Table 6, Appendix B). Douglas-fir (tree), *Melica* spp. (graminoid) and honeysuckle (subshrub) had the three largest indicator values among species showing significant changes in the treated sites (Table 6). Three other shrub species also exhibited significant post treatment decreases in indicator values (beaked hazelnut, Lewis’ mock orange, and oceanspray). The remaining species were Ponderosa pine and forbs/herbs.

Table 6. Significant directional changes and observed species Indicator Values *(IV)* for both treatment groups. A negative shift in *IV* indicates a decrease after treatments and a positive shift, an increase. For each species, the associated mean *(IV)* and standard deviation accompany a Monte Carlo *p*-value associated with a test of no significant difference between treatment years, based on 1000 randomizations. A (!) also indicates a significant change in *(IV)* after thinning (year 2). The species matrix had 169 species and 128 transects.

Species	Direction of Change	Indicator Value (IV)	Mean	Std. Dev	*p* *
Unbuffered					
(!)*Pseudotsuga menziesii* (Mirb.) Franco	(-)	47.2	25.3	3.33	<0.005
Melica L.	(-)	44.6	33.2	3.42	0.01
Lonicera hispidula (Lindl.) Douglas ex Torr. & A.Gray	(-)	41.2	31.9	3.64	0.02
Corylus cornuta Marsh.	(-)	28.9	21.7	3.36	0.04
Philadelphus lewisii Pursh	(-)	23.5	13.7	2.94	0.01
Holodiscus discolor (Pursh) Maxim.	(-)	22.9	16.2	2.98	0.03
Madia madioides (Nutt.) Greene	(-)	16.7	10.6	2.59	0.03
(!)*Torilis arvensis* (Huds.) Link	(+)	16.6	10.3	2.37	0.03
Dichelostemma congestum (Sm. Kunth)	(-)	16	10.1	2.51	0.03
Pinus ponderosa C. Lawson	(-)	12.5	6.4	2.02	0.01
Buffered					
(!)*Dichelostemma congestum* (Sm. Kunth)	(-)	33.1	17	3.07	<0.005
(!)*Torilis arvensis* (Huds.) Link	(+)	31.4	19.9	3.17	0.01
(!)*Claytonia parviflora* Douglas ex Hook.	(-)	14.5	6.8	2.13	0.01
(!)*Nemophila parviflora* Douglas ex Benth.	(-)	14	7.2	2.13	0.01
Vulpia L.	(-)	13.7	6.3	2.05	0.01
Ranunculus occidentalis Nutt.	(-)	12.7	6.8	2.1	0.02
Achnatherum L.	(-)	12.5	7.3	2.18	0.03
Anthriscus caucalis M. Bieb.	(-)	12.1	5.9	1.99	0.02
(!) *Madia* L.	(-)	11.6	5.8	1.94	0.02

* the proportion of randomized trials with indicator value equal to or exceeding the observed indicator value. p = (1 + number of runs >= observed)/(1 + number of randomized runs)

Vegetative Life Form Cover

The greatest changes in plant cover occurred in the unbuffered subcanopy life form stratum. The average percent reduction in subcanopy cover among unbuffered replicates was significantly more than the average change which occurred in replicate buffered basins (Fig. 5). Additionally, the mean difference in total subcanopy life form cover and specific life form categories (i.e. shrub, subshrub, saplings) between paired replicates from before to after treatments changed significantly (Table 7).

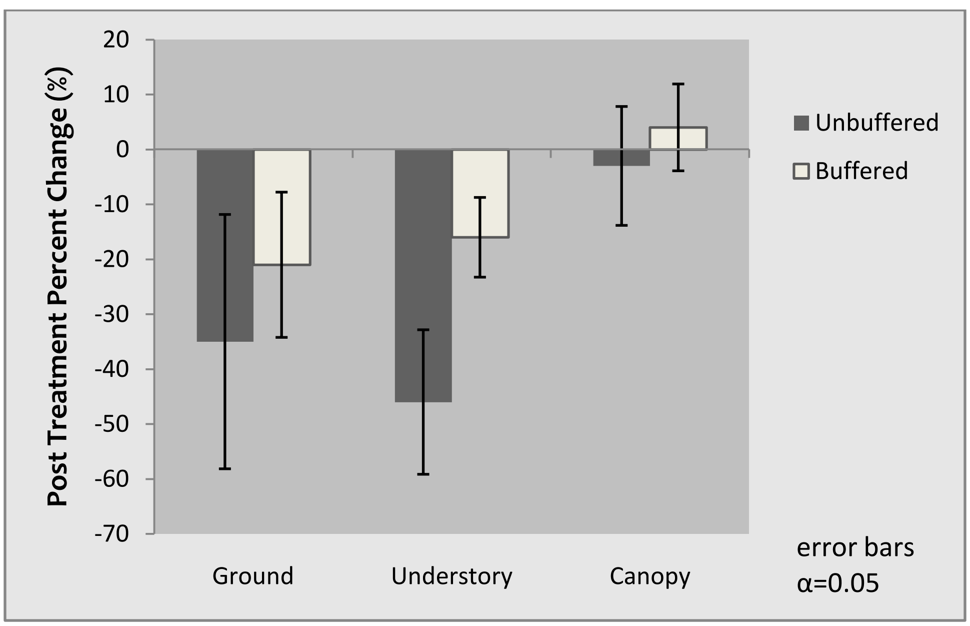

Figure 5. Average percent change in general life form cover groups following treatments in unbuffered and buffered replicate paired basins. Error bars indicate CI95%.

Table 7. Test statistics for BACI paired two sample t-Test of mean life form cover categories resulting in significant values for a test of no difference in the relationship of mean differences between treatment groups (control-impact)before and after treatment.

Life Form	df	n	*t*	*p*
Subcanopy	3	4	-3.5	0.04
Subshrub	3	4	-3.5	0.04
Shrub	3	4	-4.3	0.02
Sapling	3	4	-4.1	0.03

Canopy Cover

Pretreatment canopy tree cover was similar between buffered and unbuffered basins, with unbuffered basins having slightly greater average very large tree (DBH>33in (84cm)) cover and slightly less pole tree cover, though the distribution of very large trees varied among individual buffered basins (Fig. 6). Despite a slight increase in the medium tree size class cover in buffered basins, large canopy tree cover (>9 in (23cm) DBH) did not significantly change between before and after treatments in either buffered or unbuffered basins (Fig. 7). The average percent change in canopy tree cover was not significantly different for any of the tree size classes between treatment groups (Fig. 8).

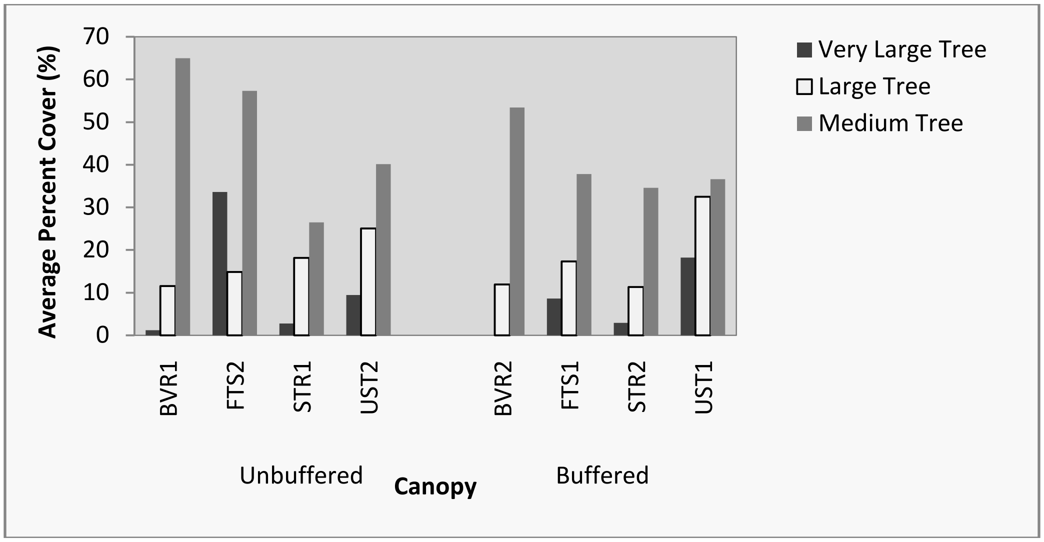

Figure 6. Average pretreatment canopy cover among buffered and unbuffered study basins. Size class definitions are according to FIREMON methods (USDA 2004): Very Large Tree (VLT) (DBH> 33 in (84cm), Large Tree (LT) (DBH 21-33 in (53-84cm), and Medium Tree (MT) (DBH 9-21 in (23-53cm).

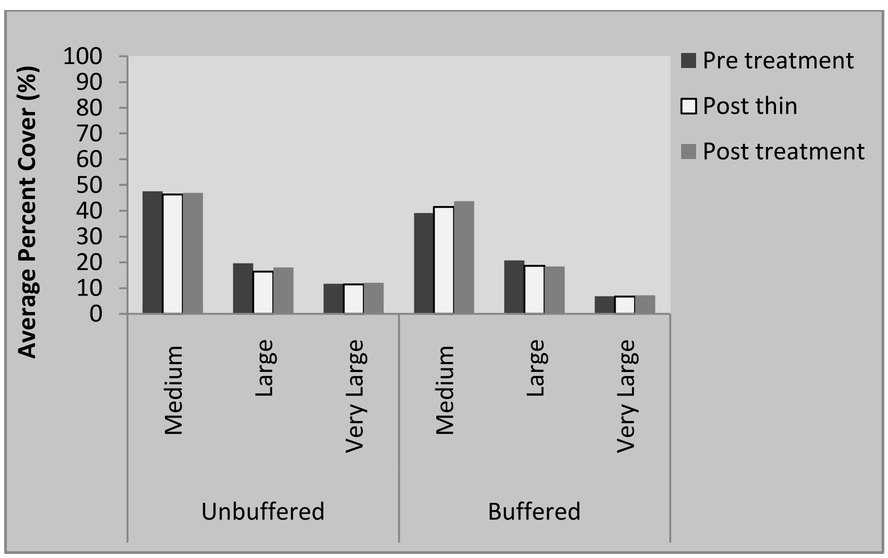

Figure 7. Average canopy percent cover before and after thinning and burning treatments. Size class definitions are according to FIREMON methods (2004): Very Large Tree (VLT) (DBH> 33 in (84cm), Large Tree (LT) (DBH 21-33 in (53-84cm), and Medium Tree (MT) (DBH 9-21 in (23-53cm).

