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ROOST-SITE SELECTION AND POTENTIAL PREY SOURCES AFTER WILDLAND FIRE FOR TWO INSECTIVOROUS BAT SPECIES (*MYOTIS EVOTIS* AND *MYOTIS LUCIFUGUS*) IN MID-ELEVATION FORESTS OF WESTERN MONTANA

by

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Roost-site selection and potential prey sources after wildland fire for two insectivorous bat species (*Myotis evotis* and *Myotis lucifugus*) in mid-elevation forests of western Montana

Chairperson: Dr. Kerry R. Foresman

Wildland fire in mid-elevation forests commonly results in mixed-severity and stand replacement burns leaving behind many standing dead trees. Numerous wildlife species use these trees including bats. Little brown and long-eared myotis were tracked via radio-telemetry to specific roost sites within two fires from the 2003 fire season in western Montana. Two logistic regression models, a biological and a management model, were constructed from variables collected at multiple scales. The biological model included all variables collected and the management model included only variables easily manipulated by land managers. The biological model contained the number of trees greater than 31-cm diameter at breast height and the number of linear stream meters within a 500-meter radius around the roost tree. The management model predicted an increase in the odds of use for trees larger in diameter, in plots of higher tree densities, and closer to water than randomly available plots. I suggest retaining large-diameter trees, in stands of higher densities, and closer to water to minimize the negative effects of post-fire management practices on little brown and long-eared myotis.

Potential prey sources within burned forest were sampled with ultra-violet light traps and compared to adjacent unburned forest. The first year post-fire insect communities included the highest family richness (n=77) and experienced a dramatic increase in Diptera, Coleoptera, and Trichoptera numbers while Lepidopteran numbers remained equal among years and between burned and unburned sites. Twenty-eight families were restricted to burned sites and 16 families were found only in unburned sites. This research suggests burned forest provides highly productive insect habitat and may attract insectivorous predators like bats.

Table of Contents

Chapter 1

Chapter 2

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Chapter 1. Bat roost-site selection

INTRODUCTION

Wildland fire dominates Western North America as the primary natural disturbance force and must be incorporated into land management plans (Agee 1993). Wildland fire altered 22,683,876 ha of land between 1994-2004 in the United States [NIFC 2005] and 911,194 ha burned in Montana alone between 1999-2003, averaging 182,239 ha per year [NRCC 2005]. Researchers are gaining insight into the importance of this form of disturbance to vegetation (Brown and Smith 2000), mammals (Smith 2000), birds (Kotliar et al. 2002), amphibians (Pilliod et al. 2003), insects (Saint-Germain et al. 2004), and fungi (Pilz et al. 2004). Wildland fire creates a unique habitat used by a diverse array of taxa, with some requiring it for a part or all of their life cycles (Hart 1998).

Increased food quantity or quality are thought to be the main factors driving the positive response to fire exhibited by large mammals (Smith 2000), small mammals (Krefting and Ahlgren 1974), birds (Hutto 1995), and insects (Saint-Germain et al. 2004). Fire removes ground cover and opens cones making the seed-bank ready to raid by granivorous birds and mammals. The large amount of snags created by high-severity fire provides a superabundant supply of dead trees for insect larvae to consume, and represent a biological legacy passed from the pre-fire to the post-fire ecosystem (Franklin et al. 2000). Insect larvae developing in these trees in turn provide food for birds, especially woodpeckers, and after the larvae mature and emerge as adults, provide food for insectivorous bats and birds. The creation of snags, through mixed-severity and stand-replacement fire common at higher elevations in the Rocky Mountains, also supports many bird and other vertebrate species including bats because of increased nesting and roosting opportunities (Hutto 1995, pers. obs.). The bark of trees common at these elevations (Engelmann spruce, subalpine fir, and lodgepole pine) has a tendency to peel away from the trees, due to heat, and provide roosting and nesting opportunities for bats and birds (personal obs.).

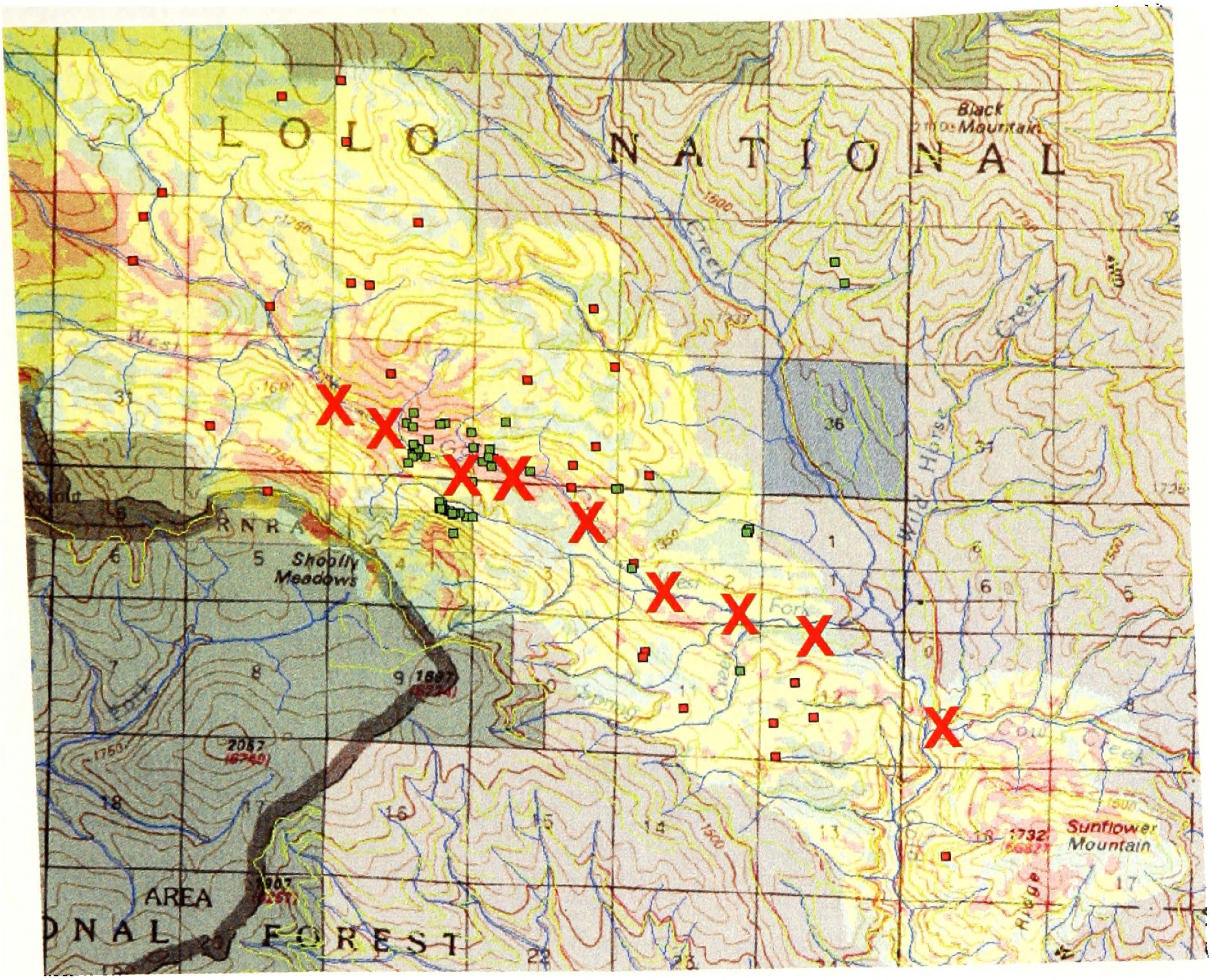
Use of post-fire forested lands has been a point of contention on public lands often resulting in expensive litigation. More research on the effects of pre-fire fuel management and post-fire effects on vegetation and wildlife is needed to craft a science-based fire policy (Franklin and Agee 2003). This multi-scale study constitutes one step towards that goal by attempting to determine the utility of burned forest to bats (Chiroptera) and to understand the characteristics associated with bat roosts, probably the most limiting factor for bat populations (Humphrey 1975, Kunz 1982). The information gained can be developed for use as a management tool, retaining important forest structural elements and minimizing any negative effects to bats through potential post-fire salvage logging. Currently, little to no information exists on bat use of burned forest.

Forest bats are known to use large-diameter trees in early to intermediate stages of decay for roosting habitat in unburned forest (Brigham et al. 1997, Campbell et al. 1996, Lacki and Schwierjohann 2001, Ormsbee and McComb 1998, Vonhoff and Barclay 1996, Waldien et al. 2000, Weller and Zabel 2001). The timber harvest strategy of salvage logging removes merchantable dead trees after wildland fire, and may remove critical roosting trees for bat communities.

The overall intent of this research is to determine if bats use burned forest and gain an understanding of the implications of wildland fire to forest bat communities. The primary focus of this research is to identify characteristics of roost trees, the most limiting factor for bat populations, and encourage the retention of this tree category in salvage logging management plans. The secondary objective of this research is to describe and quantify nocturnal insect communities in burned and unburned forest. This research provides a qualitative outlook on the utility of burned coniferous forest to forest-dwelling bat communities, addressing research needs for the Montana Bat Conservation Strategy and Plan (Schwab and DuBois 2004) and provides an important link to address the management priorities of the North American Bat Conservation Partnership (Keeley et al. 2003). Answering such questions with empirical data will increase our knowledge of bats in the West and improve land management practices for bats.

STUDY AREAS

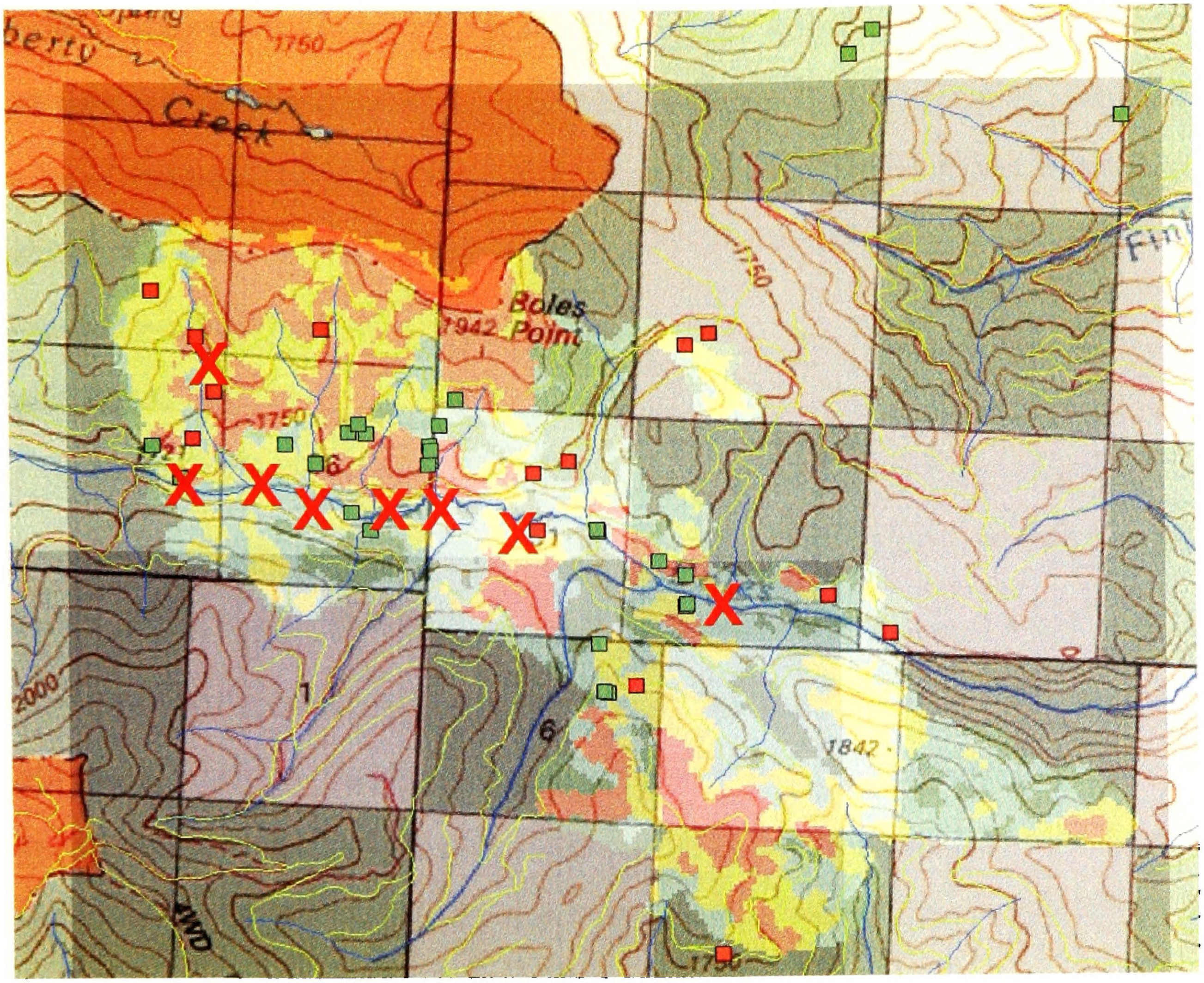
I conducted this study in the West Fork of Gold Creek (Fig. 1) and Boles Meadow (Fig. 2) second-order stream drainages of western Montana, about 30 kilometers northeast of Missoula. These two sites represent 2 different fires, the Mineral-Primm fire and the Boles Meadow fire, respectively, separated by two ridges and 11.6 km. The tree species composition of these forests represent the typical mid-elevation forests of western Montana. Both sites burned in 2003, so this study represents the effects of fire 1 and 2 years post-disturbance.



■ = Random tree locations
■ = Roost locations
x = Trap sites

Fig. 1- Random tree locations, roost locations, and trapping sites in Gold Creek, Montana.

The Gold Creek drainage, predominantly owned by Plum Creek Timber (PCT), is a heavily managed area ranging in elevation from 1067 to 1950m. As a result of timber management practices, many different age structures of various tree species are available including: large diameter (> 100 cm) ponderosa pine (*Pinus ponderosa),* western larch (*Larix occidentalis*), Douglas-fir (*Psuedotsuga mensezii*), Engelmann spruce (*Picea* *englemanni*) and lodgepole pine (*Pinus contorta*) as well as younger regenerating stands. The Mineral-Primm fire in this drainage occurred from 6 August to 19 September 2003, burning approximately 10,203 ha.



■ = Random tree locations
■ = Roost locations
x = Trap sites

Fig. 2. Random tree locations, roost locations, and insect trap sites in Boles Meadow, Montana.

The Boles Meadow site ranges in elevation from 1372 to 1900m consisting of lodgepole pine, Engelmann spruce, Douglas-fir, subalpine fir, and western larch, from 5-cm dbh sapling stands, resulting from clearcutting, to mature stands of 60-cm dbh trees. Checkerboard ownership (Lolo National Forest and PCT) characterizes this landscape with most private lands experiencing post-fire salvage logging before this study. A 1,809 ha fire of variable fire severities burned the area from 8 to 24 August 2003. Extensive and intensive timber harvest dominates the area, which is bordered by the Mission Mountain and Rattlesnake Wilderness areas.

METHODS

Between 7 June 2004 and 14 August 2005 I captured bats with mist nets near riparian areas, since bats are known to concentrate activity in these areas (Holloway and Barclay 2000). The following measurements and assessments were determined: forearm length (mm), mass (g), sex, age (Adult/Juvenile according to Anthony 1988), reproductive condition (pregnant, lactating, post-lactating, or scrotal), and species. I attached the smallest radiotransmitters available [Holohil Systems, Canada Ltd. (Type LB-2N, mass=0.35 g)] to the inter-scapular region after clipping fur and applying Skin-Bond adhesive (Smith Nephew United, Largo, Florida, USA). Radiotransmitters represented 4.5 to 6.6% of the bat's total mass. Only adults received transmitters. Previous researchers strongly recommend transmitters be $\leq$5% of a bat's total mass (Aldridge and Brigham 1988; Neubam et al. 2005). The 6.6% represents a male little brown myotis that disappeared from the 10,000-ha study area only to return 6 days later, suggesting minimal influence of transmitter mass on movement patterns.