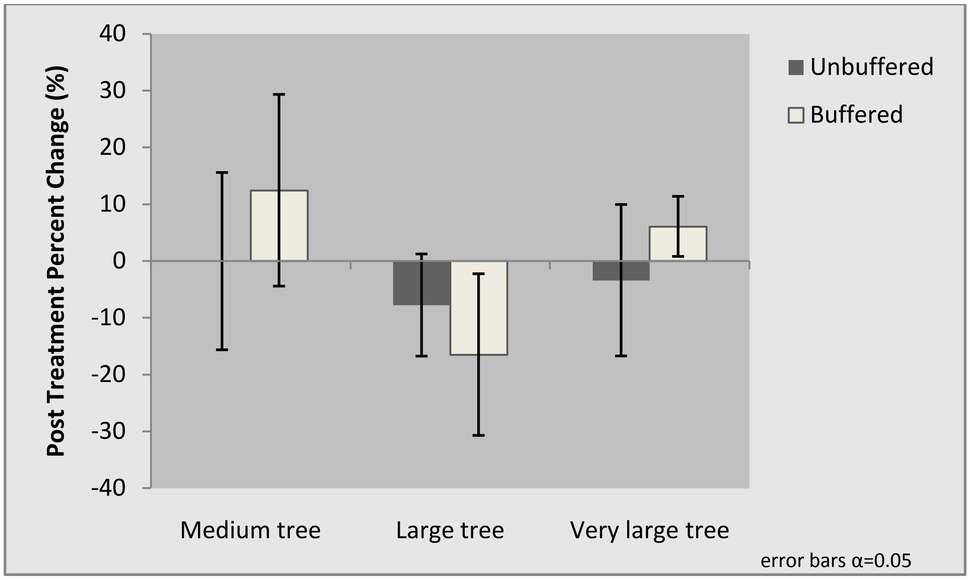

Figure 8. Average percent change in canopy size class cover after treatments for unbuffered and buffered replicate paired basins. Size class definitions are according to FIREMON methods (2004): Very Large Tree (VLT) (DBH> 33 in (84cm), Large Tree (LT) (DBH 21-33 in (53-84cm), and Medium Tree (MT) (DBH 9-21 in (23-53cm). Error bars indicate CI95%.

Subcanopy Cover

The average percent subcanopy cover generally decreased for both treatment groups (Fig. 9), though unbuffered riparian basins had greater decreases in shrub (-49%), sapling (-66%) and pole tree cover (-36%) than unbuffered basins, which ranged from minus 13% to 18% (Fig. 9).

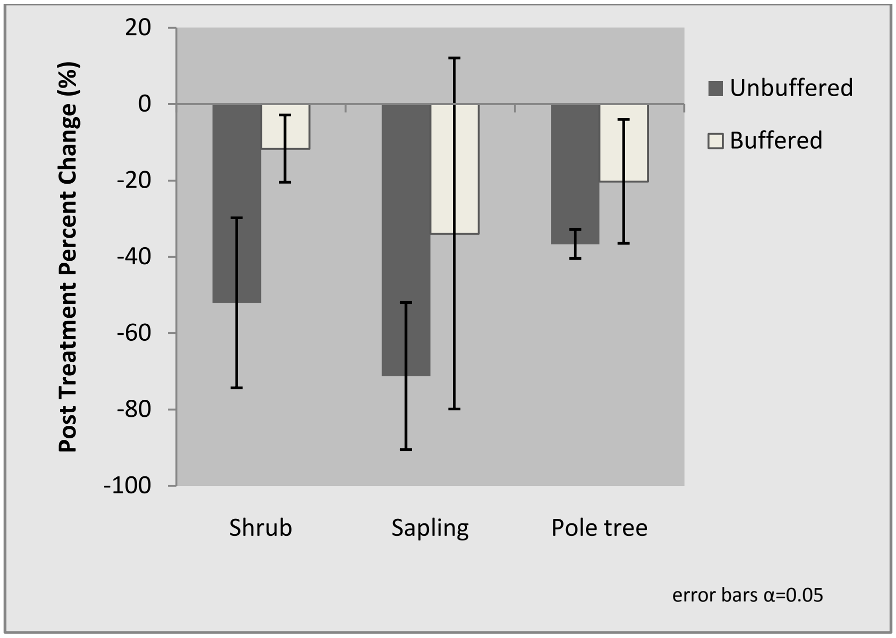

Figure 9. Average percent change in subcanopy life form cover after treatments for unbuffered and buffered replicate paired basins. Error bars indicate CI95%.

The decrease in unbuffered subcanopy cover resulted in significant ($p<0.05$) Friedman values among all life form categories, and for sapling and pole trees in buffered riparian areas (Fig. 10). In unbuffered riparian areas the largest decrease in tree/shrub, sapling, and pole tree cover followed thinning treatments. Sapling cover in buffered riparian areas slightly decreased post thinning and then rebounded after prescribed burning, while pole tree cover consistently decreased following treatments (Fig. 9).

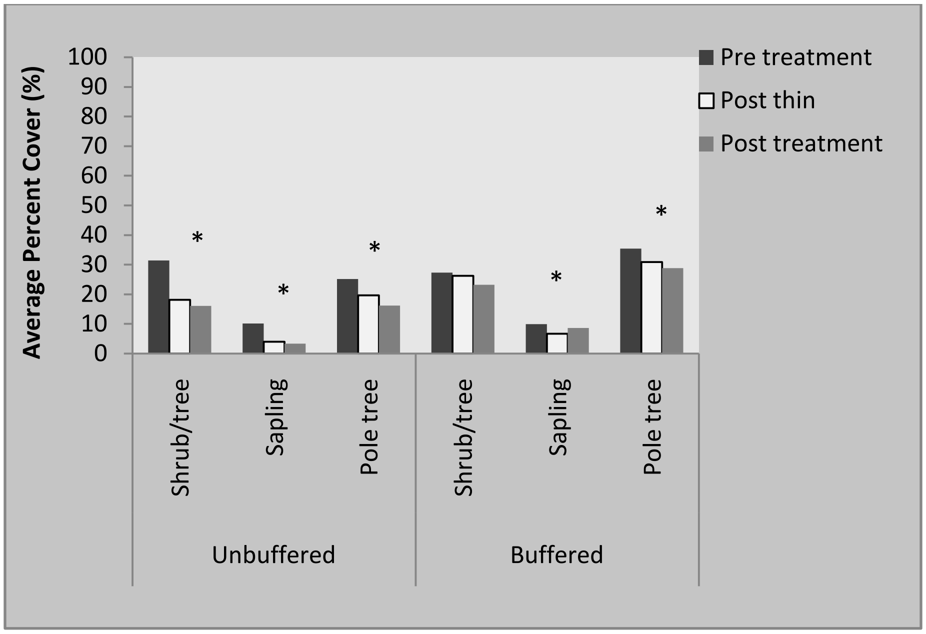

Figure 10. Average percent cover for subcanopy vegetation before and after thinning and burning. A (*) denotes a significant (*p*<0.05) Friedman test result.

Pre treatment pole tree cover varied considerably (13-60%) between basins. All basins, except one buffered basin (STR2), showed a consistent decrease in pole tree cover following each sample year (Fig. 11). Before treatments, sapling tree cover was minimal and varied in basins from 3 to 17% cover (Fig. 12). Sapling cover decreased in all unbuffered basins over the course of treatments, and this change from pre treatment cover was significant in three of the four. Sapling cover slightly decreased in all buffered basins following thinning treatments, while cover rebounded in two basins after burning.

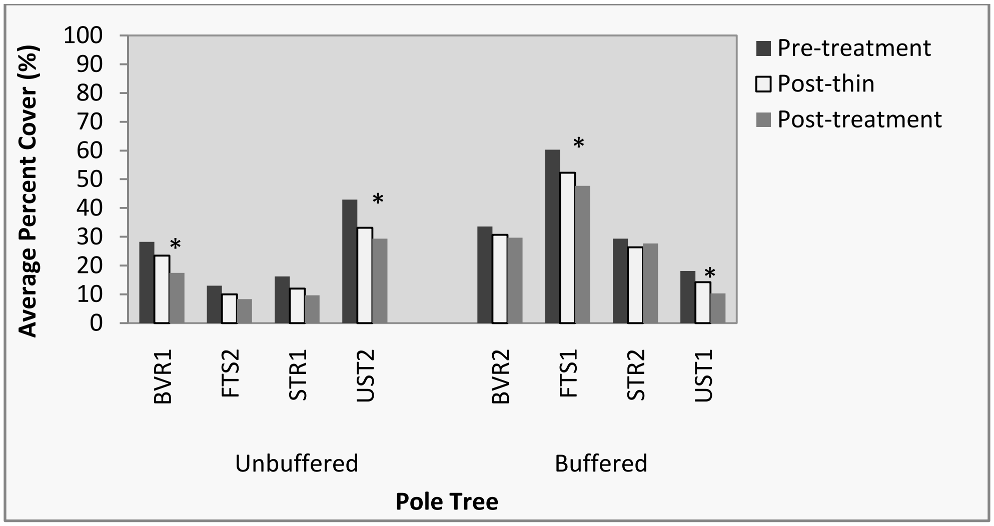

Figure 11. Average pole tree percent cover before and after thinning and burning for buffered and unbuffered riparian basins. A (*) denotes a significant ($p<0.05$) Friedman test result.

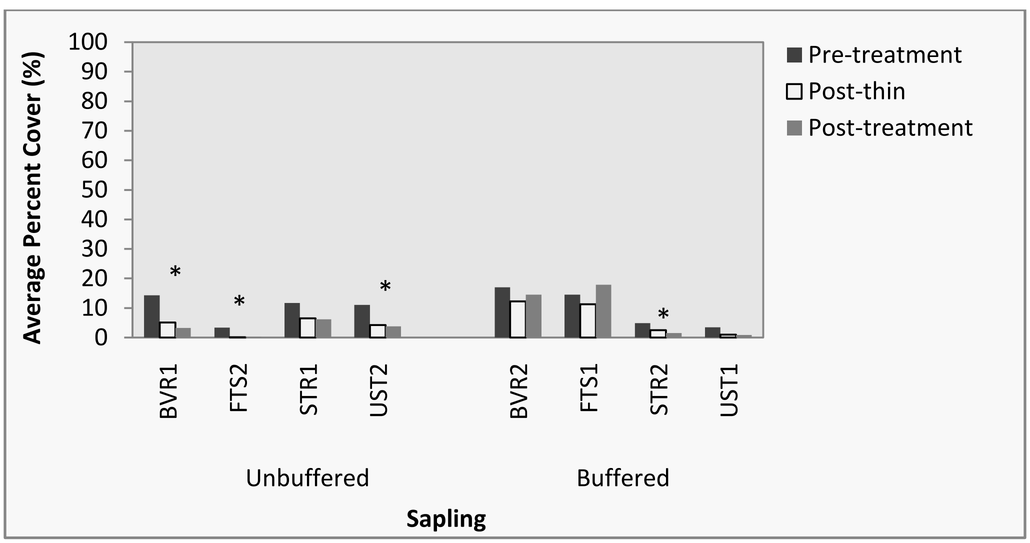

Figure 12. Average sapling tree percent cover before and after thinning and burning for buffered and unbuffered riparian basins. A * denotes a significant ($p<0.05$) Friedman test result.

Pre treatment shrub cover ranged from 22-42% in all basins, except for BVR2 (10%). After thinning, shrub cover significantly decreased, by nearly 50%, in all unbuffered basins (Fig. 13). A decrease occurred, at a lesser magnitude, again following prescribed burning in BVR1, STR1, and UST2. Shrub cover in individual buffered basins varied, increasing post thinning for some and decreasing for others, resulting in no discernable pattern of significance (Fig. 13).

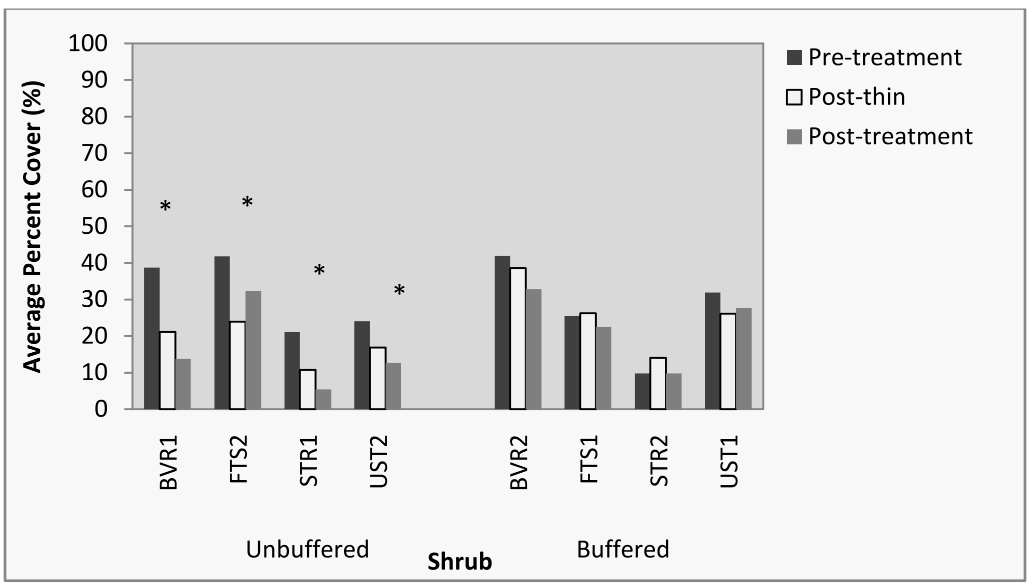

Figure 13. Average shrub percent cover before and after thinning and burning for buffered and unbuffered riparian basins. A (*) denotes a significant ($p<0.05$) Friedman test result.

Ground Cover

In buffered basins, subcanopy and forest floor cover remained relatively static, with fluctuations and slight decreases in some areas (Fig. 14). The only significant ($p<0.05$) decrease in cover in buffered basins, occurred in the forb/herb life form (Fig. 14). Unbuffered areas also displayed significant changes in forb/herb cover between sample years (Fig. 14). Unbuffered basins had a significantly greater average percent decrease among paired replicates than buffered basins in subshrub cover (-37%) (Fig. 15). Though the mean percent change in seedling, graminoid, and forb/herb cover had wide variation in distribution, there was no statistically significant difference between treatment groups (Fig. 15).

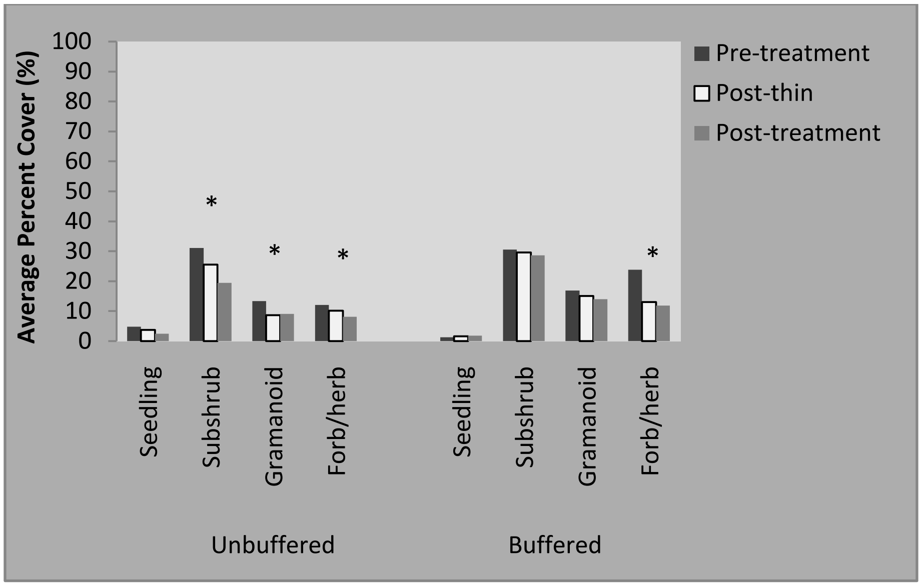

Figure 14. Average percent forest floor cover before and after thinning and burning. A (*) illustrates a significant (p<0.05) Friedman test result.

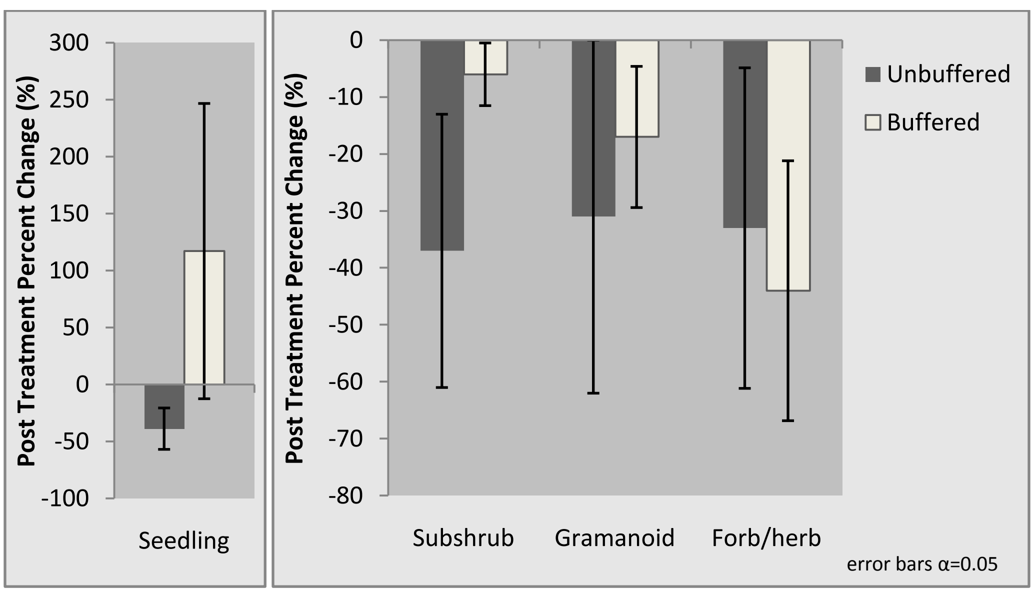

Figure 15. Average percent change in cover for forest floor vegetation before and after treatments. Error bars indicate 95% confidence.

Low seedling cover (1-5%) characterized all basins in pre- and post treatment conditions, and did not significantly change over the course of treatments (Fig. 14). Pretreatment subshrub cover was very similar among basins, ranging from 28-39%. In the three underburned unbuffered basins (BVR1, STR1, and UST2), cover significantly ($p<0.05$) decreased following treatments (Fig. 16). Within buffered basins subshrub cover remained relatively static over the course of treatments (Fig. 16). Pretreatment graminoid cover ranged from 5-24% among basins and varied from basin to basin and year to year after treatments, providing no discernable pattern of treatment effect (Fig. 17). Pretreatment forb/herb cover was similar among the majority of basins, ranging from 11 to 24%, with exceptions in UST2 (4%) and STR2 (43%). Forb/herb cover significantly ($p<0.05$) decreased after treatments in three basins in each treatment group, and remained static for one basin in each treatment group (Fig. 18).

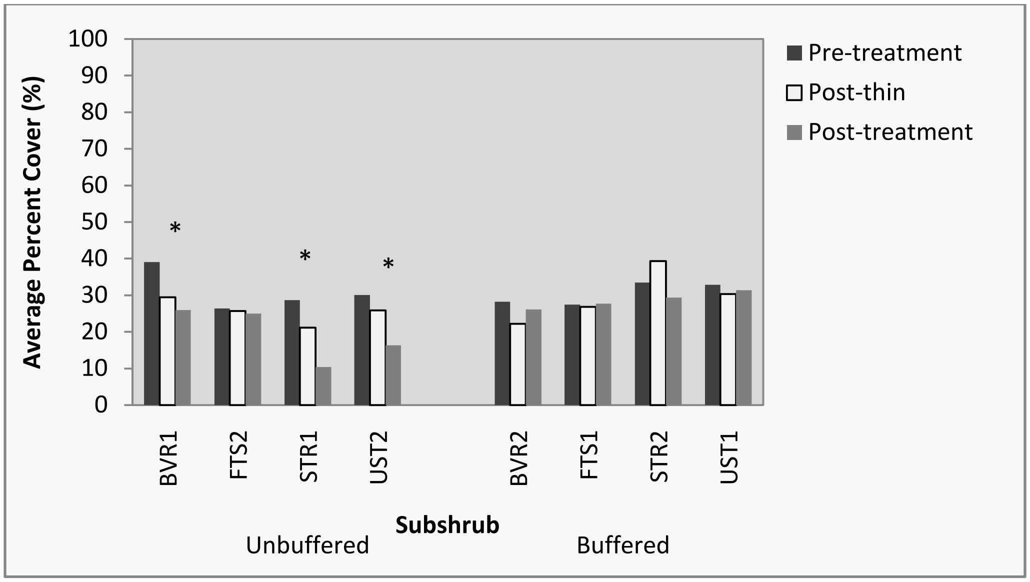

Figure 16. Average percent subshrub cover before and after thinning and burning for buffered and unbuffered riparian basins. A (*) denotes a significant (p<0.05) Friedman test result.