We located roost trees using Telonics TR-4 receivers and Yagi 3-element antennas and determined, whenever possible, exact roost locations with unaided vision or binoculars. Trees used by bats the day after release were noted; however, only trees used by bats after the second day were included in the analysis to minimize the unknown effects of radiotagging stress on bat roosting behavior (Elmore et al. 2004). Up to six bats were tracked every day, but not all bats were found each day. Trees and stumps were both treated as tree roosts.

After identifying a roost tree, the following variables were characterized or measured: tree location (in burned or unburned site), tree species, diameter at breast height (dbh) (cm), tree height (m), decay stage (Vonhoff and Barclay 1996), crown class-dominant, codominant, intermediate, or suppressed (Smith et al. 1997), roost type (cavity, crack, or exfoliating bark), if roost created by fire, roost height (m), roost aspect, and distance to nearest tree of same or taller height.

Stand-level attributes were determined by inventorying a 17.8-m-radius plot centered on the roost/randomly available tree: snag density (# snags/ha), average stand height (m), average percent canopy closure and understory vegetation height (3, 5 and 15 m from tree in 4 cardinal directions), aspect, and elevation. Within the 17.8-m-radius (0.1-ha) plot centered on the roost/random tree I counted all trees with a dbh greater than 4 cm, and recorded dbh, species, and whether individual trees were "available." Available trees required a space under bark, a crack, or a cavity at least 2 cm x 2 cm. Specific methods of measurements are available in Appendices A-B.

Each roost tree plot had one random location assigned. ArcMAP version 9.0 (ESRI, Redlands, California) generated random points within the defined burn boundary to determine the starting point for an "available" tree search. The search for "available" trees occurred by walking concentric circles until the "available" tree was located. After the "available" roost trees were identified, the same variables as described above were measured. Randomly available trees were assumed unused, and each tree within the burn was assumed accessible to all bats.

Landscape-level attributes measured with ArcMap were: distance to nearest perennial stream channel (m), linear meters of perennial stream channel within a 500-m radius of roost/random tree, and area (m^2) of high-severity and low-severity fire within 500-m radius of roost. A five-hundred-meter radius equals 1,000 m diameter, which was the average maximum distance moved by the bats in this study. I calculated movement between roosts using ArcMap for all bats with more than 1 roost location and expressed results as the mean ± standard error (SE).

All of the results, except for the rock and tree day analysis, in the body of the text under the sub-heading *Myotis evotis* and *Myotis lucifugus*, include pooled *M. evotis* and *M. lucifugus* roost trees and pooled randomly available trees. Appendices C-E provide graphical comparisons of categorical variables between *M. evotis* and *M. lucifugus*; each variable only compared to the available trees from each respective site, without pooling available trees.

Data analysis

All data analyses presented in the body of the text result from a pooled analysis of *Myotis evotis* and *Myotis lucifugus*. Differences in roosting habits do exist between the two species, but I do not believe pooling hides important differences between these species. Management for bats will not likely be implemented on a per species basis, e.g., only manage for little brown myotis and not other species in the genus *Myotis*, thus I feel justified pooling this data in the analysis. This is especially true for two bats in the same genus, with generally similar roosting habits (under bark). For clarity and readability only the pooled results are given in this paper. However, between species differences are presented in a graphical format (categorical variables) and with separate logistic regression analysis (continuous variables) in Appendices C-E & F-H.

The number of rock versus tree days [one bat, in a roost (tree or rock) for one day, constitutes one tree or rock day] were calculated using Pearson's chi-square. All other categorical variables including roost versus available tree species, roost versus available aspects, and roost versus available canopy classes were analyzed with likelihood ratio Chi-square tests.

The pool of continuous variables for all random plots was reduced by performing a rank-sum test and retaining only those variables not significantly different between sites. Pearson's and Spearman's correlation coefficients were used to eliminate correlated variables and further reduce the number of variables used in the logistic regression analysis. Results given in Table 3 describing the differences between roost and random plots were calculated using a rank sum test. Logistic regression models were constructed according to Hosmer and Lemeshow (2000). Likelihood ratio tests were used to identify the most parsimonious combination of variables distinguishing bat roost plots and random/available plots. Lack of fit for all models was evaluated with the Hosmer and Lemeshow lack-of-fit test and classification rates. The fundamentals of logistic regression are based on used vs. unused plots (Keating and Cherry 2004), although the use of logistic regression in this use vs. available capacity is pervasive in the literature. This logistic regression analysis follows other bat roost-site selection studies (Bernardos et al. 2004), assuming the randomly selected available trees are not used by radio tagged bats during the study period, although we cannot ensure the randomly selected available trees were not used by other bats. All statistical tests were generated with SPSS and employed a significance level of p=0.05.

Results

Over the course of two field seasons 121 bats of 8 species were captured (Table 1) at 17 sites. Bat captures in Boles Meadow were heavily skewed toward males, and captures in Gold creek resulted in a nearly even sex ratio (Table 2). Of the 40 bats fitted with radio transmitters, roosting information was obtained for 29 bats. Of all roosting locations, 29 (33%) were in rocks, and 59 (67%) were in trees. The 59 trees included 3 trees and 4 stumps outside the burn boundary and 49 trees and 3 stumps inside the burn boundary translating into 87 (91%) tree days within the burn compared to 9 (9%) tree days outside the burn.

More than 1 roost location was found for 19 bats. For all bats, the average maximum distance traveled between roosts was 970 ± 307 m, range 35-5154m. Females (n=11) traveled a mean maximum distance of 654 ± 162m, range 35-1707; while males (n=8) traveled a mean maximum distance of 1404 ± 691 m, range 105 to 5154 m.

Table 1. Total captures, sex ratios, number of each species radio tagged, and the number of bats followed to at least one rock or tree roost. Boles Meadow and Gold Creek, Montana 2004-2005.

Species	# captured	Male : Female	♀ tagged	♂ tagged	# with data
Eptesicus fuscus	16	14:2	0	1	1
Lasiurus cinereus	12	11:1	1	2	0
Lasionycteris noctivagans	19	12:7	3	5	2
Myotis californicus	15	3:12	0	0	-
Myotis ciliolabrum	4	1:3	0	0	-
Myotis evotis	28	15:13	9	8	14
Myotis lucifugus	18	17:1	0	11	10
Myotis volans	9	7:2	1	0	1

Table 2. The number of males and females captured at each site between 2004 and 2005, Boles Meadow (BM) and Gold Creek (GC).

Site	Males	Females
BM	49	7
GC	31	34

Long-eared myotis (*Myotis evotis*) and Little brown myotis (*Myotis lucifugus*)

Rock vs tree roosts (includes trees within burn and trees outside burn)

Of the 10 little brown myotis males, 5 roosted in 7 rocks, for a total of 10 rock days (Fig. 3), averaging 2 rock days per bat. Nine of the 10 males roosted in 21 trees for a total of 42 tree days, averaging 4.7 tree days per bat. The null hypothesis that little brown myotis males, on average, roost equally in rocks and trees (in terms of days) was supported (χ^2=14.7, df=9, p=.0995).

Of the 9 long-eared myotis females, 7 roosted in 11 rocks, for a total of 20 rock days, averaging 2.9 rock days per bat. All 9 females roosted in trees at least once for a total of 25 trees, and a total of 41 tree days, averaging 4.6 tree days per bat. The null hypothesis that female long-eared myotis, on average, roost equally in rocks and trees (in terms of days) was supported (χ^2=8.6, df=8, p=.3772). Of the 4 male long-eared myotis, 4 roosted in 8 rocks, for a total of 20 rock days, averaging 5 rock days per bat. Two males roosted in 5 trees for a total of 5 tree days, averaging 2.5 tree days per bat. The null hypothesis that each male long-eared myotis, on average, roost equally in rocks and trees (in terms of days) was supported (χ^2=6.3, df=3, p=.0979; Fig.3). The roosting locations, and total number of days located for each bat are available in Appendix I.

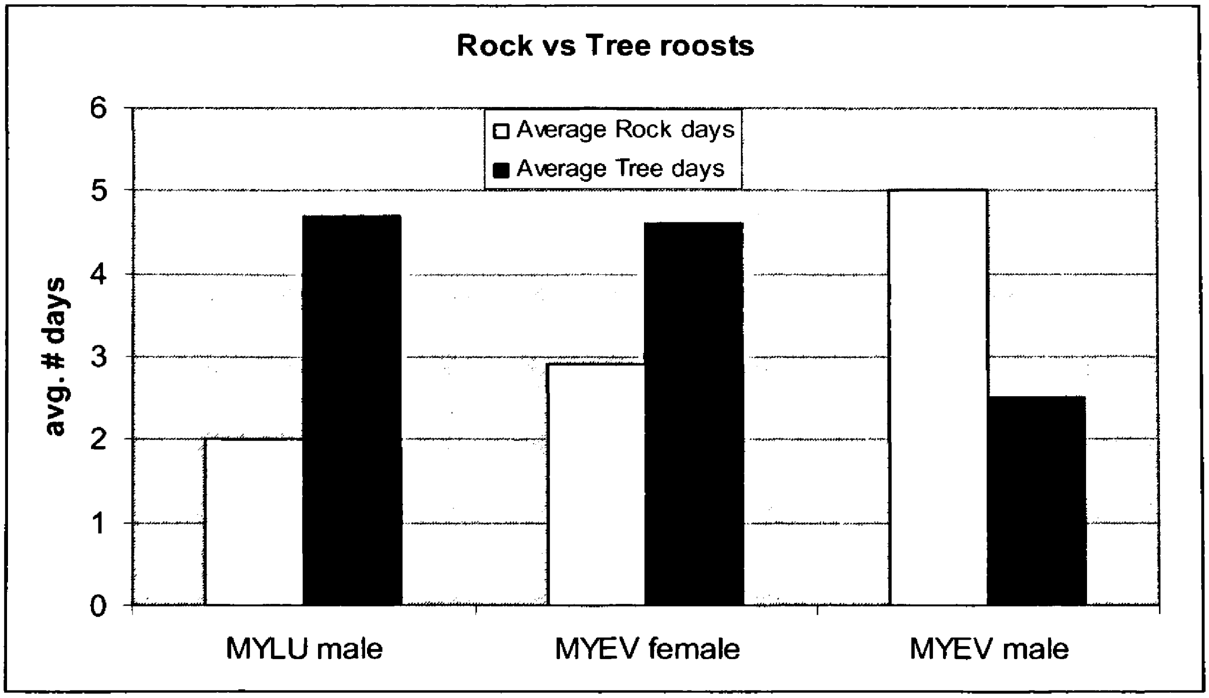


Fig. 3. The average number of days in rock and tree roosts delineated by sex and species for *Myotis evotis* (MYEV) and *Myotis lucifugus* (MYLU). Boles Meadow and Gold Creek, Montana 2004-2005.

Tree roosts (all within burn)

All analyses in this section include only trees used by *M. evotis* and *M. lucifugus* located within the burn. Nine little brown myotis males were tracked to 20 different trees, each using 1-7 trees. Nine long-eared myotis were tracked to 26 different trees, each bat using 1-6 trees. A total of 51 random/available trees were identified, 22 at Boles Meadow and 29 at Gold Creek, and compared to roost trees. Roost trees included 16 Engelmann Spruce, 11 Douglas-fir, 7 subapline fir, 4 lodgepole pine, 4 western larch, 4 unknowns (Fig. 4).

Using conventional statistical criteria, *M. evotis* and *M. lucifugus* roosted randomly with respect to tree species (likelihood ratio Chi-square, χ^2=9.440, df=4, p=0.051; Fig.4), but used more Engelmann spruce (16) than available (10) and less lodgepole pine (4) and Subalpine fir (7) than available (11 and 14, respectively). The average diameters per species for roost and random trees were as follows: Engelmann spruce (roost =38.8 cm, random=28.7 cm), Douglas-fir (roost=35.1 cm, random =31.8 cm), subalpine fir (roost =32.0 cm, random=20.4 cm), and lodgepole pine (roost =28.4 cm, random = 19.1 cm).

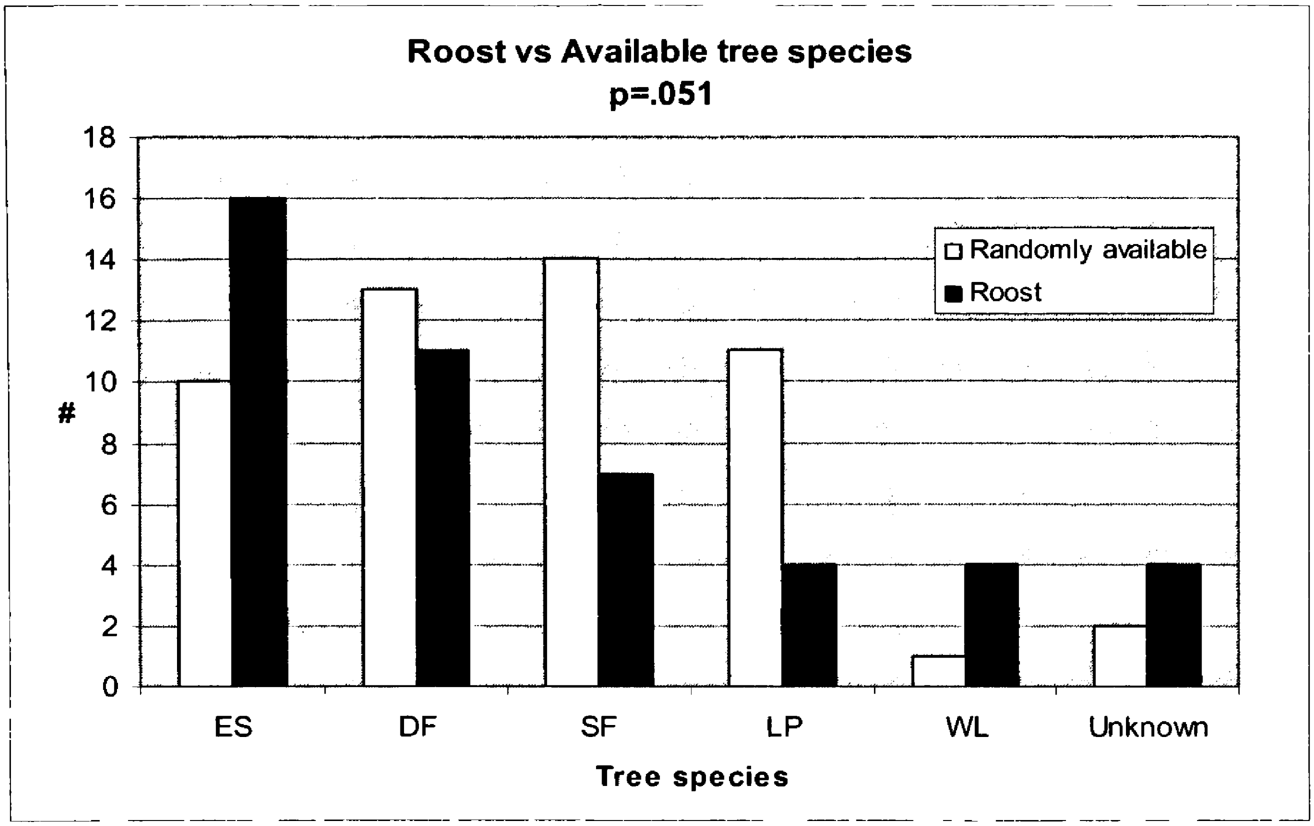


Fig. 4. Tree species of *Myotis evotis* and *Myotis lucifugus* roost trees and randomly available trees. DF=Douglas-fir, ES=Engelmann spruce, SF= Subalpine fir, LP= Lodgepole pine, WL= Western larch and Unknown= unknowns. Boles Meadow and Gold Creek, Montana 2004-2005.

M. evotis and *M. lucifugus* roosted randomly with respect to aspect (likelihood ratio Chi-square, χ^2=12.84, df=7, p=.076; Fig.5), but the majority (81.6%) of roost aspects were east, southeast, or south. Available trees facing east, southeast, or south comprised 57.1% of all available tree aspects. No roost aspects were oriented northwest, and only one roost was oriented north and northeast. Aspects for eight roost trees could not be determined.

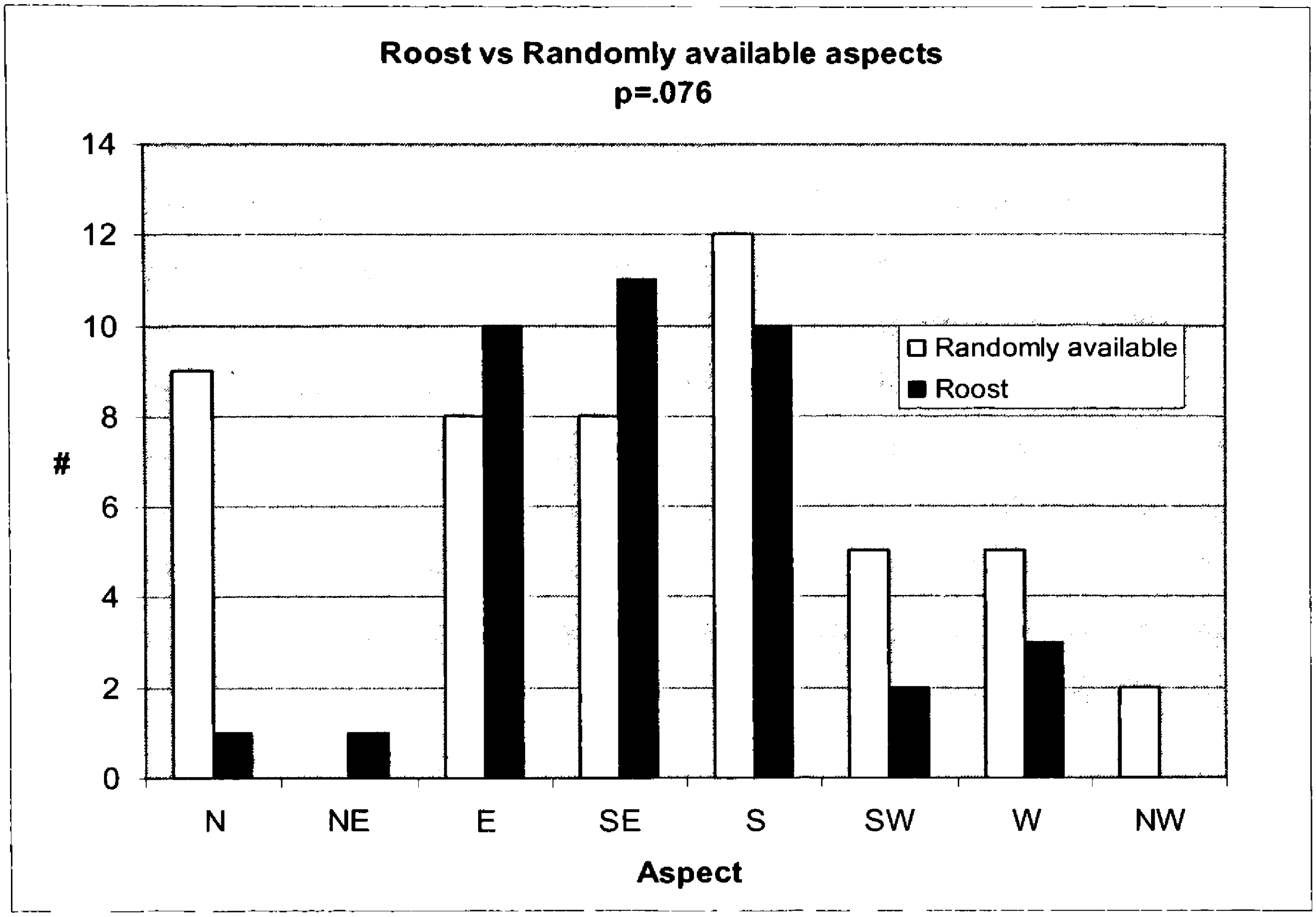


Fig. 5. Roost aspects of *M. evotis* and *M. lucifugus* compared to randomly available tree roost aspects. Boles Meadow and Gold Creek, Montana 2004-2005.

Long-eared and little brown myotis roosted randomly with respect to tree crown class (likelihood ratio Chi-square, χ^2=4.683, df=3, p=.197; Fig. 6.). Fifteen available trees were classified as intermediate and only 6 roost trees were classified as intermediate.

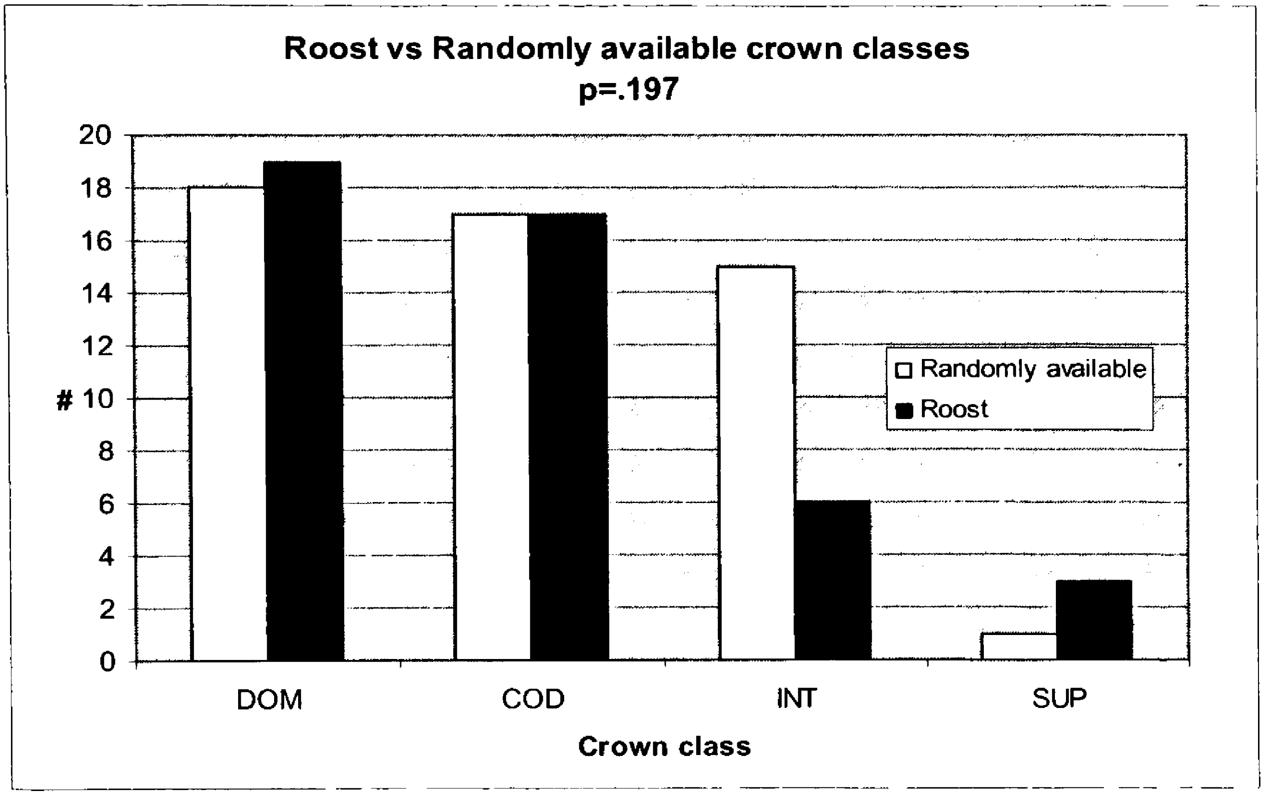


Fig. 6. Crown classes for roost and available trees for *M. evotis* and *M. lucifugus* in Boles Meadow and Gold Creek, Montana 2004-2005. DOM=dominant, COD=codominant, INT=intermediate, SUP=suppressed.

Roost vs. Random plot differences using rank sum test

Thirteen of the 15 variables collected to describe plot characteristics were significantly different between roost and randomly available plots (Table 3).

Table 3. Roost plot (n=46) and randomly available plot (n=51) means ± 1 std. dev. (SD) for long-eared and little brown myotis. Significance of the difference assessed with rank-sum test.

	Roost	Random	
Variable	$\bar{X}$ ± 1 SD	$\bar{X}$ ± 1 SD	p
Diameter (cm)[a]	40.0 ± 19.5	25.3 ± 13.5	<.0001
Tree height (m)[a]	21.5 ± 9.78	13.6 ± 7.06	<.0001
Distance to nearest tree (m)[a]	7.1 ± 5.2	8.8 ± 7.6	0.431
Available trees (# / plot)[b]	22.7 ± 16.4	9.8 ± 11.2	<.0001
Canopy cover[b]	15.9 ± 9.9	8.1 ± 10.3	<.0001
Arcsin % Engelmann spruce[b]	0.145 ± .152	.0773 ± .121	0.004
Trees dbh> 31 cm (# / ha)[b]	90.4 ± 60.2	34.1 ± 48.9	<.0001
Average stand height (m)[b]	23.0 ± 5.19	16.0 ± 6.74	<.0001
Tree density (# / ha)[b]	947 ± 636	577 ± 471	0.002
Snag density (# / ha)[b]	247 ± 184	108 ± 137	<.0001
Basal area (m^2/ ha)[b]	23.2 ± 13.1	11.0 ± 10.2	<.0001
Perennial stream (m)[c]	1920 ± 594	798 ± 628	<.0001
High severity fire area (m^2)[c]	289425 ± 162324	122215 ± 136425	<.0001
Low severity fire area (m^2)[c]	101066 ± 68102	112878.8 ± 110656	0.891
Minimum distance to water (m)[c]	90.6 ± 79.6	288 ± 209	<.0001

[a] tree level variable
[b] stand level variable
[c] landscape level variable

Logistic regression models

The following variables were not significantly different between randomly available plots and entered into the initial logistic regression analysis for the biological model: diameter (cm), nearest tree (m), fire severity, number of available trees, canopy cover, arcsin % Engelmann spruce, number of trees greater than 31 cm dbh, perennial stream meters, high severity fire area (m^2), low severity fire area (m^2), and minimum distance to perennial water. The logistic regression model predicting tree use by day-roosting bats generated by pooling randomly available trees and pooling bat species found that the number of trees greater than 31 cm (B=.019, p=.001, Table 4) and the number of perennial stream meters within a 500-m radius of the roost tree (B=.003, p<.0001, Table 4) provided the most parsimonious combination of variables predicting tree use by bats. This model did not indicate a lack of fit (Hosmer and Lemeshow test p=.577) and correctly classified 86.3% of the available trees and 84.8% of the roost trees for an overall classification rate of 85.6%.

Table 4. A final logistic regression biological model predicting tree use by day roosting little brown and long-eared myotis

Variable	B	S.E.	df	Significance	E^(B)
Trees dbh> 31 cm (#/ha)[a]	0.019	0.006	1	0.001	1.019
Perennial stream (m)[b]	0.003	0.001	1	0.0000017	1.003

[a] stand level variable
[b] landscape level variable

The following variables were entered into the initial logistic regression analysis for the management model: diameter (cm), tree height (m), minimum distance to perennial water, basal area (m^2/ha), density (trees/ha), fire severity, and arcsin % Engelmann spruce. The final management model (Table 5) included diameter (B=.067, p=.009), tree density (B=.002, p=.002), and distance to nearest perennial water (B= -.010, p<.0001). This model exhibited no lack of fit (Hosmer and Lemeshow test, p=.561) and correctly classified 78.4% of the random trees and 84.4% of the roost trees for a total classification rate of 81.3%.

Table 5. A final logistic regression management model predicting tree use by day roosting little brown and long-eared myotis.

Variable	B	S.E.	df	Significance	E^(B)
Diameter (cm)[a]	0.067	0.026	1	0.009	1.069
Density (# / ha)[b]	0.002	0.001	1	0.002	1.002
Minimum distance to water (m)[c]	-0.01	0.003	1	0.0004	0.99

[a] tree level variable
[b] stand level variable
[c] landscape level variable

DISCUSSION

Bats indeed use forests experiencing mixed-severity and stand-replacement wildland fire in higher elevation forests dominated by Engelmann spruce and subalpine fir in western Montana. These fire events create numerous roosting opportunities for under-bark roosting species, including the two bats in this study, *M. lucifugus* and *M. evotis*. Fifty-two out of 59 roost trees located were within the burn suggesting bats extensively use roost trees created by fire in these forest types. However, this number could be biased because not all bat roosts were found every day, and more effort was expended finding bats within the burns to increase the strength in determining the characteristics of bat roosts in burned forest. Bats are known to be dependent on snags for available roosting sites and burned forests contain large numbers of snags and thus likely numerous roost sites.

I captured 8 of the 11 possible bat species present in western Montana and located 3 maternity colonies of 3 different species (*M. evotis, M. volans, L. noctivagans*) within the burn boundary. Fire probably created roost sites for 2 of these 3 colonies. The existence of multiple maternity colonies, made up of many females, within burned forest suggests burns are appropriate habitats to raise young and offer resources for a variety of species.

Rock vs. Tree roosts vs. Sex

Use of tree and rock roosts (in terms of days used), although not statistically significant, differed between sexes and species. Male little brown myotis roosted mostly in trees, while male long-eared myotis used predominantly rocks. Female long-eared myotis, on average, used trees more often than rocks and maternity colonies were only found in trees. Rocks may provide a stable, cooler average temperature, compared to a tree roost that experiences more temperature fluctuations and higher average temperatures. Male bats should seek to employ torpor for energetic savings while female bats generally avoid torpor during pregnancy and lactation, which would result in slower fetal developmental rates. Also females need to care for young and thus need to maintain their body heat to help young maintain body heat (young spend less energy maintaining heat and put more energy into growth). Most of the male little brown myotis using trees were at a higher elevation and could have possibly entered torpor because the trees at higher elevation were cool enough to allow for torpor, similar to rocks at lower elevations (*M. evotis* males). Anecdotally, both sexes seemed to choose more temperature stable rock roosts on cooler days, possibly because trees, which experience a greater temperature fluctuation might have required bats expend more energy to maintain homeothermy.

Tree roosts within burn

Little brown and long-eared myotis roosted more in Engelmann spruce than their availability would predict, and less in lodgepole pine and subalpine fir than their availability. All three tree species are thin-barked species. The more frequent use of Engelmann spruce may indicate some unknown benefit (i.e., bark sloughing in large pieces), or may simply be a by-product of tree diameter. Of all available trees, Engelmann spruce averaged 28.7 cm in diameter, while subalpine fir and lodgepole pine averaged 20.4 and 19.1 cm, respectively. Douglas-fir trees were used in similar proportions to their availability and also represent an important tree species to little brown and long-eared myotis in post-fire forests.

Roost aspect appears to be important, despite a lack of statistical significance. The majority (81.6%) of roost aspects were oriented east, southeast, and south, aspects which should capture the most radiant heat from the sun compared with northernly aspects. This characteristic would be very important for small mammals such as bats which have a large surface area to volume ratio and resultant high energetic demands. Of all roosts, only 1 north aspect was used as a roost, indicating a potential avoidance of northern aspects.