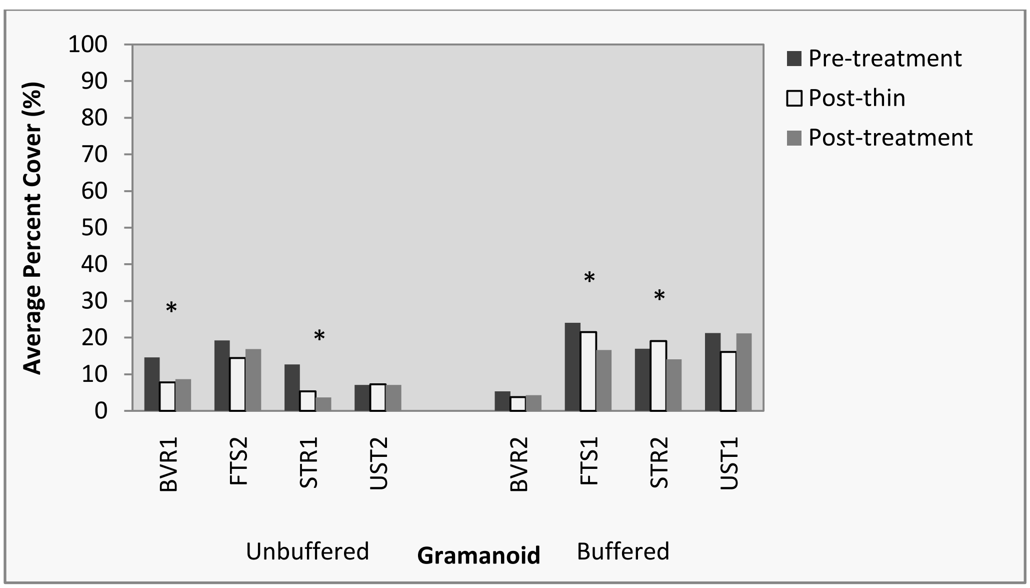

Figure 17. Average percent graminoid cover before and after thinning and burning for buffered and unbuffered riparian basins. A (*) illustrates a significant (p<0.05) Friedman test result.

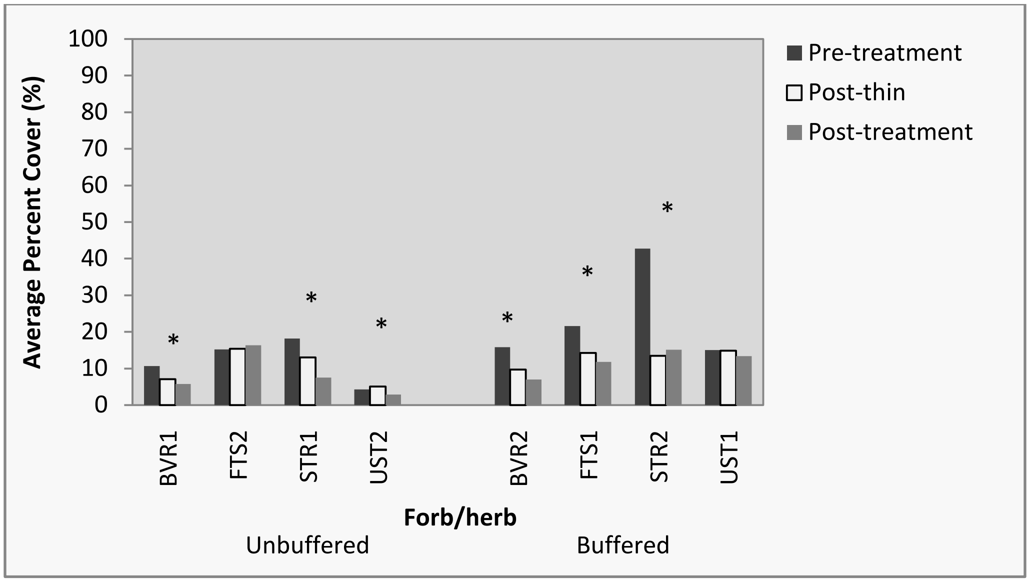

Figure 18. Average percent forb/herb cover before and after thinning and burning for buffered and unbuffered riparian basins. A (*) denotes a significant (p<0.05) Friedman test result.

Exotic Species Cover

There was not enough exotic life form cover to support tests of significance for change in distribution after treatments at either the basin or treatment group level. Pretreatment exotic cover was minimal (0-5%) for subshrubs, graminoids and forb/herbs (Fig. 19) and over the course of treatments, changes in cover occurred, but do not appear to be a result of treatment influence. Regardless of treatment group (buffered/unbuffered), exotic grass and forb cover generally increased following year two.

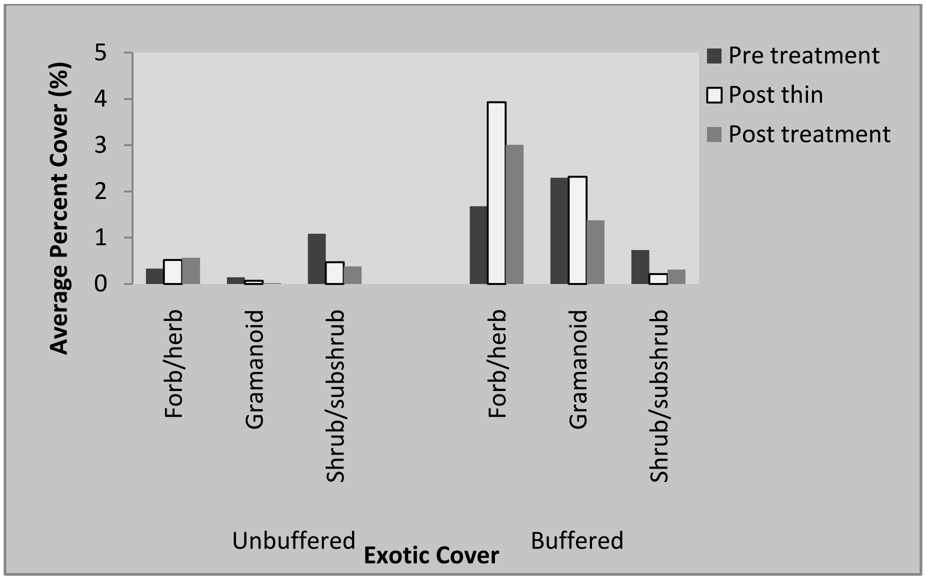

Figure 19. Average percent exotic cover before and after thinning and burning in buffered and unbuffered riparian treatment groups.

Pretreatment exotic grass cover ranged between 0-1% in most basins (Fig. 20). Though, two unbuffered basins (FTS1 and STR2) had greater pretreatment cover (4-5%) of exotic grasses, which slightly increased following thinning treatments and then decreased after burning. This decrease in cover post burning also occurred in all other basins, except one buffered basin.

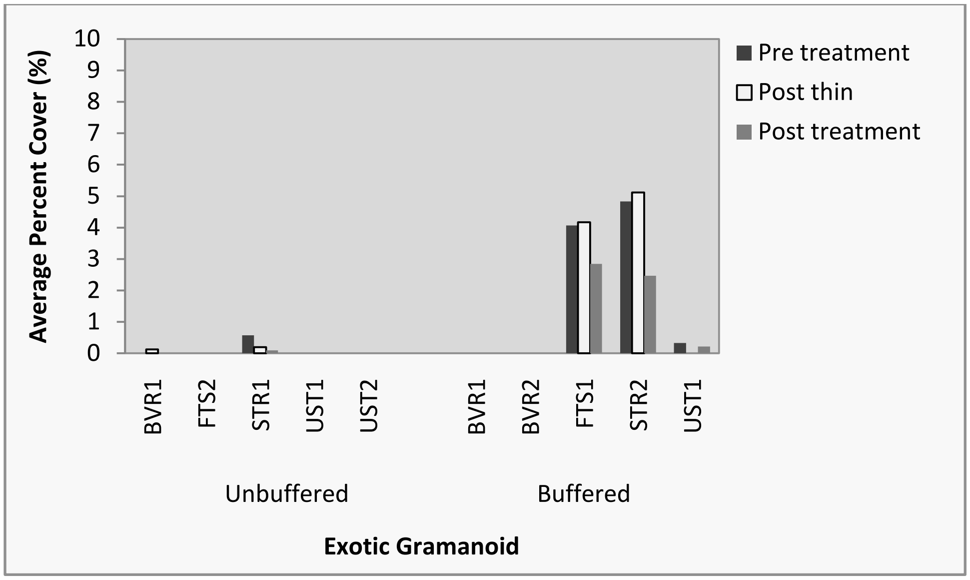

Figure 20. Average percent exotic graminoid cover before and after thinning and burning for buffered and unbuffered riparian basins.

Again, minimal cover of exotic shrub/subshrubs (0-5%) occurred in the pretreatment conditions of only three basins and treatment produced no changes in cover (Fig. 21).

Exotic forb/herb cover was present in more basins than either exotic subshrubs or graminoids. Pretreatment cover ranged from 0 -4% and was generally higher in buffered areas. All exotic forb/herb cover increased from year one to year two, this increase was nearly twofold in buffered basins. Following year three (underburning treatment), the response in exotic forb/herb cover varied, slightly increasing in some cases and drastically decreasing in others (Fig. 22).