Bats most frequently roosted in trees with a dominant or codominant crown class and roosted less frequently in intermediate crown class trees. Crown class takes into account the position of the tree in relation to the rest of the canopy so dominant trees are taller, and usually have a larger diameter than surrounding trees. Smaller diameter intermediate trees, although having a crack or cavity and considered "available," are rarely used in comparison to the larger diameter dominant and codominant trees. Three stumps were used by two post-lactating long-eared myotis females and one male long-eared myotis within the burn boundary. Roosting in stumps was not common during this study, although several previous studies have documented stump use by long-eared myotis (Waldien et al. 2000, Vonhof and Barclay 1997).

Nearly all measured variables were significantly different between roost plots and random plots (Table 3). Logistic regression can prove helpful in determining which of these characteristics or variables are most predictive of tree use by bats in recently burned forests. The most parsimonious model with the best fit for predicting tree use by bats included the number of trees greater than 31 cm in diameter per ha (extrapolated from 0.1 ha plots) and the number of perennial stream meters within a 500 m radius around the roost. Both variables in this model were highly significant in predicting tree use by bats. With every increase of 10 trees greater than 31 cm per ha, the odds of use increase by 21% and the odds of use increase by 35% with an increase of 100 m of perennial stream surrounding the roost.

The landscape variable, number of perennial stream meters around the roost, was included in nearly every model constructed. Landscape level variables obviously cover a broad spatial scale and therefore, can potentially be correlated. The increased number of perennial stream meters surrounding roost trees may simply result from minimizing foraging distances and choosing a centrally located roost near abundant foraging areas. Riparian areas are highly productive ecosystems, supporting large numbers of insects for bats. Alternatively, assuming large-diameter trees are important roost sites, roost trees located near water are likely to be larger in diameter due to increased availability of water, a limiting factor in tree growth.

Although these variables (number of trees greater than 31cm in dbh and number of perennial stream meters) may be biologically relevant and can be taken into account when developing management strategies, they are not easily manipulated and are rarely quantified by land managers. For this reason, I constructed a logistic regression model (Table 5) starting only with variables that can be altered or retained through common management practices, like tree harvest. Most of the variables entered into this model were correlated, like basal area (m^2/ha) and density (trees/ha), but I still consider this a worthwhile endeavor to identify the specific variables for developing management guidelines.

The outcome of this management model included one variable at each spatial scale. Diameter (cm) at the tree level, density (trees/ha) at the stand level, and distance to nearest perennial water at the landscape scale. Large-diameter trees are often found as important variables in bat roost-site selection studies (Kalcounis-Rüppell et al. 2005), including this study. The odds of tree use increases substantially with an increase in tree diameter. According to my model, for every 10 cm increase in tree diameter, the odds of use increase by 95%, or almost double.

Bats in unburned forest are known to use large-diameter trees in the early to intermediate stage of decay, but it is unknown if this affinity for large diameter is simply a by-product of decay stage. Burned forest provided an excellent opportunity to observe if use of large diameter trees stems only from the related decay. Many trees were seemingly "available" (contain a crack or space under bark) in the recently burned forests I studied; the diameter of randomly available trees averaged 25.3 cm, and ranged from 8.9 cm to 79 cm. Despite the apparent availability of these small diameter trees, the smallest tree used as a bat roost was 15.5 cm, and all roost trees were between 15.5 and 127.3 cm in diameter, averaging 40.0 cm. The presence and minimal use of small diameter trees with "available" roost sites suggest large diameter roosts are not used simply for the associated decay. Increased diameter may provide a more thermally stable environment, and therefore be more attractive to tree roosting bats.

Tree density also had a positive coefficient in the model.Therefore, the higher the density of trees, the more likely a tree would be used as a bat roost. High or low tree densities do not necessarily reflect small or large diameter trees due to the intensive management at these sites. If, for example, a stand is thinned to a lower density, one would expect tree diameters to be large, however, if not enough time has passed since the treatment, the target effects of the treatment (larger diameter trees) may not be evident until more time passes. Increased tree densities would equate to higher fuel loads, and therefore, should burn at higher intensities, possibly creating more bark sloughing and therefore more potential roosting sites. The addition of 100 trees per hectare increases the odds of bat use by 1.22, or 22%. This increase in density may also simply reflect a higher proportion of suitable trees surrounding the roost, minimizing search costs for new roosts. The densities calculated here do not represent live tree densities as an average of 77.5% of the standing trees in the roost plots were dead. Extrapolating the importance of tree density for bat use from burned to unburned forest, or to any other forest differing in the number of standing dead trees may not be appropriate.

Decreasing distance to nearest perennial water source increased the odds of tree use. Trees located only 100 meters closer to perennial water increased in the odds of use by 2.72, or almost 3 times. This result further strengthens the argument for retaining trees within streamside management zones (SMZ). Current SMZ guidelines require at least a 15.2- m buffer between water and tree harvesting activities. Our research shows the average minimum distance between roost sites and perennial water to be 90 meters. If these SMZ guidelines were altered and the buffer distance increased even 50 additional meters, adherence to the SMZ policy and improved management for bats could be met simultaneously. It is important to note that roost trees closer to water may also be a by-product of previous harvests leaving trees near water which have more time to increase in diameter and thus be more attractive to bats. Also, bat trapping occurred in riparian areas and could result in capturing bats preferring roost sites near water, therefore overestimating the importance of the minimum distance to water and the number of perennial stream meters surrounding roost sites.

These two models may help identify trees most likely to be used as roosts by little brown and long-eared myotis in recently burned mid-elevation forests. The inference of this study can only be applied to the trees in the areas disturbed by the Mineral-Primm and Boles Meadow fires, but the results of this study can provide a preliminary look into the roosting characteristics for bats in burned forest. Knowledge of these characteristics will hopefully provide land managers with a tool to minimize negative impacts to bats in a post-fire forest landscape.

MANAGEMENT IMPLICATIONS

To provide the most beneficial environment to little brown and long-eared myotis in post-fire forests, land management practices should retain large-diameter trees close to water. Engelmann spruce, Douglas-fir, subalpine fir, and lodgepole pine were all used as roost sites thus preference for retention should be focused on diameter rather than species . Engelmann spruce and Douglas-fir were the most frequently used tree species and should be retained if diameters of potential leave trees are similar. Despite the high statistical significance assigned to density, I am apprehensive in suggesting retaining trees in higher density stands due to the mosaic structure of fire and the potentially confounding effects of fire behavior or severity, regardless of density. However, density in two different forms, number of trees greater than 31 cm dbh per hectare and number of trees per hectare, were important variables in predicting tree use by bats. The density of trees in unburned forest has not been found in previous studies to differ significantly between roost and random plots (Kalcounis-Rüppell et al. 2005), but the presence of fire creates conditions attractive to bats (i.e., dead trees) in dense forest stands. The increased availability of roost sites, coupled with the explosion of insects after fire (Chapter 2) may increase the reproductive success for bats in burned forest.

Bats in recently burned mid-elevation forests of western Montana used trees larger in diameter in plots of higher tree densities and closer to perennial water compared to random plots. The most recent meta-analysis by Kalcounis-Rüppell et al. (2005) concluded forest bats are using larger diameter and taller trees in more open canopied and higher snag density plots, compared to random plots. The results from our study closely concur with this meta-analysis, leading me to believe bats use similar structures in recently burned forest as unburned forest. The ephemeral nature of snags as important roost structures in unburned forest require attention to long term planning for green tree retention and snag recruitment. Snag retention is the only tool available in burned forest as snag recruitment will not occur for possibly 100 years. The lack of ability to recruit new snags must be taken into consideration for post-fire forests when planning actions for all wildlife not just bats. Retaining snags after wildfire is vitally important to many wildlife species and current snag management policies for green-tree forests are probably not appropriate for post-fire forests (Hutto in press). Retaining snags provides roosting and nesting habitat for the mammalian and avian predators of insects (i.e., Cerambycidae) invading recently burned forest.

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APPENDIX-A Methods

Tree variables recorded-

Diameter- diameter at breast height with loggers tape in centimeters

Height- height of tree using a reliskop in meters

Crown class- Dominant, codominant, intermediate, or suppressed (according to Smith et al. 1997)

Roost height- height of roost in meters with reliskop or meter tape

Roost aspect- aspect of roost to nearest bi-cardinal direction (i.e., northwest)

Roost tree burned ?- Yes or no

Roost created by fire?- Yes or no (to the best of my ability)

Woodpecker activity?- Yes or no (obvious woodpecker activity)

Decay stage- 1-7 according to Vonhof and Barclay 1996

Nearest tree- distance to the nearest tree of equal or taller height in meters

Stand variables recorded- within 17.8 meter radius plot centered on roost or randomly available tree (focal tree)

Density- number of trees per hectare

Basal area- entered the diameters of trees into spreadsheet provided by Dr. Paul Alaback

Snag density- number of dead trees greater than 15.5 cm dbh (smallest roost tree)

Number of available trees- number of trees with a space under bark, crack or cavity of at least 2 centimeters x 2 centimeters

Number of trees > 31 cm- number of trees greater than 31 centimeters dbh

Arcsin % Engelmann spruce- Arcsin transformed the percentage of Engelmann spruce in the plot

Average stand height- measured tree heights of 8 trees in 17.8 m plot using relaskop, attempted to measure 2 trees of each crown class

Canopy cover- Number of quadrants containing vegetation through a spherical densitometer at 3, 5, and 15 meters from focal tree in all cardinal directions

Understory vegetation height- Measured height of any vegetation, except trees, in the understory at 3, 5, and 15 meters from focal tree in all cardinal directions

Fire severity- Nearly all trees dead in and surrounding plot- high severity; less than 75% of trees dead in and surrounding plot- medium severity; only young trees dead- low severity fire.

Elevation- elevation in meters with a 3-D location on a Garmin eMap GPS unit

Landscape variables recorded-

Perennial stream meters- number of linear meters of perennial water within a 500 meter radius around the focal tree

Minimum distance to water- minimum distance between focal tree and perennial water in meters

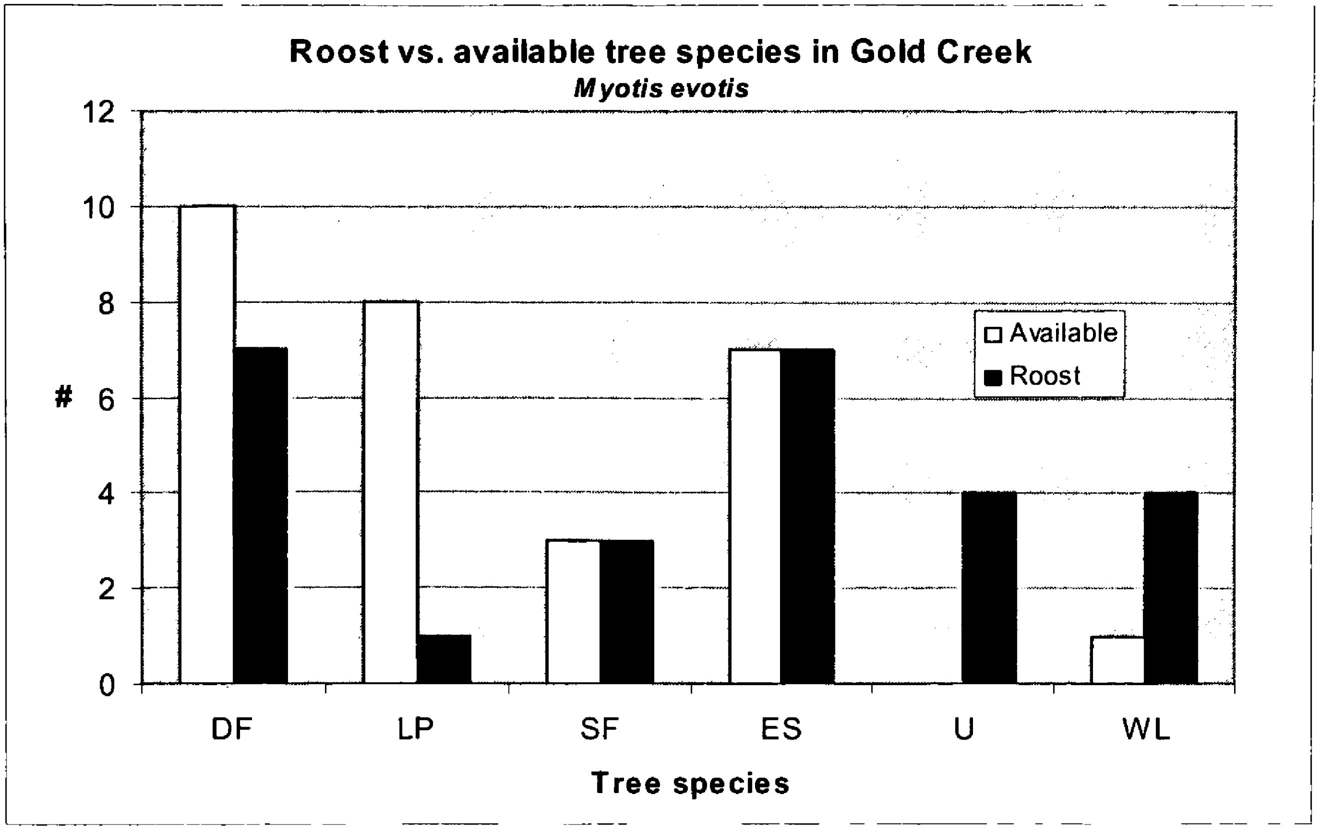
Area of high severity fire- number of square meters of high severity fire within a 500 meter radius centered on focal tree. Severity interpreted in terms of land change by U.S. Forest service spatial analyst.

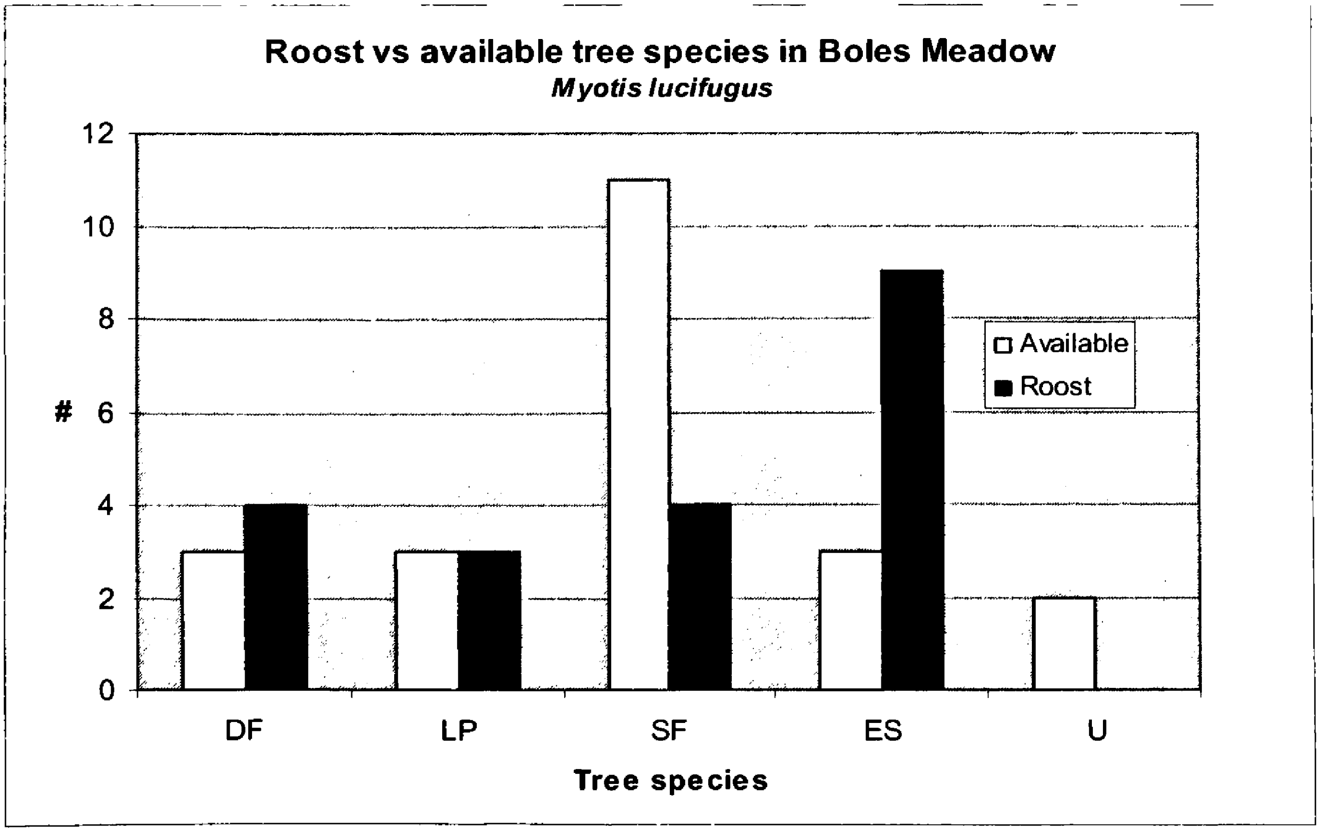
Area of intermediate severity fire- number of square meters of intermediate severity fire within a 500 meter radius centered on focal tree. Severity interpreted in terms of land change by U.S. Forest service spatial analyst.

Area of low severity fire- number of square meters of low severity fire within a 500 meter radius centered on focal tree. Severity interpreted in terms of land change by U.S. Forest service spatial analyst.

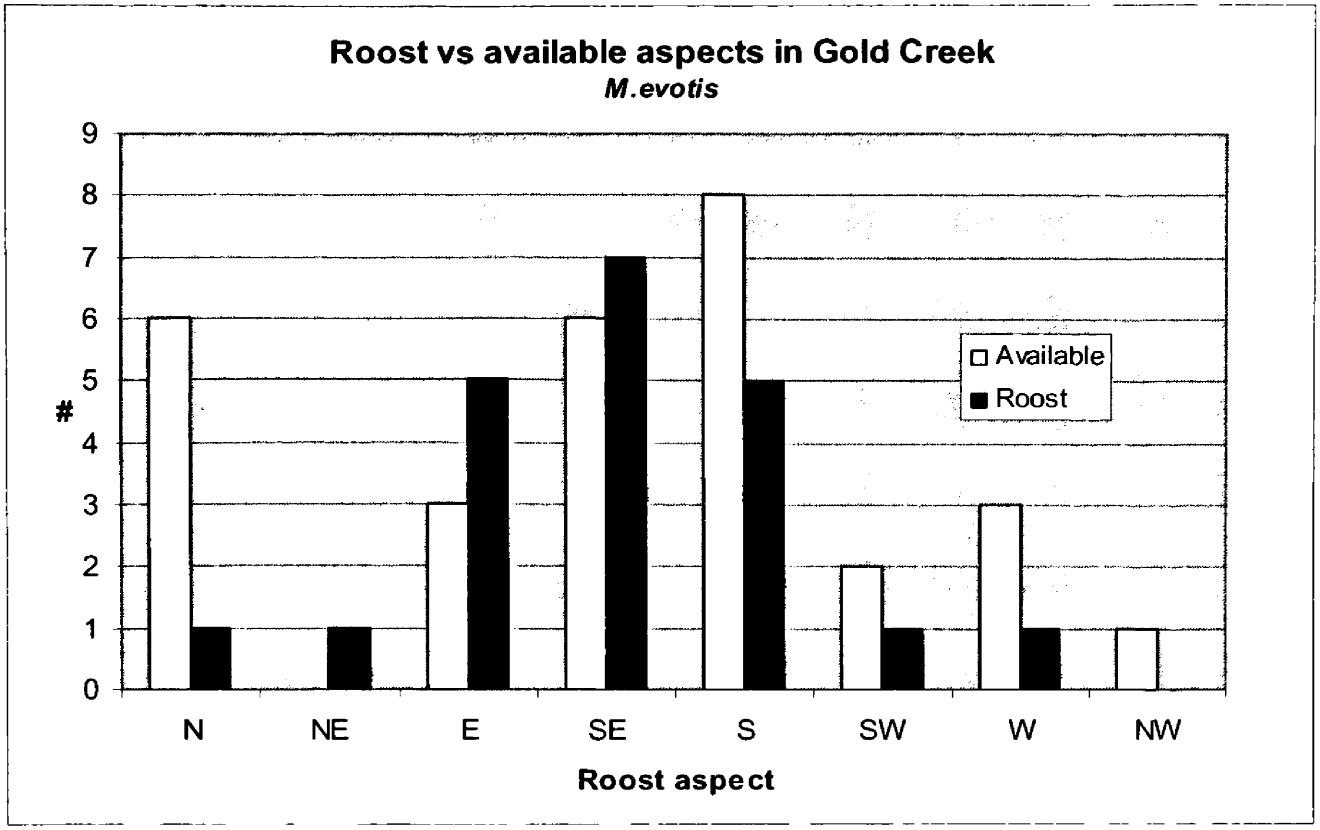
Area of unburned- number of square meters of unburned area within a 500 meter radius centered on focal tree. Unburned area interpreted in terms of land change by U.S. Forest service spatial analyst.

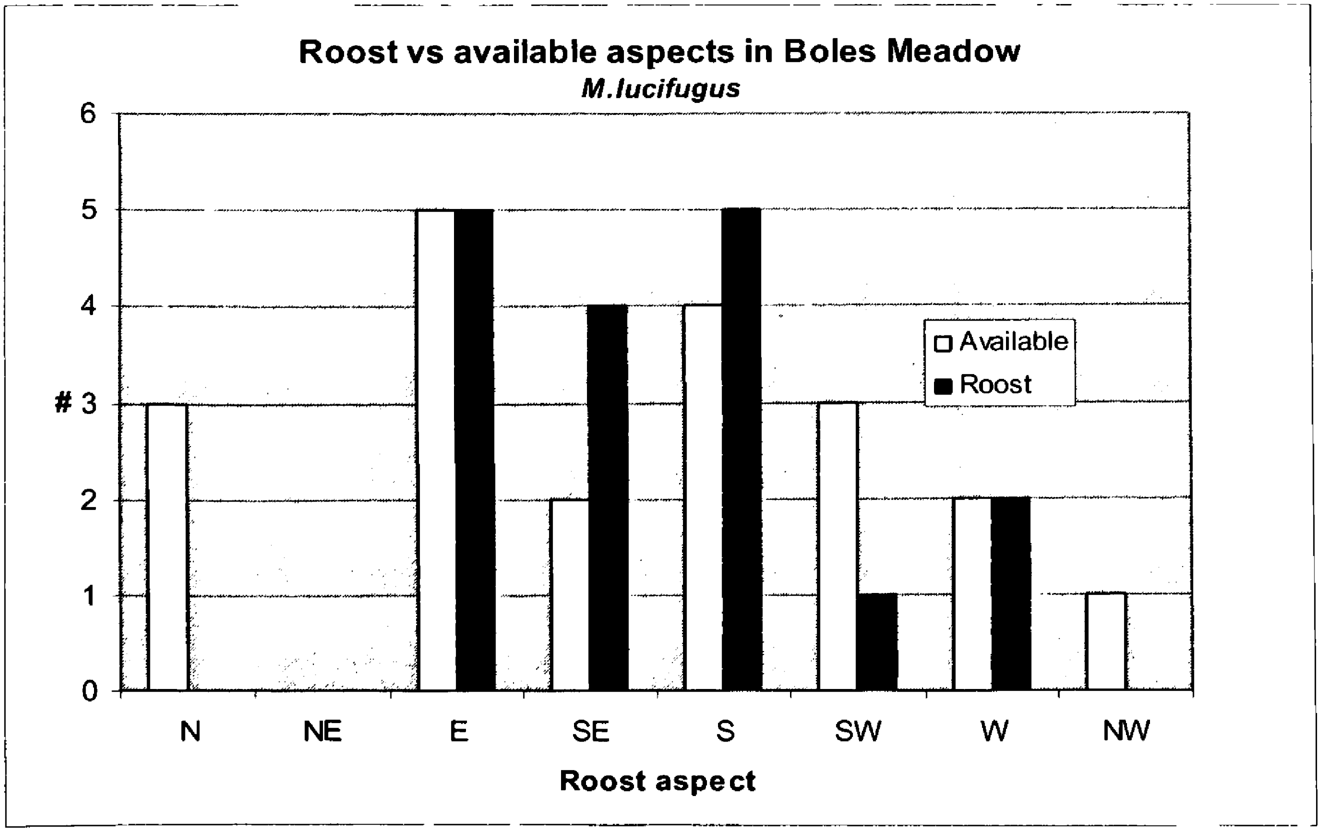
APPENDIX-C Roost vs. available tree species. Includes only random trees from each respective site, i.e., random trees not pooled.



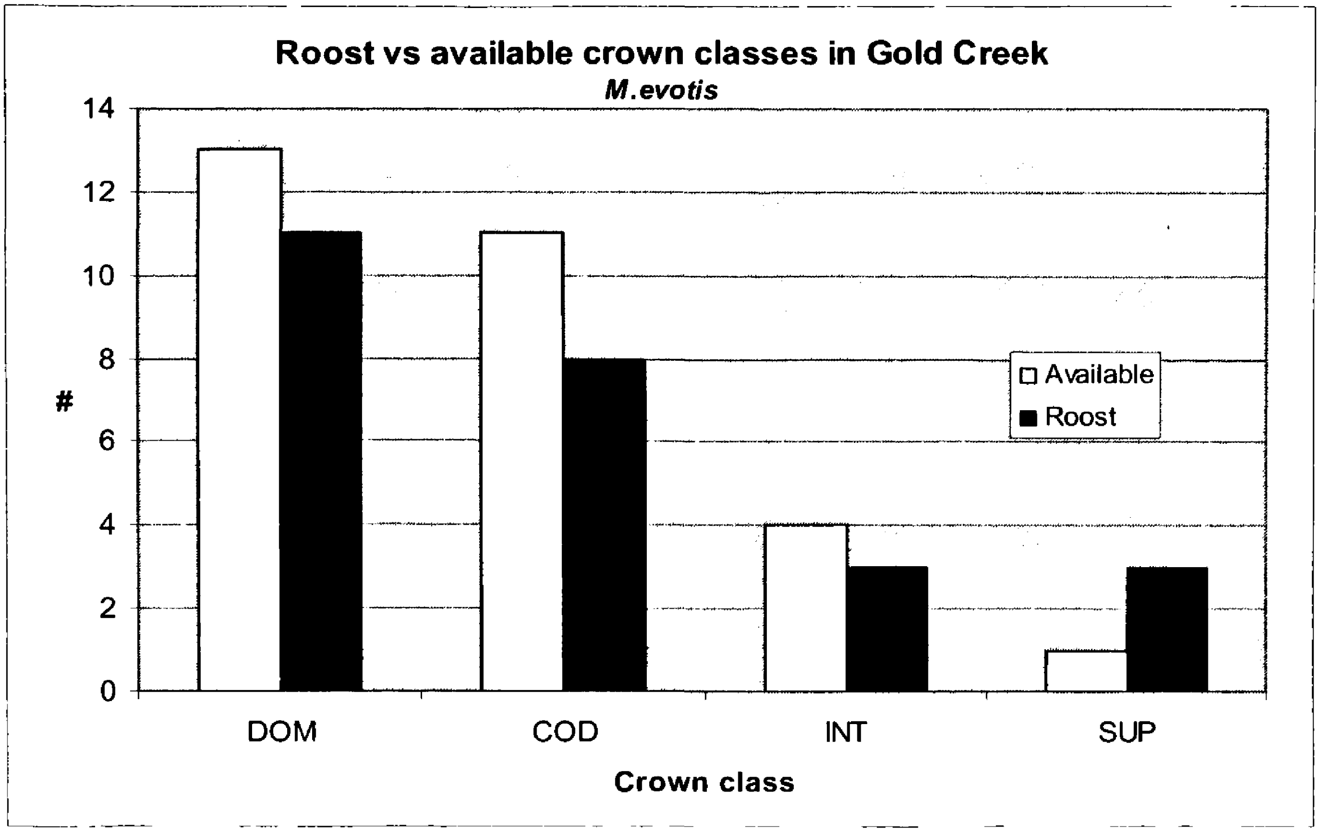


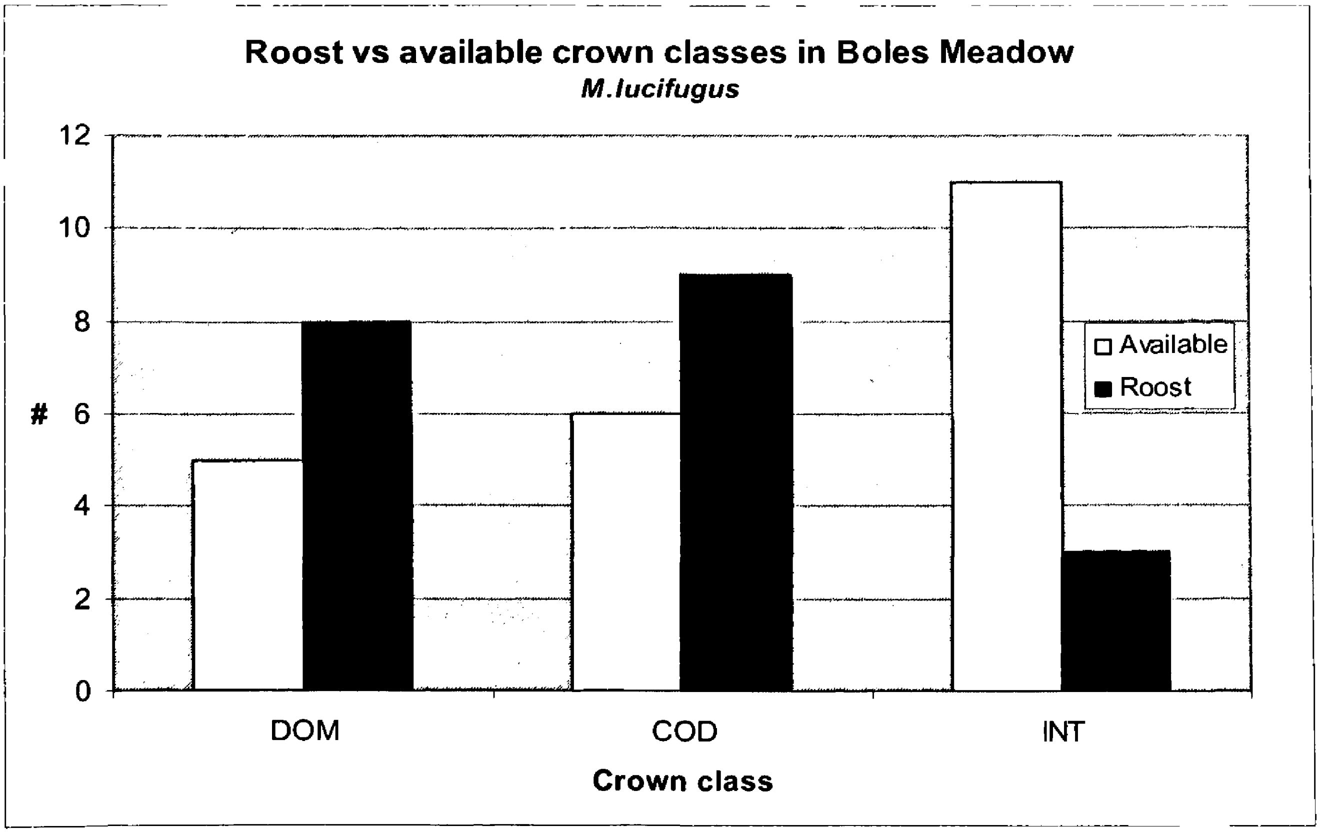
APPENDIX- D Roost vs. available aspects. Includes only random trees from each respective site, i.e., random trees not pooled.