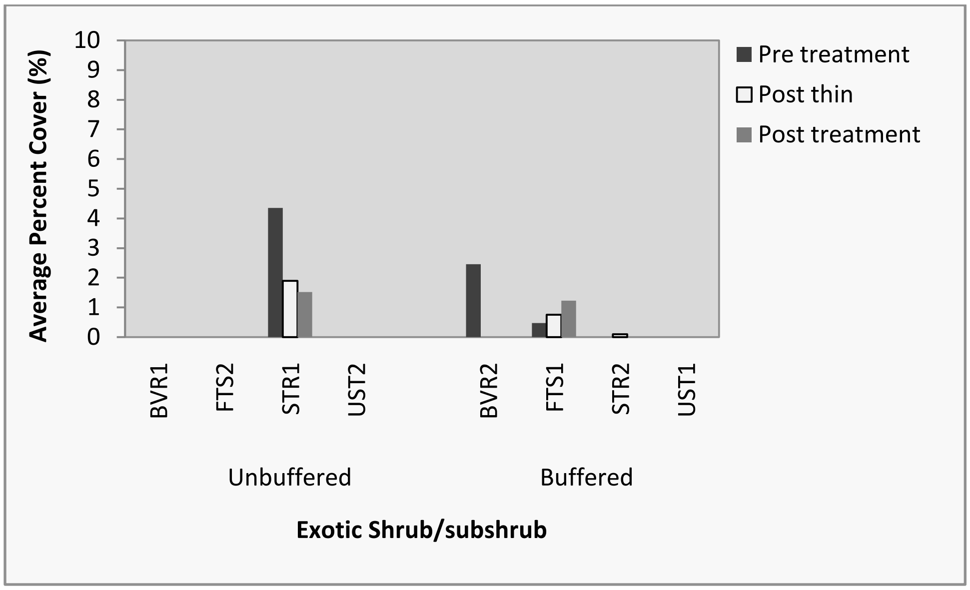

Figure 21. Average percent exotic shrub/subshrub cover before and after thinning and burning for buffered and unbuffered riparian basins.

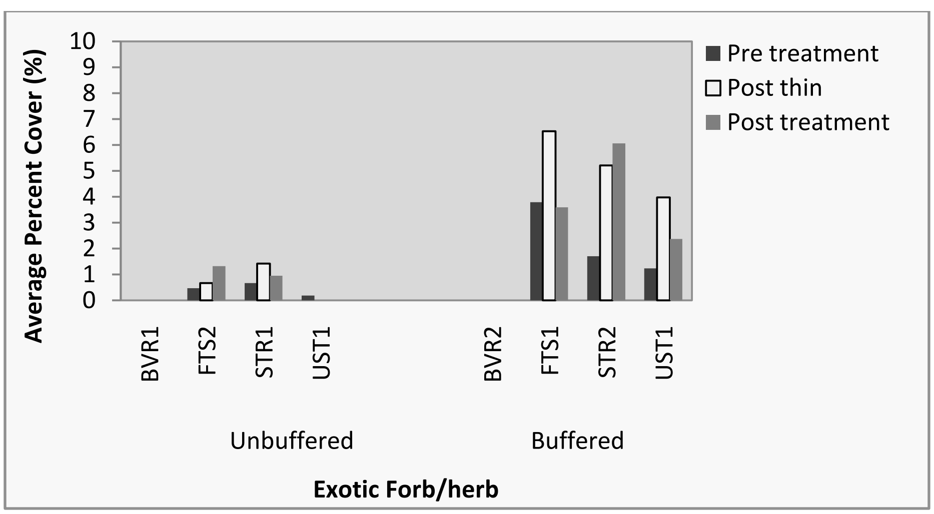

Figure 22. Average percent exotic forb/herb cover before and after thinning and burning for buffered and unbuffered riparian basins.

DISCUSSION

What are the short-term effects of fuels treatments on plant species diversity, composition, and life form cover?

It was hypothesized that vegetative characteristics (diversity, species composition, and functional life form cover) would not change in the buffered riparian areas, which did not receive thinning and direct ignition. It was also anticipated that some of these parameters would change in unbuffered areas where fuel treatments occurred.

Extensive efforts were made to select paired watersheds of similar topographical and vegetative features, and conduct prescribed burning under similar conditions, though unavoidable differences did exist and likely explain a portion of the discrepancy in the observed effects. Additionally, despite the buffer from direct thinning and ignition, four transects in the buffers did receive thinning treatments, while others did support a backing fire during prescribed fire operations (KBO and BLM

2009- companion study). The backing fire resulted in 20% low fire severity in buffered treatment areas, largely occurring in one basin (STR2) and assuredly altered some vegetative characteristics.

Results showed a trend of overall reduction in species diversity, which was most pronounced in unbuffered areas following thinning treatments. Conversely, following the application of prescribed fire, gamma species richness slightly increased in unbuffered areas (Table 3). Buffered areas showed a slight continual decline in alpha and gamma species diversity indicators over the three year sampling period.

At the treatment level significant changes in species composition only occurred in the unbuffered riparian group. Though, at the basin level, species composition significantly changed in both the buffered and unbuffered basins in the STR pair. The significant shift in species composition for the unbuffered basin coincides with significant changes observed in additional vegetative characteristics in other unbuffered basins. The significant shift in the buffered basin appears to be an anomaly relative to changes in other buffered basins, which may in part be a result of areas of this basin supporting more backing fire relative to other buffered basins during prescribed burning (companion study- DeJuilio and Martin *in prep*).

Canopy cover (>9 in DBH) was similar at all sites before treatments and did not change significantly post treatment. This lack of change corresponded to the fuel treatment prescription which only targeted small diameter (<8in DBH) trees for removal. In contrast, an overall reduction occurred in subcanopy and forest floor plant cover, with greater decreases in unbuffered areas.

Among unbuffered basins, decreases in cover were more pronounced and significant in nearly all of the basins which were underburned. Consequently, FTS2 which was not underburned did not follow the same noticeable decline in cover particularly in those life form categories that resulted in overall significant decreases in unbuffered groups (i.e. shrub, subshrub).

Combined treatments resulted in significant reductions in the abundance and frequency of small diameter Douglas-fir and Ponderosa pine, corresponding to the thinning prescription and observed reductions in vegetative cover among sapling and pole trees.

Reductions also occurred in abundance and frequency of deciduous mesic shrub species in unbuffered basins. Atypical of the xeric species normally associated with fuels treatments, these shrubs typically occur in moist habitats (Hickman (Ed.) 1993). In the winter and early spring when thinning treatments occur, these deciduous shrubs lack leaves to aid in identification. Future riparian fuel treatment prescriptions which intend to avoid thinning these species might need to emphasize their dormant physiognomies.

In buffered basins, subcanopy and forest floor cover remained mostly unchanged. Fluctuations and slight decreases in some cover categories occurred, though significant effects were mostly concentrated in indicator forb/herb species and cover (Fig. 5, Table 6). While in unbuffered areas significant changes occurred in indicator species values and cover among all life forms (small trees, shrubs, herbs, grasses). These variable effects to species composition and vegetative life form cover in unbuffered areas might promote future diversity in structure and composition, relative to buffered areas that did not experience the same range in structural and compositional effects.

Exotic species had very low pretreatment representation (0-5% cover), even too low to perform statistical tests on changes between treatments. Additionally, exotic life form categories were not represented in all basins and the anecdotal results did not indicate a difference between treatments. Exotic forb and grass cover slightly increased following thinning treatments (maximum cover 7%) and may have resulted in part from the disturbance associated with sampling efforts and/or sampling method limitations, coupled with the ecological strategy of these exotic annual species. Responses in cover were mixed following the prescribed fire, not showing any discernable trend

Due to the ephemeral nature of the majority of herbaceous vegetation, slight changes observed in both unbuffered and buffered sites may have resulted from factors associated with sampling methods in combination with specific treatments (buffered/ unbuffered) and low water years in subsequent sampling seasons (KBO and BLM 2009 – companion study). Phenologic periods were similar between repeat measures in basins and generally between paired basins, but phenological sampling was not necessarily similar between all basins, as sampling occurred over a 2-3 month period. Additionally, the point-intercept sampling method can have limitations in accurately representing the cover of species with infrequent occurrence (USDI-NPS 2003). These potential sampling and climatic complicating factors would have applied to both treatments equally.

Although unbuffered basins had significant reductions in cover, some amount of cover remained in all lifeform categories. These are very short-term effects to vegetative characteristics and long-term monitoring would further benefit the understanding of fuels treatments in these headwater riparian areas, particularly the effects to species composition in this fire evolved ecosystem.

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Appendix A. Transect Coordinates and Physical and Sampling Attributes

Basin & Site	**Trn. No.**	**UTM_X**	**UTM_Y**	**Dist. from stream edge (m)**	**Trn. Az.**	**Elev. (m)**	**Bank Asp.**	**Slope (%)**	**Stream Type**	**Treat.**	**Sample Month**	**Pheno. Stage**
BVR1_01	T1	500367	4661470	6	280	807	S	22	PER	UNBUF	6	flr/frt
BVR1_01	T2	500367	4661470	4	84	807	N	32	PER	UNBUF	6	flr/frt
BVR1_03	T1	500463	4661460	6	309	828	S	10	PER	BUF	6	flr/frt
BVR1_03	T2	500463	4661460	2	86	828	N	24	PER	BUF	6	frt
BVR1_04	T1	500512	4661449	5	109	839	S	22	PER	UNBUF	6	frt
BVR1_04	T2	500512	4661449	2	279	839	N	20	PER	UNBUF	6	frt
BVR1_05	T1	500561	4661444	4	86	845	S	30	PER	UNBUF	6	flr/frt
BVR1_05	T2	500561	4661444	5	269	845	N	23	PER	UNBUF	6	frt
BVR1_10	T1	500805	4661458	2.5	232	882	SE	28	INT	UNBUF-NO RxFire	7	frt
BVR1_10	T2	500805	4661458	2	50	882	NW	24	INT	UNBUF-NO RxFire	7	frt
BVR1_11	T1	500843	4661490	4	232	887	E	20	INT	UNBUF-NO RxFire	7	frt
BVR1_11	T2	500843	4661490	3	53	887	NW	27	INT	UNBUF-NO RxFire	6	frt
BVR1_12	T1	500879	4661524	4	40	895	E	33	INT	UNBUF-NO RxFire	7	frt