APPENDIX E- Roost vs. available crown classes. Includes only random trees from each respective site, i.e., random trees not pooled.





APPENDIX F- A final logistic regression model for *Myotis evotis* and *Myotis lucifugus*, on a per bat basis with pooled randoms. Includes Hosmer and Lemeshow lack of fit test and classification rates.

Variables initially entered into model: diameter (cm), nearest tree (m), available trees (# / plot), canopy cover, arcsin % Engelmann spruce, trees dbh>31 cm (# / ha), perennial stream meters within 500 m radius buffer of roost (m), high severity burn area (m^2), low severity (m2), distance nearest perennial water (m)

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	4.864	8	.772

Classification Table[a]

Observed			Predicted		
			Roost=1		Percentage Correct
			0	1	
Step 1	Roost=1	0	48	3	94.1
		1	7	11	61.1
	Overall Percentage				85.5

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	@#available	.077	.031	6.366	1	.012	1.080
	linearw	.003	.001	13.896	1	.000	1.003
	Constant	-5.531	1.231	20.188	1	.000	.004

a. Variable(s) entered on step 1: @#available, linearw.

APPENDIX G- A final logistic regression model for *Myotis evotis*, on a per tree basis with pooled randoms. Includes Hosmer and Lemeshow lack of fit test and classification rates.

Variables initially entered into model: diameter (cm), nearest tree (m), fire severity (high, intermediate, low, unburned), available trees (# / plot), canopy cover, arcsin % Engelmann spruce, trees dbh>31 cm (# / ha), perennial stream meters within 500 m radius buffer of roost (m), high severity burn area (m^2), low severity (m2), distance nearest perennial water (m)

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	2.405	8	.966

Classification Table[a]

			Predicted		
			Roost=1		Percentage Correct
	Observed		0	1	
Step 1	Roost=1	0	46	4	92.0
		1	3	23	88.5
	Overall Percentage				90.8

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	firesev			4.853	3	.183	
	firesev(1)	13.972	18151.251	.000	1	.999	1169631
	firesev(2)	20.912	18151.251	.000	1	.999	1.2E+09
	firesev(3)	20.225	18151.251	.000	1	.999	6.1E+08
	canopy_cover	.106	.050	4.374	1	.036	1.111
	sqmeter4	.000	.000	7.798	1	.005	1.000
	distance_nearestwaterm	-.019	.007	7.178	1	.007	.981
	Constant	-22.374	18151.251	.000	1	.999	.000

a. Variable(s) entered on step 1: firesev, canopy_cover, sqmeter4, distance_nearestwaterm.

APPENDIX H- A final logistic regression model for *Myotis lucifugus*, on a per tree basis with pooled randoms. Includes Hosmer and Lemeshow lack of fit test and classification rates.

Variables initially entered into model: diameter (cm), nearest tree (m), fire severity (high, intermediate, low, unburned), available trees (# / plot), canopy cover, arcsin % Engelmann spruce, trees dbh>31 cm (# / ha), perennial stream meters within 500 m radius buffer of roost (m), high severity burn area (m^2), low severity (m2), distance nearest perennial water (m)

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	6.959	8	.541

Classification Table[a]

			Predicted		
			Roost=1		Percentage Correct
	Observed		0	1	
Step 1	Roost=1	0	46	5	90.2
		1	4	16	80.0
	Overall Percentage				87.3

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	@#available	.066	.030	4.727	1	.030	1.068
	@31	.024	.010	6.298	1	.012	1.024
	linearw	.003	.001	11.305	1	.001	1.003
	Constant	-7.642	2.027	14.220	1	.000	.000

a. Variable(s) entered on step 1: @#available, @31, linearw.

APPENDIX I-

Number of different tree and rock roosts per bat, and total number of days located.

BAT	SEX	REPRO	YEAR	#trees	#rocks	total # days located
MYLU1	M		2004	2	0	2
MYLU2	M		2004	4	0	5
MYLU3	M		2004	2	2	11
MYLU1	M	NR	2005	0	1	2
MYLU2	M	NR	2005	6	1	11
MYLU4	M	NR	2005	2	1	7
MYLU5	M	NR	2005	2	0	3
MYLU6	M	NR	2005	3	2	7
MYLU7	M	NR	2005	1	0	3
MYLU8	M	NR	2005	1	0	2
MYEV1	M	NR	2005	0	1	5
MYEV11	M	NR	2005	0	1	1
MYEV12	M	NR	2005	1	5	10
MYEV16	M	NR	2005	4	1	9
MYEV2	F	PREG	2005	3	1	6
MYEV3	F	PREG	2005	4	0	4
MYEV4	F	NR	2005	1	1	2
MYEV7	F	PL	2005	1	0	1
MYEV8	F	PL	2005	3	3	11
MYEV9	F	PL	2005	3	2	10
MYEV10	F	PL	2005	2	3	10
MYEV14	F	LACT	2005	2	1	8
MYEV15	F	PL	2005	6	1	9
LANO1	F		2005	2	0	2
LANO2	M		2005	1	0	2
MYVO1	F		2005	2	0	3

REPRO: NR=non-reproductive, PREG= pregnant, PL= post-lactating, LACT= lactating

Chapter 2. Insect communities in burned and unburned mid-elevation forest

INTRODUCTION

Fire disrupts the continuity of succession through time, occurring on almost every continent, in almost every terrestrial ecosystem. Boreal forest, temperate coniferous forest, temperate deciduous forest, tall- and shortgrass prairies, chapparal, and savannahs are a few of the vegetation types affected by fire. The effects of fire are realized by soils, microorganisms, invertebrates, plants, mammals, and birds at least within, and possibly outside the fire perimeter. The interdependent responses of these biotic and abiotic categories provide the framework to study post-disturbance dynamics. Previous research on fire effects has primarily focused on plants; however, this research observed the effects of wildland fire on nocturnal invertebrates, an equally essential component to post-disturbance dynamics.

Multiple physical attributes of fire, including, but not limited to, season, patchiness, extent, and severity influence the structuring of invertebrate communities after fire (Agee 1993). Each of these attributes differentially affect different taxa in the community depending upon their ecological requirements. Fire may affect invertebrates directly by causing mortality or indirectly through effecting structural changes in vegetation or organic debris layers (Niwa and Peck 2002, Swengel 2001). Direct effects relate to the degree of exposure to flames, smoke and heat, which may be reduced for organisms living below ground, or within or under unburned substrate, or above the reach of flames in treetops (Swengel 2001). The severity of direct effects may also be highly correlated with the seasonal timing of fire. Life stage plays a considerable role in the degree of effect of fire on invertebrates (Swengel 2001). The two study sites in this research were created by fires in August and September of 2003, probably representing the historic fire period in Montana.

Seasonal timing of fires may be the single most important factor of fire effects on invertebrates, especially prescribed burning in the spring or fall. Most insects experience several life stages, growing stages with periods of dormancy (diapause), and fire may pose a unique threat to some or all stages (McCullough et al. 1998, Swengel 2001). Insects spending dormancy underground, out of the reach of intense heat and outside the typical fire season, may not be affected by "out of season" prescribed burns (Moretti et al. 2002). If the timing of dormancy is not in synchrony with the fire period, organisms may be active or emerging during the fire period and experience mortality, or fire may remove vegetation when adults or larvae need it (Main 2001, Swengel 2001).

Panzer and Schwartz (2000) found cool season burning on a rotational basis (burn every 2-3 years) did not negatively affect insects, but in fact increased species richness in prairie grasslands. However, even if cool season burning appears to have no negative effects on insects in prairies, with a historically high fire frequency (<3 years), what about prescribed, "out of season" burns in temperate coniferous forest with debated fire frequencies (3-30 years)? Niwa and Peck (2002) warn that insects adapted to fire in summer may experience mortality during spring and fall "out of season" burns. However, Panzer (2003) has shown that spring burns are patchier and although not natural, may leave enough green patches, or refugia, for recolonization.

Unburnt patches after fire are common in a forest setting, but prairie grassland fires burn hot and fast with seemingly less heterogeneity. Marini-Filho (2000) suggests large-scale complete burns favor in-situ colonization from diapausing insects, while patchy burns favor non-diapausing insect colonization from green patches (refugia) (Moretti et al. 2002). Diapause timing and colonization ability may be tradeoffs in the life history traits of organisms in fire-affected landscapes.

In general, prairie, savannah and forest invertebrates recolonize burned areas at a relatively quick rate (Marini-Filho 2000, Tooker and Hanks 2004). One to two year post-fire responses of Coleopterans (Moretti et al. 2004, Muona and Rutanen 1994, Villa-Castillo and Wagner 2002,), Hymenopterans (Potts et al. 2003, Tooker and Hanks 2004), and Lepidopterans and Homopterans (Panzer and Schwartz 2000) exhibited an increase in species richness or individual abundance. Some studies have reported similar species richness' before and after fire, but have shown an entirely different overall composition (York 2000).

Bark beetles attack stressed trees partially killed by fire which retain some remaining live phloem, while wood borers mainly infest dead trees (Ryan and Amman 1996). Crown scorch, without severe scorching of inner bark, and circumference of bole girdled by fire was found to have a negative correlation with resin defenses and positive correlation with attractiveness and/or susceptibility for beetles (McCullough et al. 1998, Rasmussen et al. 1996, Wallin et al.2003). This relationship creates an interesting interaction between fire, bark beetles, and wood borers; insect outbreaks increase fire likelihood, and fire increases insect outbreaks (McColluogh et al.1998). Beetle build up in fire-injured trees can result in infestation of uninjured trees (Rasmussen et al. 1996) further influencing this potential positive feedback system. Would removal of trees killed by fire via salvage logging reduce the risk of beetle attack, or possibly restrict avian and mammalian predator nesting and roosting sites?

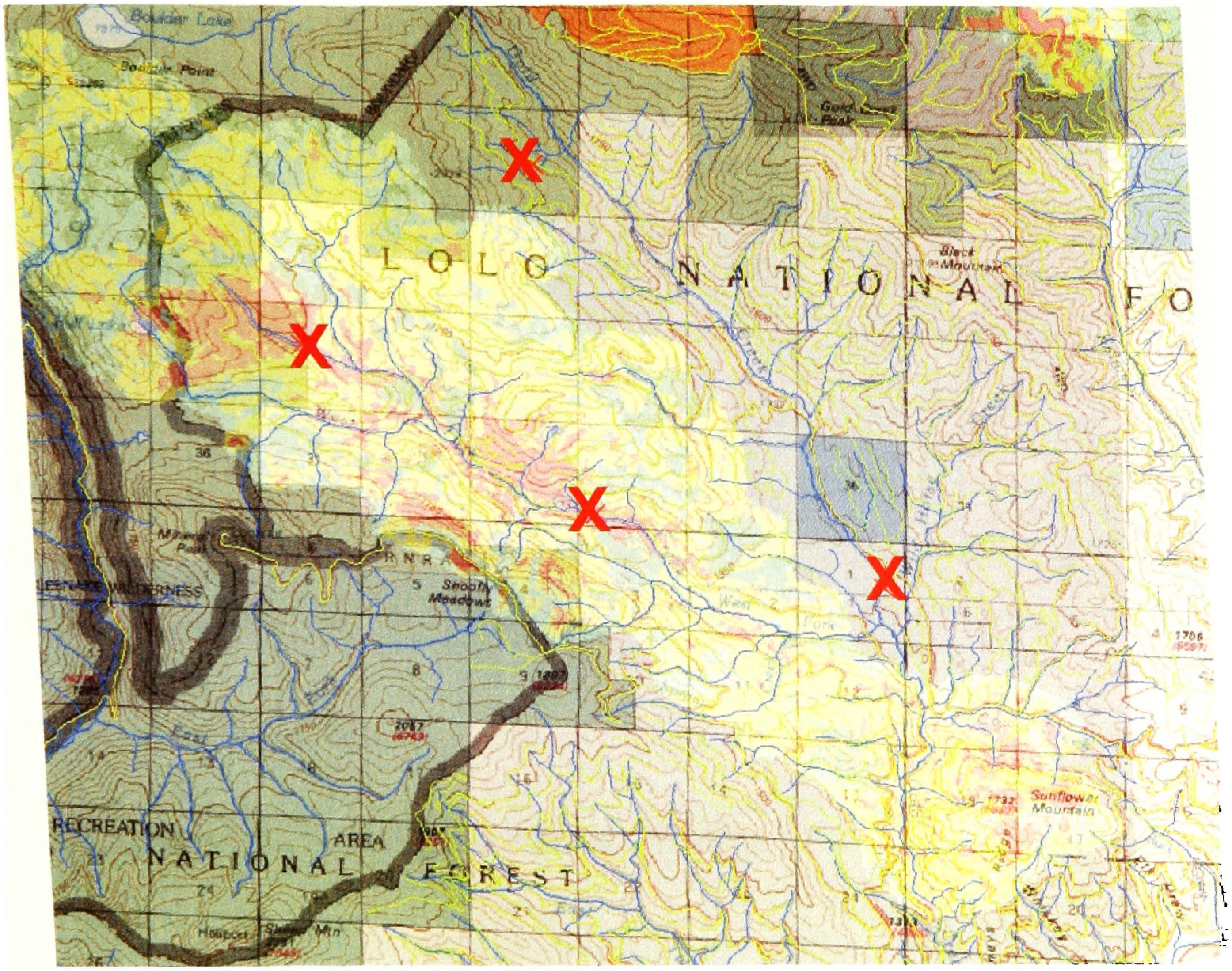
Overall, generalizations pertaining to insect response after fire are difficult to extract from the literature. Moretti et al. (2002) suggest a quick recovery of insect populations after fire is evidence of adaptation to a frequent fire regime. This could be true for the invertebrates of the prairie, but the data for temperate coniferous forest is not conclusive. Equivocal responses of invertebrates have been documented in the literature, most likely a result of differences in fire patterns, climate, and/or habitat.

The objectives of this research included an exploratory look into the differences between nocturnal insect communities in burned and unburned forests and assessing potential prey sources for bats in the mid-elevation forests of western Montana.

STUDY AREAS

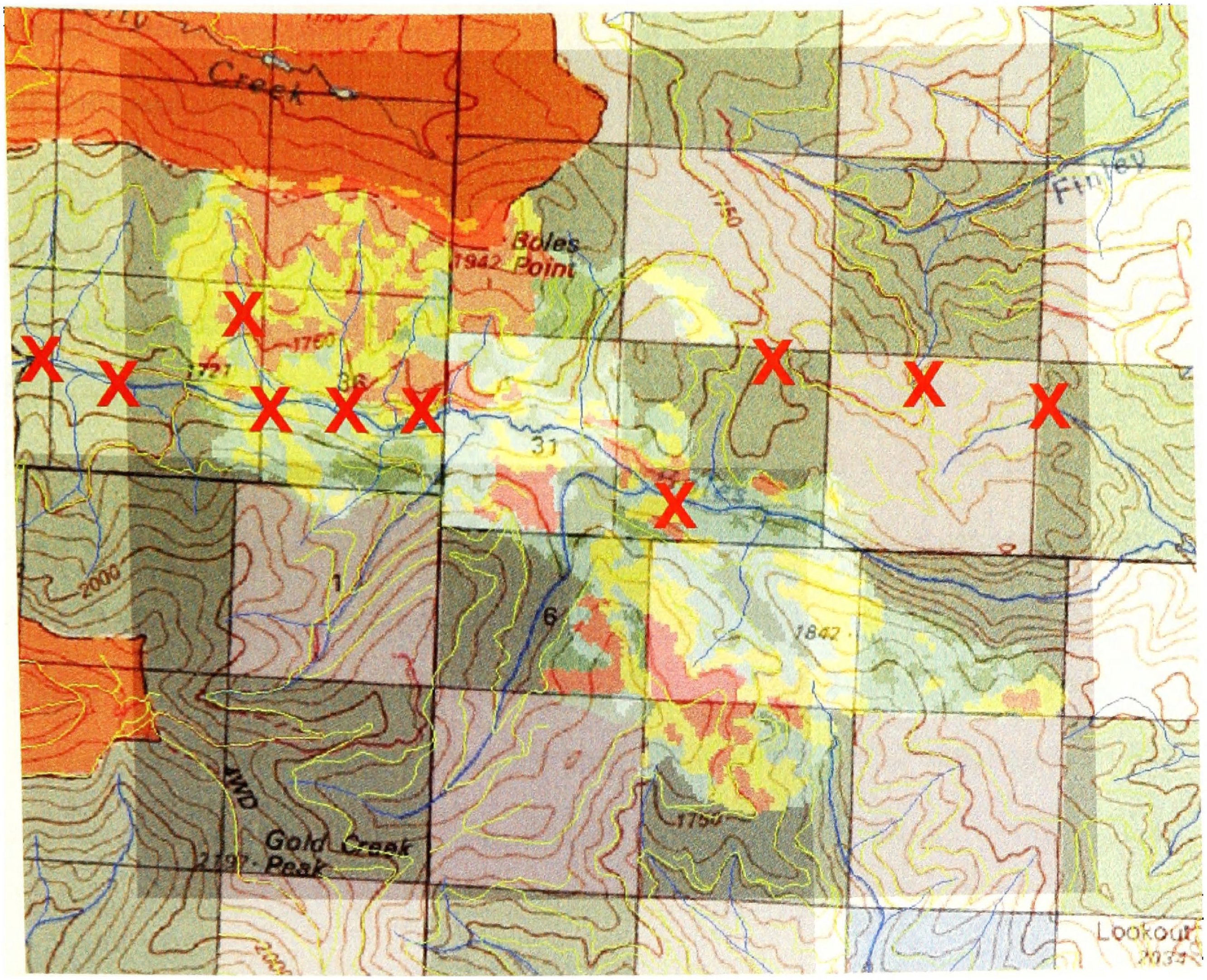
I conducted this study in the West Fork of Gold Creek (Fig. 1) and Boles Meadow (Fig. 2) second order stream drainages of western Montana, about 30 km northeast of Missoula. These two sites represent 2 different fires, the Mineral-Primm fire and the Boles Meadow fire respectively, separated by two ridges and 11.6 km. The tree species composition of these forests represent the typical mid-elevation forests of western Montana. Both sites burned in 2003, so this study represents the effects of fire 1 and 2 years post-disturbance.

The Gold Creek drainage, predominantly owned by Plum Creek Timber (PCT), is a heavily managed area ranging in elevation from 1067 to 1950m. As a result of timber management practices, many different age structures of various tree species are present including: large diameter (> 100 cm) ponderosa pine (*Pinus ponderosa),* western larch (*Larix occidentalis*), Douglas-fir (*Psuedotsuga mensezii*), Engelmann spruce (*Picea* *englemanni*), lodgepole pine (*Pinus contorta*) and young regenerating stands. The Mineral-Primm fire in this drainage burned from 6 August to 19 September, 2003, burning approximately 10,203 ha.



x = Insect trap sites

Fig. 1. Insect trap sites in Gold Creek, Montana.



X = Insect trap sites

Fig. 2. Insect trap sites in Boles Meadow, Montana

The Boles Meadow site ranges in elevation from 1372 to 1900m consisting of lodgepole pine, Engelmann spruce, Douglas-fir, subalpine fir, and western larch, from 5-cm dbh sapling stands, resulting from clearcutting, to mature stands of 60-cm dbh trees. Checkerboard ownership (Lolo National Forest and PCT) characterizes this landscape with most private lands experiencing post-fire salvage logging before this study. An 1,809 ha fire of variable fire severities burned the area from 8 August to 24 August, 2003.

Extensive timber harvest dominates the area, which is bordered by the Mission Mountain and Rattlesnake Wilderness areas.

METHODS

Between 7 June 2004 and 28 July 2005 I captured insects with 12-watt ultraviolet light traps (Model 2851U from BioQuip, Rancho Domingez, California) placed in burned and unburned forest at night. Placement of traps included one in riparian habitat and one trap 100 m from the stream in the forest, both suspended 2 m from the ground at each site. Maps of trap site locations are available for Boles Meadow (Fig.1) and Gold Creek (Fig.2). All burned sites experienced high-severity fire, although not all immediate streamside vegetation burned in the fire. Trapping sessions started 30 min prior to sunset and ran continuously for 4 hr. After 4 hours, traps were collected and covered until the morning at which time insects were identified to order and stored in 70% ethyl alcohol. Identifying the insects to the family level occurred in the lab using a dissecting scope and various reference materials, e.g., Triplehorn and Johnson (2005). Trapping alternated between burned and unburned sites every night. Optimally, trapping would occur in burned and unburned habitats on the same night, but logistical constraints prohibited this approach. Seven burned sites and 7 unburned sites were sampled, and most sites were visited at least twice during each summer. HOBO data loggers recorded the temperature at each trap, as capture rates commonly decrease with temperature.

Data Analysis

Only insects in Lepidoptera, Diptera, Coleoptera, and Trichoptera were included in statistical analyses, unless otherwise stated, as these orders made up the bulk (97%) of the sample. Trap locations (riparian and forest) at each site were pooled after no significant difference was detected with the non-parametric rank-sum test. I constructed multiple regression models for the response of all insects, insects by Order, and the most abundant Families starting with Equation 1. Regression models were restricted to groups with enough captures to produce accurate inference about model parameters.

Equation 1.

$$\mu\,\{\log\,(\text{insect} + .1) \mid \log(\text{temperature}),\ \text{treatment},\ \text{year}\} = \beta_0 + \beta_1(\log\ \text{temperature}) + \beta_2(\text{treatment}) + \beta_3(\text{year}) + \beta_4(\text{treatment x log temp.}) + \beta_5(\text{treatment x year})$$

Treatment =burned or unburned, Year = 2004 or 2005

From this equation I can detect the effects of each variable on the mean response of log insects + 0.1. The addition of 0.1 to the response variable allows for a logarithmic transformation making the data normally distributed with constant variance, satisfying the assumptions of multiple regression. The explanatory variable temperature (°F) was also log transformed and will be referred to only as temperature for the remainder of the text. I used multiple regression to ask specific questions about each variable after accounting for the other variables in the equation and to detect the interactive effects of treatment x temperature and treatment x year. If an interaction was significant, re-parameterized models were used to answer the questions of interest. In addition to multiple regression, I used t-tests and rank-sum tests, and in all cases the alpha level for significance was set at 0.05.

The Simpson diversity index (see Equation 2) was calculated for each treatment and year. All families from Lepidoptera, Diptera, Coleoptera, Trichoptera, Homoptera, Hymenoptera, and Neuroptera were included in the diversity index analysis. I chose to use the Simpson index to determine if any families dominated a site and because of its robustness against small sample sizes.

Equation 2. The Simpson's Diversity Index

$$D = 1 / \sum pi^2$$

where pi = relative abundance

RESULTS

Between 8 June 2004 and 28 July 2005 I sampled 21 nights at unburned and 22 nights at burned sites, collecting over 12,500 insects, representing at least 106 families and 11 orders. Each insect Order graphed is represented by the 9 most abundant families collected. The raw data, in table format, is available for all insect orders and families in the following appendices: All insects (Appendix A - Table 1), Lepidoptera (Appendix A - Table 3), Diptera (Appendix C - Table 1), Coleoptera (Appendix E - Table 1), Trichoptera (Appendix F - Table 2), Homoptera (Appendix G - Table 2), and Hymenoptera (Appendix G - Table 3). The mean captures per trapping site, by family are available in the following appendices: Lepidoptera (Appendix H & I), Diptera (Appendix J, K, L & M), Coleoptera (Appendix N, O, P & Q), and Trichoptera (Appendix R & S).

Insect totals

Between 2004 and 2005, the average total number of captures for Lepidoptera (moths), Diptera (flies), Coleoptera (beetles), and Trichoptera (caddis flies) were statistically different, (p=.051, t-test, Fig 1) with the median capture rate in the burn 1.78

times higher than the median captures in the unburned sites (95% C.I. -.993 to 3.45, t-test). The year after fire (2004), the median capture rate for Lepidoptera, Diptera, Coleoptera, and Trichoptera were 3.43 times greater in the burn than median captures in the unburned sites (p-value=.012, 95% C.I. 1.22 to 9.31, t-test) and 8 of the 11 orders of insects were more abundant in burned sites. According to the multiple regression model for log average total insects, year (p=.001) and temperature (p<<.001) significantly affected the median numbers of insects captured after accounting for year, temperature, and treatment (Appendix A - Table 2).

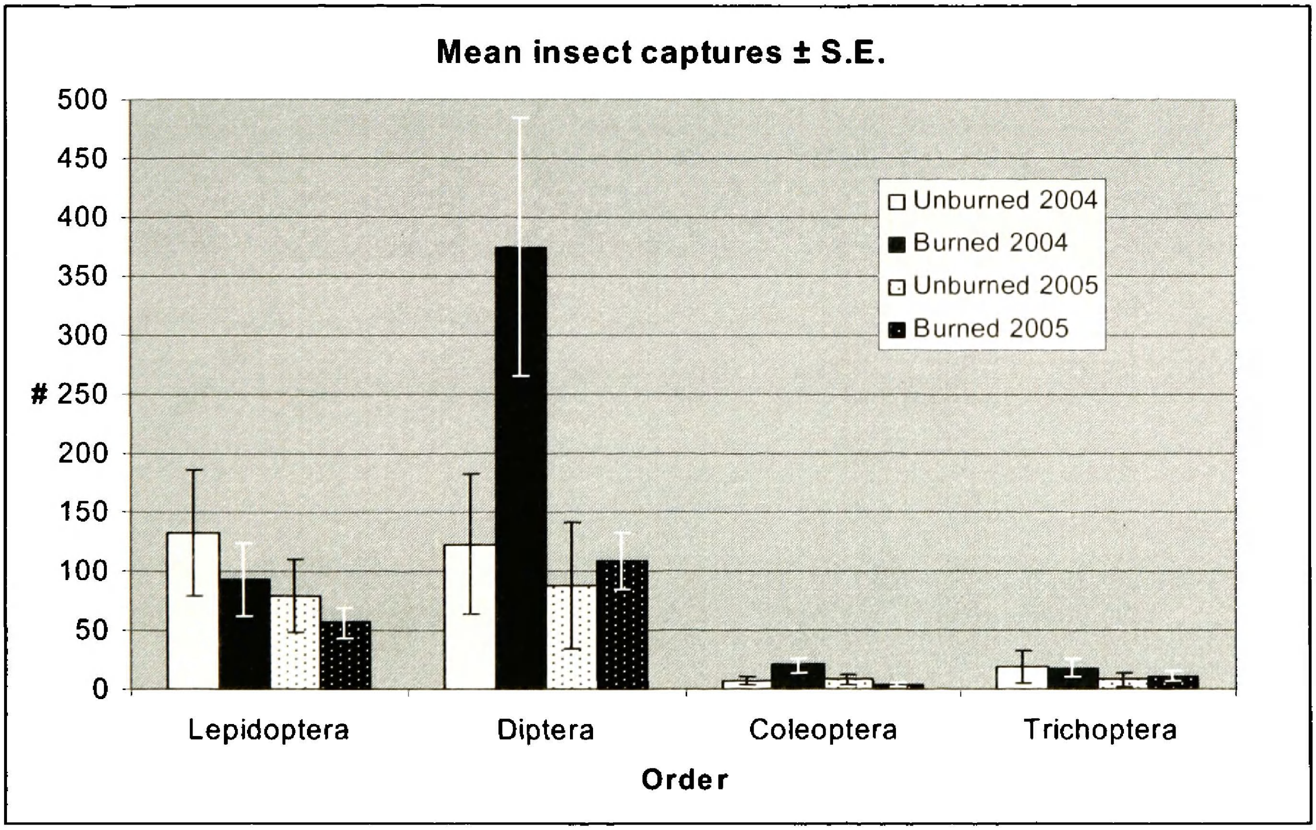


Figure 1. Mean insect captures ± S.E. for unburned and burned sites between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

Order totals

Lepidoptera

Treatment (p=.24), burned or unburned, did not have a significant effect on median Lepidopteran captures after accounting for temperature and year, according to the multiple regression model (Fig. 2; Appendix B - Table 1).

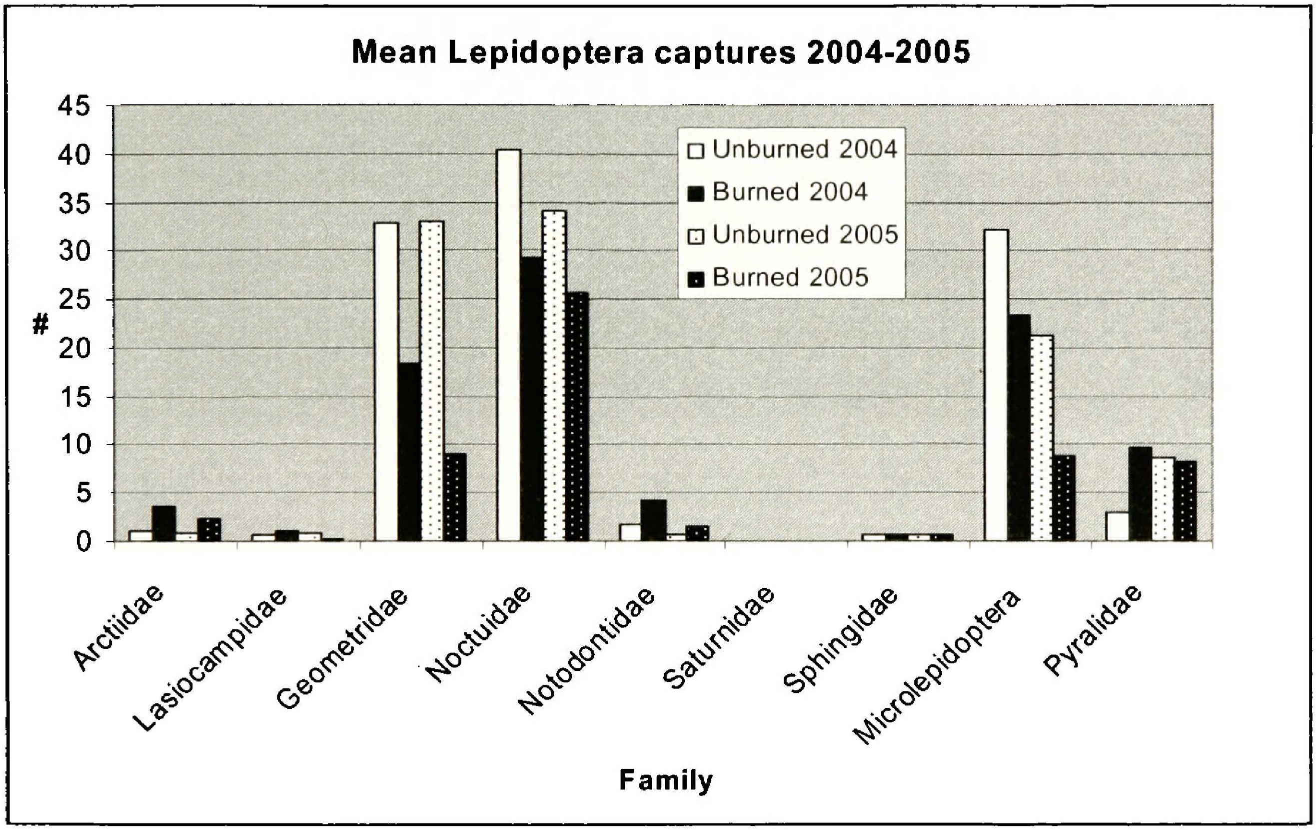


Figure 2. Mean Lepidoptera captures for selected families in unburned and burned sites between 2004 and 2005, in Gold Creek and Boles Meadow, Montana.