Basin & Site	Trn. No.	UTM_X	UTM_Y	Dist. from stream edge (m)	Trn. Az.	Elev. (m)	Bank Asp.	Slope (%)	Stream Type	Treat.	Sample Month	Pheno. Stage
BVR1_12	T2	500879	4661524	3	210	895	W	40	INT	UNBUF-NO RxFire	7	flr/frt
BVR1_13	T1	500911	4661563	5	42	901	E	24	INT	UNBUF-NO RxFire	7	flr/frt
BVR1_13	T2	500911	4661563	2	218	901	W	27	INT	UNBUF-NO RxFire	7	flr/frt
BVR2_01	T1	501140	4660629	4	222	843	SE	20	PER	BUF	7	flr
BVR2_01	T2	501140	4660629	3	32	843	NW	12	PER	BUF	7	flr/frt
BVR2_02	T1	501178	4660660	6	46	849	SE	44	PER	BUF	7	flr/frt
BVR2_02	T2	501178	4660660	6	225	849	W	36	PER	BUF	7	flr
BVR2_03	T1	501205	4660703	7	248	854	SE	24	PER	BUF	7	flr/frt
BVR2_03	T2	501205	4660703	6	4	854	W	44	PER	BUF	7	flr/frt
BVR2_04	T1	501225	4660748	5	224	859	SE	18	PER	BUF	7	flr/frt
BVR2_04	T2	501225	4660748	7	220	859	NW	20	PER	BUF	7	flr/frt
BVR2_05	T1	501247	4660825	2	238	860	SE	36	INT	BUF	7	flr/frt
BVR2_05	T2	501247	4660825	2	25	860	NW	36	INT	BUF	7	flr/frt
BVR2_07	T1	501271	4660921	1	32	865	SE	46	INT	BUF	7	flr/frt
BVR2_07	T2	501271	4660921	5	210	865	NW	40	INT	BUF	7	flr/frt
BVR2_08	T1	501287	4660968	3	342	867	NE	40	INT	BUF	7	flr/frt

Basin & Site	Trn. No.	UTM_X	UTM_Y	Dist. from stream edge (m)	Trn. Az.	Elev. (m)	Bank Asp.	Slope (%)	Stream Type	Treat.	Sample Month	Pheno. Stage
BVR2_08	T2	501287	4660968	1	193	867	W	20	INT	BUF	7	flr/frt
BVR2_11	T1	501373	4661078	3	250	877	SE	40	INT	BUF	7	flr/frt
BVR2_11	T2	501373	4661078	2	42	877	NW	30	INT	BUF	7	frt
FTS1_06	T1	490677	4691682	2	278	452	SE	6	PER	BUF	7	frt/dry
FTS1_06	T2	490677	4691682	4	109	452	N	18	PER	BUF	7	frt/dry
FTS1_10	T1	490874	4691682	6	80	474	S	12	PER	BUF	7	frt/dry
FTS1_10	T2	490874	4691682	4	135	474	NE	5	PER	BUF	7	frt/dry
FTS1_20	T1	491306	4691888	2	60	573	SE	38	PER	BUF	7	frt
FTS1_20	T2	491306	4691888	6	66	573	NW	2	PER	BUF	7	flr/frt
FTS1_26	T1	491593	4691964	2	276	575	S	12	PER	BUF	7	frt/dry
FTS1_26	T2	491593	4691964	4	67	575	NW	8	PER	BUF	7	flr/frt
FTS1_37	T1	492015	4692296	2.5	209	665	E	22	INT	BUF	7	frt/dry
FTS1_37	T2	492015	4692296	2	62	665	E	16	INT	BUF	7	frt/dry
FTS1_39	T1	492054	4692385	1	5	689	E	35	INT	BUF	7	dry
FTS1_39	T2	492054	4692385	2	185	689	W	40	INT	BUF	7	dry
FTS1_51	T1	491243	4691741	4	111	523	S	25	INT	BUF	7	dry
FTS1_51	T2	491243	4691741	2	295	523	N	2	INT	BUF	7	dry
FTS1_55	T1	491363	4691752	6	250	536	SE	22	INT	BUF	7	dry
FTS1_55	T2	491363	4691752	2	68	536	N	12	INT	BUF	7	dry

Basin & Site	Trn. No.	UTM_X	UTM_Y	Dist. from stream edge (m)	Trn. Az.	Elev. (m)	Bank Asp.	Slope (%)	Stream Type	Treat.	Sample Month	Pheno. Stage
FTS2_03	T1	492211	4690890	1	111	553	S	0	PER	UNBUF-NO RxFire	7	dry
FTS2_03	T2	492211	4690890	5	280	553	N	25	PER	UNBUF-NO RxFire	7	dry
FTS2_13	T1	492671	4691054	3	24	605	SE	29	PER	UNBUF-NO RxFire	7	dry
FTS2_13	T2	492671	4691054	2	191	605	W	4	PER	UNBUF-NO RxFire	7	frt/dry
FTS2_14	T1	492797	4690893	2	250	632	SE	2	PER	UNBUF-NO RxFire	7	dry
FTS2_14	T2	492797	4690893	6	69	632	N	21	PER	UNBUF-NO RxFire	7	frt/dry
FTS2_16	T1	492783	4691153	6	59	621	SE	25	PER	UNBUF-NO RxFire	7	dry
FTS2_16	T2	492783	4691153	6	264	621	NW	19	PER	UNBUF-NO RxFire	7	dry
FTS2_19	T1	492917	4691255	1	60	643	SE	0	INT	UNBUF-NO RxFire	7	dry
FTS2_19	T2	492917	4691255	4	236	643	NW	24	INT	UNBUF-NO RxFire	7	dry

Basin & Site	Trn. No.	UTM_X	UTM_Y	Dist. from stream edge (m)	Trn. Az.	Elev. (m)	Bank Asp.	Slope (%)	Stream Type	Treat.	Sample Month	Pheno. Stage
FTS2_20	T1	492941	4691299	3	29	653	SE	16	INT	UNBUF-NO RxFire	7	dry
FTS2_20	T2	492941	4691299	1	217	653	NW	27	INT	UNBUF-NO RxFire	7	dry
FTS2_21	T1	492967	4691342	6	217	662	SE	34	INT	UNBUF-NO RxFire	7	dry
FTS2_21	T2	492967	4691342	3	60	662	W	16	INT	UNBUF-NO RxFire	7	dry
FTS2_22	T1	492994	4691384	6	27	674	E	33	INT	UNBUF-NO RxFire	7	dry
FTS2_22	T2	492994	4691384	3	184	674	E	10	INT	UNBUF-NO RxFire	7	dry
STR1_01	T1	493998	4667057	2.5	190	520	SE	8	PER	UNBUF	5	grn/flr
STR1_01	T2	493998	4667057	5	0	520	W	14	PER	UNBUF	6	flr
STR1_02	T1	493998	4667107	4	190	527	SE	5	PER	UNBUF	5	grn/flr
STR1_02	T2	493998	4667107	6	6	527	W	20	PER	UNBUF	5	grn/flr
STR1_03	T1	494001	4667157	5	0	538	E	15	PER	UNBUF	5	grn/flr
STR1_03	T2	494001	4667157	3	180	538	W	18	PER	UNBUF	5	grn/flr
STR1_04	T1	493994	4667206	6	352	548	SE	10	PER	UNBUF	5	grn
STR1_04	T2	493994	4667206	2	160	548	SW	15	PER	UNBUF	5	grn

Basin & Site	Trn. No.	UTM_X	UTM_Y	Dist. from stream edge (m)	Trn. Az.	Elev. (m)	Bank Asp.	Slope (%)	Stream Type	Treat.	Sample Month	Pheno. Stage
STR1_15	T1	493953	4667626	2	176	634	E	12	INT	UNBUF	5	grn/flr
STR1_15	T2	493953	4667626	5	356	634	W	10	INT	UNBUF	5	grn/flr
STR1_16	T1	493960	4667675	3	325	638	SE	20	INT	UNBUF	5	grn
STR1_16	T2	493960	4667675	6	155	638	SW	14	INT	UNBUF	5	grn
STR1_21	T1	493996	4667912	3	188	672	E	16	INT	UNBUF	5	flr/grn
STR1_21	T2	493996	4667912	5	350	672	SW	34	INT	UNBUF	5	grn/flr
STR1_24	T1	493927	4668043	5	164	695	E	20	INT	UNBUF	5	grn/flr
STR1_24	T2	493927	4668043	4	344	695	SW	30	INT	UNBUF	5	grn/flr
STR2_01	T1	494318	4667031	7	190	514	E	20	PER	BUF	6	flr
STR2_01	T1	494318	4667031	7	190	514	E	20	PER	BUF	6	flr
STR2_01	T2	494318	4667031	2	350	514	E	24	PER	BUF	6	flr
STR2_01	T3	494318	4667031	3	190	514	W	20	PER	BUF	6	flr
STR2_01	T4	494318	4667031	10	350	514	W	0	PER	BUF	6	flr
STR2_02	T1	494309	4667089	10	170	534	E	35	PER	BUF	6	grn/flr
STR2_02	T2	494309	4667089	1	350	534	E	5	PER	BUF	6	flr
STR2_02	T3	494309	4667089	3	170	534	W	35	PER	BUF	6	flr
STR2_02	T4	494309	4667089	10	350	534	W	5	PER	BUF	6	flr
STR2_04	T1	494317	4667190	9	172	557	E	0	INT	BUF	6	flr
STR2_04	T2	494317	4667190	3	285	557	W	5	INT	BUF	6	flr

Basin & Site	Trn. No.	UTM_X	UTM_Y	Dist. from stream edge (m)	Trn. Az.	Elev. (m)	Bank Asp.	Slope (%)	Stream Type	Treat.	Sample Month	Pheno. Stage
STR2_05	T1	494319	4667239	7	0	561	E	10	INT	BUF	6	flr
STR2_05	T2	494319	4667239	2	186	561	W	10	INT	BUF	6	flr
STR2_07	T1	494314	4667336	4	178	577	E	5	INT	BUF	6	flr/frt
STR2_07	T2	494314	4667336	3	348	577	W	5	INT	BUF	6	flr/frt
STR2_11	T1	494330	4667535	2	198	624	W	0	INT	BUF	6	flr/frt
STR2_11	T2	494330	4667535	7	32	624	E	5	INT	BUF	6	flr/frt
UST1_03	T1	488127	4669237	3	152	795	NE	5	PER	BUF	7	flr/frt
UST1_03	T2	488127	4669237	4	310	795	SW	12	PER	BUF	7	flr/frt
UST1_05	T1	488053	4669305	2	345	818	E	5	PER	BUF	7	flr/frt
UST1_05	T2	488053	4669305	2	162	818	SE	10	PER	BUF	7	flr/frt
UST1_10	T1	488053	4669305	4	142	818	NE	22	PER	BUF	7	flr/frt
UST1_10	T2	488053	4669305	2	6	818	SW	16	PER	BUF	7	flr/frt
UST1_13	T1	487846	4669637	3	160	868	NE	5	PER	BUF	7	flr/frt
UST1_13	T2	487846	4669637	4	340	868	SW	5	PER	BUF	7	frt
UST1_19	T1	487722	4669900	4	333	911	NE	17	INT	BUF	7	frt
UST1_19	T2	487722	4669900	2.5	134	911	SW	14	INT	BUF	7	frt
UST1_22	T1	487656	4670033	5	173	953	NE	16	INT	BUF	7	frt
UST1_22	T2	487656	4670033	1	330	953	SW	30	INT	BUF	7	frt
UST1_23	T1	487632	4670078	5	346	961	NE	23	INT	BUF	7	frt/dry

Basin & Site	Trn. No.	UTM_X	UTM_Y	Dist. from stream edge (m)	Trn. Az.	Elev. (m)	Bank Asp.	Slope (%)	Stream Type	Treat.	Sample Month	Pheno. Stage
UST1_23	T2	487632	4670078	6	148	961	SW	20	INT	BUF	7	dry
UST1_25	T1	487596	4670170	3	170	1002	NE	20	INT	BUF	7	frt/dry
UST1_25	T2	487596	4670170	4	345	1002	SW	12	INT	UNBUF	7	frt/dry
UST2_08	T1	488944	4669715	5	166	769	NE	32	PER	UNBUF	7	frt/dry
UST2_08	T2	488944	4669715	2	0	769	SW	14	PER	UNBUF	7	frt/dry
UST2_15	T1	488843	4670041	2	327	810	NE	21	PER	UNBUF	7	frt/dry
UST2_15	T2	488843	4670041	5	179	810	SW	36	PER	UNBUF	7	frt/dry
UST2_16	T1	488839	4670090	4	7	820	NE	22	PER	UNBUF	7	frt/dry
UST2_16	T2	488839	4670090	6	183	820	SW	28	PER	UNBUF	7	frt/dry
UST2_19	T1	488816	4670239	2	160	847	NE	6	INT	UNBUF	7	dry
UST2_19	T2	488816	4670239	4	350	847	SW	21	INT	UNBUF	7	dry
UST2_24	T1	488761	4670481	6	167	890	NE	21	INT	UNBUF	7	dry
UST2_24	T2	488761	4670481	1	350	890	SW	0	INT	UNBUF	7	dry
UST2_26	T1	488729	4670578	3	180	908	E	11	INT	UNBUF	7	dry
UST2_26	T2	488729	4670578	2	17	908	W	22	INT	UNBUF	7	dry
UST2_27	T1	488711	4670625	4	342	914	NE	22	INT	UNBUF	7	frt/dry
UST2_27	T2	488711	4670625	3	160	914	SW	°30	INT	UNBUF	7	frt/dry
UST2_31	T1	488707	4670816	5	1	958	E	28	INT	UNBUF	7	frt/dry
UST2_31	T2	488707	4670816	5	162	958	SW	7	INT	UNBUF	7	frt/dry

Appendix B. Transect UTM Coordinates and Physical and Sampling Attributes – COLUMN HEADING DEFINITIONS

Basin & Site – refer to the three letter basin code (fig. 1) and the randomly selected site number as a unique identifier

Trn. No. – Transect Number

UTM X – Universal Transverse Mercator North American Datum (NAD) 1983 Easting coordinate

UTM Y - Universal Transverse Mercator North American Datum (NAD) 1983 Northing coordinate

Dist. from stream edge (m) - Distance from stream edge (m) of the 0 meter end of the transect (fig.3)

Trn. Az. – Transect Azimuth from the 0 meter end.

Elev. (m) – Elevation in meters

Bank Asp. – Stream bank aspect

Slope (%)- Percent slope of stream bank

Stream Type – Perennial or Intermittent per BLM stream survey data and corporate GIS layers

TRT – Treatment: BUF (Buffered), UNBUF (Unbuffered), UNBUF_NO_RxFire (Unbuffered, which was only handpiled and burned

Sample Month – Month number in which data was collected

Pheno. Stage – Phenological stage when data was collected: grn – green-up, flr – flowering, frt – fruiting, and dry – drying

APPENDIX B: PLANT SPECIES LIST AND ATTRIBUTES FOR SAMPLED TRANSECTS

[1]Scientific Name with Author	[2]Nativity	[3]Common Name	[4]Family	[5]Lifeform	[6]Duration
Anthriscus caucalis M. Bieb.	e	Burr chervil	Apiaceae	f/h	Ann.
Stellaria media (L.) Vill.	e	Common chickweed	Caryophyllaceae	f/h	Ann., Per.
Torilis arvensis (Huds.) Link	e	Spreading hedgeparsley	Apiaceae	f/h	Ann.
Aira caryophyllea L.	e	Silver hairgrass	Poaceae	gr	Ann.
Bromus spp.	e	Brome	Poaceae	gr	Per.
Cynosurus echinatus L.	e	Bristly dogstail grass	Poaceae	gr	Ann.
Poa bulbosa L.	e	Bulbous bluegrass	Poaceae	gr	Per.
Rosa eglanteria L.	e	Sweetbriar rose	Rosaceae	Sh	Per.
Rubus armeniacus Focke	e	Himalayan blackberry	Rosaceae	v/SubSh	Per.
Rubus laciniatus Willd.	e	Cutleaf blackberry	Rosaceae	v/subSh	Per.
Achillea millefolium L.	n	Common yarrow	Asteraceae	f/h	Per.
Adenocaulon bicolor Hook.	n	American trailplant	Asteraceae	f/h	Per.
Agoseris retrorsa (Benth.) Greene	n	Spearleaf agoseris	Asteraceae	f/h	Per.
Apocynum androsaemifolium L.	n	Spreading dogbane	Apocynaceae	f/h	Per.
Arnica latifolia Bong.	n	Broadleaf arnica	Asteraceae	f/h	Per.
Artemisia douglasiana Besser	n	Douglas' sagewort	Asteraceae	f/h	Per.
Astragalus accidens S. Watson	n	Rogue River milkvetch	Fabaceae	f/h	Per.
Balsamorhiza deltoidea Nutt.	n	Deltoid balsamroot	Asteraceae	f/h	Per.

[1]Scientific Name with Author	[2]Nativity	[3]Common Name	[4]Family	[5]Lifeform	[6]Duration
Boschniakia strobilacea A. Gray	n	California groundcone	Orobanchaceae	f/h	Per.
Calochortus tolmiei Hook. & Arn.	n	Tolmie star-tulip	Liliaceae	f/h	Per.
Campanula prenanthoides Durand	n	California harebell	Campanulaceae	f/h	Per.
Campanula scouleri Hook. ex A. DC.	n	Pale bellflower	Campanulaceae	f/h	Per.
Cardamine nuttallii Greene	n	Nuttall's toothwort	Brassicaceae	f/h	Per.
Clarkia purpurea (W. Curtis) A. Nelson & J.F. Macbr.	n	Winecup clarkia	Onagraceae	f/h	Ann.
Claytonia parviflora Douglas ex Hook.	n	Streambank springbeauty	Portulacaceae	f/h	Ann.
Collomia grandiflora Douglas ex Lindl.	n	Grand collomia	Polemoniaceae	f/h	Ann.
Collomia heterophylla Douglas ex Hook.	n	Variableleaf collomia	Polemoniaceae	f/h	Ann.
Cystopteris fragilis (L.) Bernh.	n	Brittle bladderfern	Dryopteridaceae	f/h	Per.
Delphinium spp.	n	Larksupr	Ranunculaceae	f/h	Per.
Dichelostemma congestum (Sm.) Kunth	n	Ookow	Liliaceae	f/h	Per.
Digitaria horizontalis Willd.	n	Hooker's fairy-bells	Liliaceae	f/h	Per.
Dodecatheon hendersonii A. Gray	n	Mosquito bills	Primulaceae	f/h	Per.
Dryopteris arguta (Kaulf.) Watt	n	Coastal woodfern	Dryopteridaceae	f/h	Per.
Equisetum hyemale L.	n	Scouringrush horsetail	Equisetaceae	f/h	Per.
Erythronium spp.	n	Fawnlily	Liliaceae	f/h	Per.
Goodyera oblongifolia Raf.	n	Western rattlesnake plantain	Orchidaceae	f/h	Per.

[1]Scientific Name with Author	[2]Nativity	[3]Common Name	[4]Family	[5]Lifeform	[6]Duration
Hieracium albiflorum Hook.	n	White hawkweed	Asteraceae	f/h	Per.
Hypericum scouleri Hook.	n	Scouler's st. Johnswort	Clusiaceae	f/h	Per.
Iris chrysophylla Howell	n	Yellowleaf iris	Iridaceae	f/h	Per.
Lilium pardalinum Kellogg	n	Leopard lily	Liliaceae	f/h	Per.
Lithophragma parviflorum (Hook.) Nutt. ex Torr. & A. Gray	n	Smallflower woodland-star	Saxifragaceae	f/h	Per.
Lomatium utriculatum (Nutt. ex Torr. & A. Gray) J.M. Coult. & Rose	n	Common lomatium	Apiaceae	f/h	Per.
Lotus spp.	n	Treifoil	Fabaceae	f/h	Per.
Lupinus L.	n	Lupine	Fabaceae	f/h	Per.
Madia madioides (Nutt.) Greene	n	Forest madia	Asteraceae	f/h	Bi.
Madia spp.	n	Tarweed	Asteraceae	f/h	Ann.
Maianthemum racemosum (L.) Link	n	Feathery false lily of the valley	Liliaceae	f/h	Per.
Maianthemum stellatum (L.) Link	n	Starry false lily of the valley	Liliaceae	f/h	Per.
Microseris douglasii (DC.) Sch. Bip. ssp. *Douglasii*	n	Douglas' silverpuffs	Asteraceae	f/h	Ann.
Mitella trifida Graham	n	Threeparted miterwort	Saxifragaceae	f/h	Per.
Moehringia macrophylla (Hook.) Fenzl	n	Largeleaf sandwort	Caryophyllaceae	f/h	Per.
Nemophila parviflora Douglas ex Benth.	n	Smallflower nemophila	Hydrophyllaceae	f/h	Ann.
Osmorhiza berteroi DC.	n	Sweetcicely	Apiaceae	f/h	Per.
Pectocarya pusilla (A. DC.) A. Gray	n	Little combseed	Boraginaceae	f/h	Ann.
Perideridia bacigalupii T.I. Chuang & Constance	n	Bacigalupi's perideridia	Apiaceae	f/h	Per.

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Piperia transversa Suksd.	n	Royal rein orchid	Orchidaceae	f/h	Per.
Plagiobothrys tenellus (Nutt. ex Hook.) A. Gray	n	Pacific popcornflower	Boraginaceae	f/h	Ann.
Polystichum munitum (Kaulf.) C. Presl	n	Western swordfern	Dryopteridaceae	f/h	Per.
Pteridium aquilinum (L.) Kuhn	n	Western brackenfern	Dennstaedtiaceae	f/h	Per.
Ranunculus occidentalis Nutt.	n	Western buttercup	Ranunculaceae	f/h	Per.
Sanicula crassicaulis Poepp. ex DC.	n	Pacific blacksnakeroot	Apiaceae	f/h	Per.
Sedum lanceolatum Torr.	n	Spearleaf stonecrop	Crassulaceae	f/h	Per.
Silene hookeri Nutt.	n	Hooker's silene	Caryophyllaceae	f/h	Per.
Stachys ajugoides Benth.	n	Hedge nettle	Lamiaceae	f/h	Per.
Synthyris reniformis (Douglas ex Benth.) Benth. Var. major Hook.	n	Snowqueen	Scrophulariaceae	f/h	Per.
Tonella tenella (Benth.) A. Heller	n	Lesser baby innocence	Scrophulariaceae	f/h	Ann.
Trientalis borealis Raf. *ssp. latifolia* (Hook.) Hultén	n	Broadleaf starflower	Primulaceae	f/h	Per.
Trifolium eriocephalum Nutt.	n	Woollyhead clover	Fabaceae	f/h	Per.
Trifolium spp.	unk	Clover	Fabaceae	f/h	
Trillium ovatum Pursh	n	Pacific trillium	Liliaceae	f/h	Per.
Veronica spp.	unk	Speedwell	Scrophulariaceae	f/h	
Xerophyllum tenax (Pursh) Nutt.	n	Common beargrass	Liliaceae	f/h	Per.
Yabea microcarpa (Hook. & Arn.) Koso-Pol.	n	False carrot	Apiaceae	f/h	Ann.
Clinopodium vulgare L.	n	Yerba buena	Lamiaceae	f/h, subSh	Per.

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Linnaea borealis L. *ssp. longiflora* (Torr.) Hultén	n	Longtube twinflower	Caprifoliaceae	f/h, subSh	Per.
Sidalcea malviflora (DC.) A. Gray ex Benth.	n	Dwarf checkerbloom	Malvaceae	f/h, subSh	Per.
Fragaria vesca L.	n	Woodland strawberry	Rosaceae	f/h, v	Per.
Galium bolanderi A. Gray	n	Bolander's bedstraw	Rubiaceae	f/h, v	Per.
Galium spp.	n	Bedstraw	Rubiaceae	f/h, v	Per.
Lathyrus polyphyllus Nutt.	n	Leafy pea	Fabaceae	f/h, v	Per.
Marah oreganus (Torr. ex S. Watson) Howell	n	Coastal manroot	Cucurbitaceae	f/h, v	Per.
Vicia americana Muhl. ex Willd.	n	American vetch	Fabaceae	f/h, v	Per.
Vicia L.	unk	Vetch	Fabaceae	f/h, v	
Achnatherum spp.	n	Needlegrass	Poaceae	gr	Per.
Agrostis spp.	n	Bentgrass	Poaceae	gr	Per.
Bromus carinatus Hook. & Arn.	n	California brome	Poaceae	gr	Ann., Bi.
Bromus L.	n	Brome	Poaceae	gr	Per.
Carex sp.	n	Sedge	Cyperaceae	gr	Per.
Elymus elymoides (Raf.) Swezey	n	Squirreltail	Poaceae	gr	Per.
Elymus glaucus Buckley	n	Blue wildrye	Poaceae	gr	Per.
Fescue spp.	n	Fescue	Poaceae	gr	Per.
Festuca californica Vasey	n	California fescue	Poaceae	gr	Per.
Festuca occidentalis Hook.	n	Western fescue	Poaceae	gr	Per.
Luzula comosa E. Mey.	n	Pacific woodrush	Juncaceae	gr	Per.
Melica spp.	n	Oniongrass	Poaceae	gr	Per.
Vulpia microstachys (Nutt.) Munro	n	Small fescue	Poaceae	gr	Ann.

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Amelanchier alnifolia (Nutt.) Nutt. ex M. Roem.	n	Saskatoon serviceberry	Rosaceae	Sh	Per.
Arctostaphylos viscida Parry	n	Sticky whiteleaf manzanita	Ericaceae	Sh	Per.
Ceanothus integerrimus Hook.&Arn.	n	Deerbrush	Rhamnaceae	Sh	Per.
Ceanothus sanguineus Pursh	n	Redstem ceanothus	Rhamnaceae	Sh	Per.
Cercocarpus montanus Raf. var. glaber (S. Watson) F.L. Martin	n	Birchleaf mountain mahogany	Roaceae	Sh	Per.
Corylus cornuta Marsh.	n	Beaked hazelnut	Betulaceae	Sh	Per.
Garrya buxifolia A. Gray	n	Dwarf silktassel	Garryaceae	Sh	Per.
Holodiscus discolor (Pursh) Maxim.	n	Oceanspray	Rosaceae	Sh	Per.
Oemleria cerasiformis (Torr. & A. Gray ex Hook. & Arn.) Landon	N	Indian plum	Rosaceae	Sh	Per.
Philadelphus lewisii Pursh	n	Lewis' mock orange	Hydrangeaceae	Sh	Per.
Rhododendron occidentale (Torr. & A. Gray) A. Gray	n	Western azalea	Ericaceae	Sh	Per.
Ribes sanguineum Pursh	n	Redflower currant	Grossulariaceae	Sh	Per.
Rosa spithamea S. Watson	n	Ground rose	Rosaceae	Sh	Per.
Rubus parviflorus Nutt.	n	Thimbleberry	Rosaceae	Sh	Per.
Cornus nuttallii Audubon ex Torr. & A. Gray	n	Pacific dogwood	Cornaceae	Sh/tree	Per.
Quercus californica (Torr.) Cooper	n	California black oak	Fagaceae	Sh/tree	Per.
Quercus chrysolepis Liebm.	n	Canyon live oak	Fagaceae	Sh/tree	Per.
Quercus garryana Douglas ex Hook.	n	Oregon white oak	Fagaceae	Sh/tree	Per.

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Frangula purshiana (DC.) Cooper	n	Pursh's buckthorn	Rhamnaceae	Sh/tree	Per.
Salix L.	n	Willow	Salicaceae	Sh/tree	Per.
Chimaphila umbellata (L.) W. Bartram	n	Pipsissewa	Pyrolaceae	subSh	Per.
Eurybia radulina (A. Gray) G.L. Nesom	n	Roughleaf aster	Asteraceae	SubSh	Per.
Mahonia aquifolium (Pursh) Nutt.	n	Hollyleaved barberry	Berberidaceae	SubSh	Per.
Mahonia nervosa (Pursh) Nutt.	n	Cascade barberry	Berberidaceae	SubSh	Per.
Phlox adsurgens Torr. ex A. Gray	n	Northern phlox	Polemoniaceae	SubSh	Per.
Rosa gymnocarpa Nutt.	n	Dwarf rose	Rosaceae	SubSh	Per.
Symphoricarpos L.	n	Snowberry	Caprifoliaceae	SubSh	Per.
Calystegia occidentalis (A. Gray) Brummitt	n	Chaparral false bindweed	Convolvulaceae	subSh/v	Per.
Lonicera ciliosa (Pursh) Poir. ex DC.	n	Orange honeysuckle	Caprifoliaceae	subSh/v	Per.
Lonicera hispidula (Lindl.) Douglas ex Torr. & A. Gray	n	Pink honeysuckle	Caprifoliaceae	subSh/v	Per.
Rubus leucodermis Douglas ex Torr. & A. Gray	n	Whitebark raspberry	Rosaceae	subSh/v	Per.
Rubus ursinus Cham. & Schltdl.	n	California blackberry	Rosaceae	subSh/v	Per.
Toxicodendron diversilobum (Torr. & A. Gray) Greene	n	Pacific poison oak	Anacardiaceae	subSh/v	Per.
Vitis californica Benth.	n	California wild grape	Vitaceae	subSh/v	Per.
Whipplea modesta Torr.	n	Common whipplea	Hydrangeaceae	subSh/v	Per.

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Abies concolor (Gord. & Glend.) Lindl. ex Hildebr.	n	White fir	Pinaceae	Tree	Per.
Acer macrophyllum Pursh	n	Bigleaf maple	Aceraceae	Tree	Per.
Alnus rubra Bong.	n	Red alder	Betulaceae	Tree	Per.
Arbutus menziesii Pursh	n	Pacific madrone	Ericaceae	Tree	Per.
Calocedrus decurrens (Torr.) Florin	n	Incense cedar	Cupressaceae	Tree	Per.
Fraxinus latifolia Benth.	n	Oregon ash	Oleaceae	Tree	Per.
Pinus ponderosa C. Lawson	n	Ponderosa pine	Pinaceae	Tree	Per.
Prunus spp.	unk		Rosaceae	Tree	Per.
Pseudotsuga menziesii (Mirb.) Franco	n	Douglas-fir	Pinaceae	Tree	Per.
Taxus brevifolia Nutt.	n	Pacific yew	Taxaceae	Tree	Per.

[1]Taxon name and author; some groups of species were clustered at the genus taxonomic level. [2]Nativity status: exotic (e), native (n), and unknown (unk). [3]Commonly accepted name. [4] The taxon plant family. [5]Functional lifeform: forb/herb (F/h), graminoid (Gr), shrub (Sh), subshrub (subSh), vine (v), and tree. [6] Growth duration: Perennial (Per.), Annual (Ann.), Biannual (Bi.) (USDA-NRCS 2009).

USDA, NRCS. 2009. The PLANTS Database (http://plants.usda.gov, 26 March 2009). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.