Diptera

According to the regression model for Dipterans, year (p=.002), treatment (p=.004), and temperature (p<<.001) significantly affected the median Diptera captured after accounting for the other variables in the equation (Fig. 3; Appendix C - Table 2). The median number of flies in burned forest was 3.10 times higher than the median captures in unburned forest (95% C.I. 1.36 to 6.90) after accounting for temperature and year. The median number of flies collected were 3.42 times higher in 2004 than 2005 (95% C.I. 1.50 to 7.66).

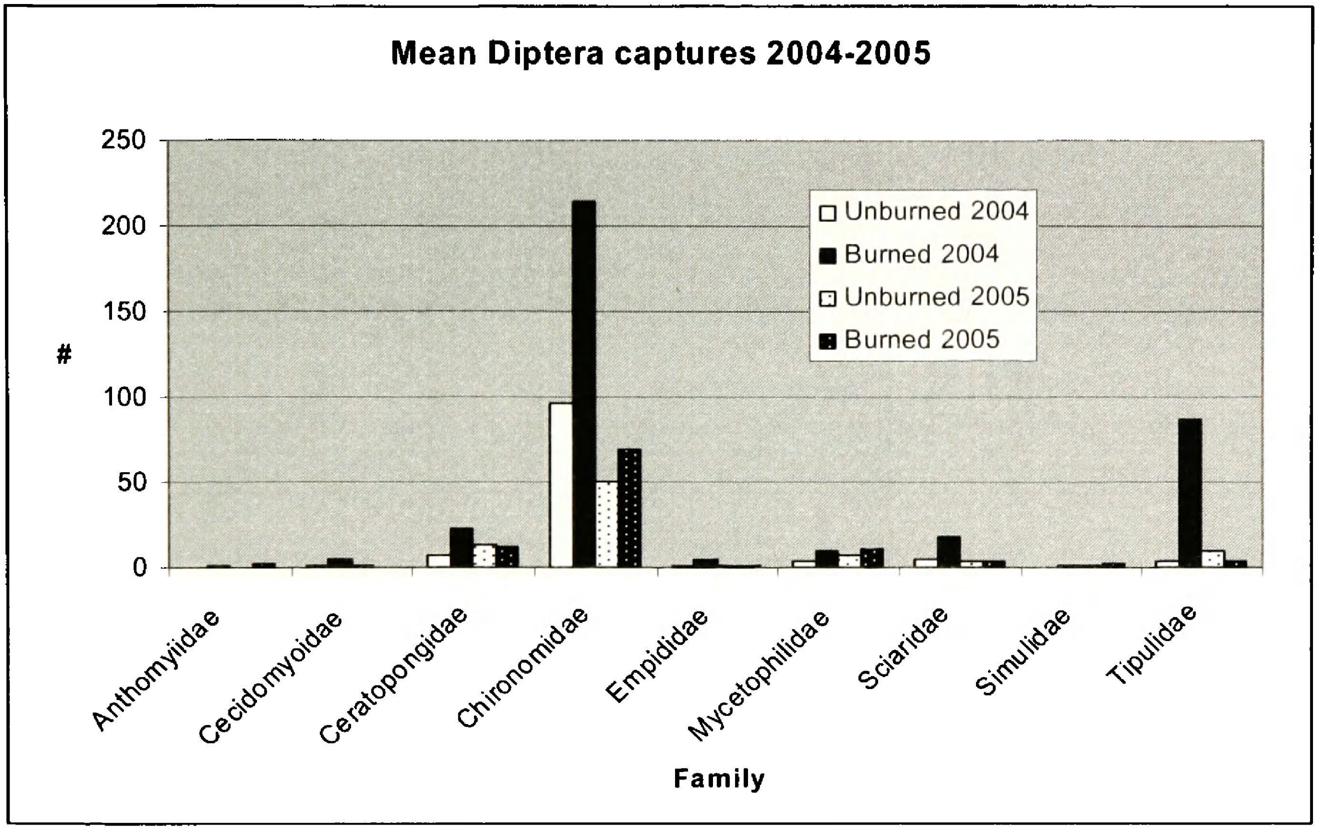


Figure 3. Mean Diptera captures of selected families in unburned and burned sites between 2004 and 2005, in Gold Creek and Boles Meadow, Montana.

Coleoptera

The median captures for Coleoptera in 2004 were 4.29 (p=.036, 95% C.I. 1.00 to 17.4) times higher in burned forest compared to unburned forest, according to the multiple regression model (Fig. 4; Appendix E - Table 2), after accounting for temperature, year, and treatment x year. In 2004, the median number of Coleoptera collected in the burn was 12.3 (95% C.I. 3.06 to 48.2) times higher than the median number of beetles in the burn in 2005. The treatment x year interaction also significantly affected the median number of beetles collected (p=.008) according to the regression model (Appendix F - Table 1).

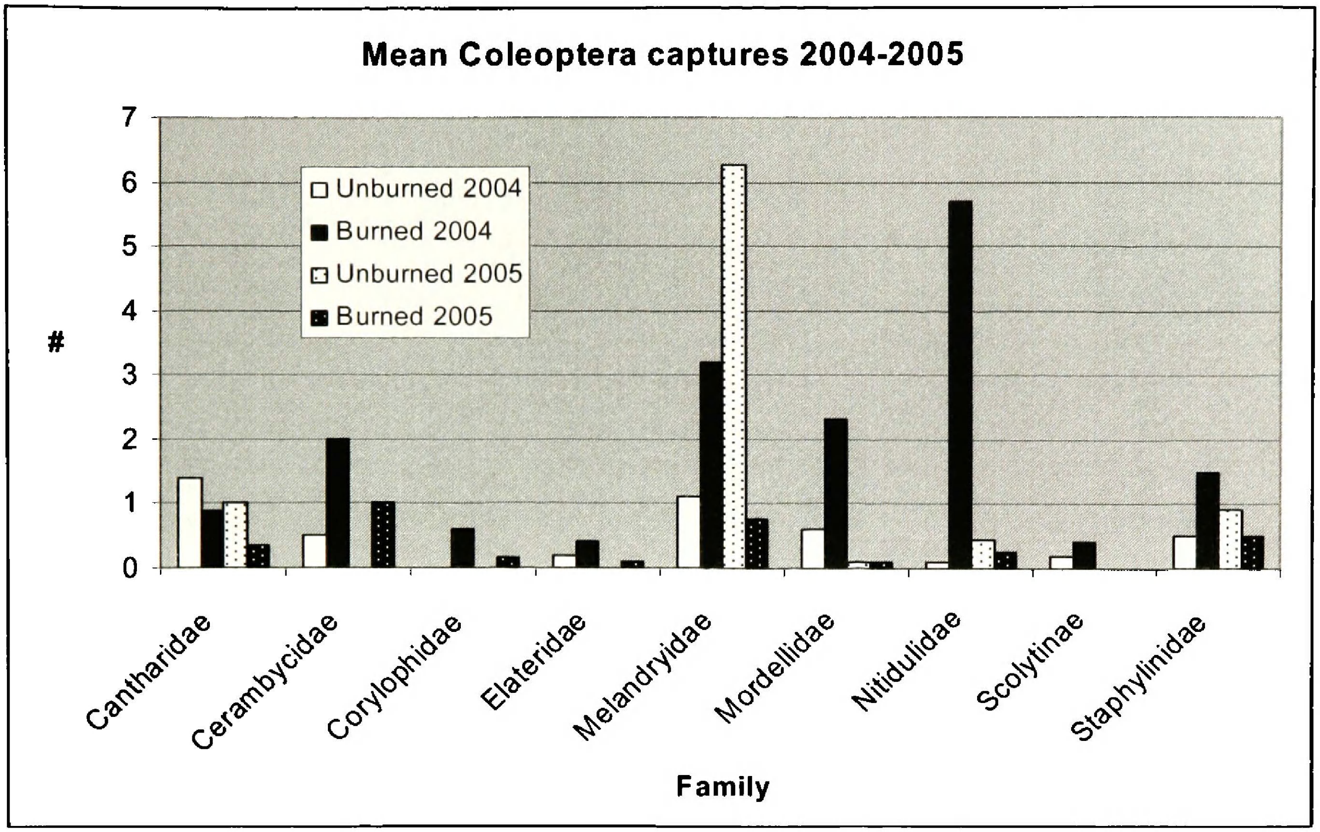


Figure 4. Mean Coleoptera captures for selected families in unburned and burned sites between 2004 and 2005, in Gold Creek and Boles Meadow, Montana.

Trichoptera

The median captures for Trichoptera were 4.11 (p=.006, 95% C.I. 1.43 to 11.5,) times higher in 2004 than 2005 after accounting for temperature and treatment, according to the multiple regression model (Fig. 5; Appendix F, Table 3).

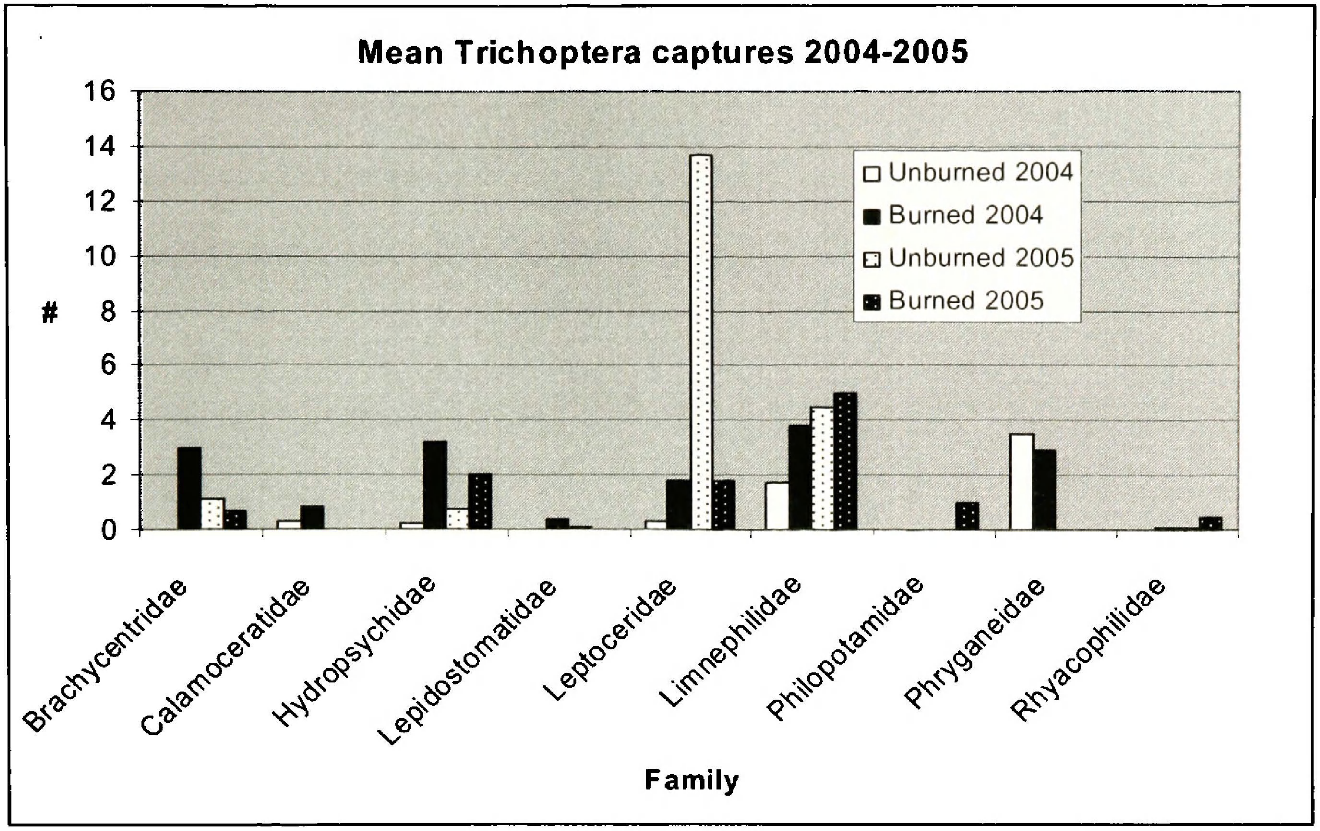


Figure 5. Mean Trichoptera captures for selected families in unburned and burned sites between 2004 and 2005, in Gold Creek and Boles Meadow, Montana.

Family totals

Lepidoptera

Between 2004 and 2005 the median number of moths in the family Arctiidae were 4.04 (p=.004, 95% C.I. 1.51 to 10.5, t-test) times higher in the burned compared to the unburned sites and the median number of moths in the family Pyralidae were 2.80 (p=.027, 95% C.I. 1.04 to 7.30, t-test) times higher in the burn compared to the unburned sites. Median Microlepidopteran captures did not differ between burned and unburned sites (p=.88), but did decrease in the second year after the fire by 2.65 fold (p=.01, 95% C.I. 1.14 to 5.99) after accounting for temperature and treatment, according to the regression model (Appendix B - Table 2). Median Noctuidae captures were not significantly different between years or between burned and unburned sites (p=.22), after accounting for temperature in the regression model (Appendix B - Table 3). The median captures for Geometridae were 2.27 (p=.027, 95% C.I. 1.00 to 4.99) times lower in the burned sites and 2.51 (p=.017, 95% C.I. 1.10 to 5.62) times lower in 2005 compared to 2004, according to the regression model (Appendix B - Table 4).

Diptera

Twenty-one of the 31 families of Diptera had more individuals captured in the burn than the unburned sites the first year after the fire (2004). Major differences were observed in 4 families. The median Chironomid (midge) captures were 4.38 (p=.01, 95% C.I. 1.35 to 13.7) times higher in the burn and 3.8 (p=.02, 95% C.I. 1.12 to 12.3) times more midges were captured in 2004 compared to 2005, after accounting for temperature, treatment and year in the regression model (Appendix D - Table1). The median Tipulid (crane fly) captures were 4.16 (p=.01, 95% C.I. 1.24 to 13.47) times higher in the burn and 8.54 (p<.001, 95% C.I. 2.53 to 28.3) times higher in 2004 compared to 2005, after accounting for temperature, treatment, and year in the regression model (Appendix D - Table 2). The median Ceratopongid captures were 4.40 (p=.002, 95% C.I. 1.63 to 11.61) times higher in the burn and 4.83 (p=.002, 95% C.I. 1.74 to 13.1) times higher in 2004 compared to 2005, after accounting for temperature, treatment, and year in the regression model (Appendix D - Table 3). The median Sciaridae captures were not significantly different between burned and unburned but, were 7.04 (p=.0002, 95% C.I. 2.60 to 18.7) times greater in 2004 than in 2005, according to the regression model (Appendix D - Table 4).

Coleoptera

No Coleopteran families contained sufficient sample sizes for analysis with multiple regression. The Cerambycidae (p=.008), Corylophidae (p=.01), and Nitidulidae (p=.008) were all significantly more abundant in burned sites for both years using the rank-sum test.

Trichoptera

No Trichopteran families significantly differed in captures between burned and unburned sites using the rank-sum test. The median captures for Limnephilidae were not significantly different between burned and unburned sites, or between years (Appendix G - Table 1) after accounting for temperature, year and treatment.

Homoptera

No significant differences were detected for the Homopteran families using the rank-sum test.

Hymenoptera

No significant differences were detected for the Hymenopteran families using the rank-sum test.

Simpson's Diversity index

The unburned sites in 2005 contained the highest value for the Simpson diversity index (Table 1). The highest family richness (n=77) and lowest evenness occurred in burned sites the first year post-fire, yielding the 4th highest values for the Simpson index, respectively. The next highest family richness was in the unburned sites in 2005 (n=58), with nearly 20 fewer families represented than in burned sites in 2004.

Table 1. Richness, evenness, and Simpson diversity index of each treatment and year for insect families captured between 2004 and 2005 in Gold Creek and Boles Meadow, Montana.

Habitat	Richness	Evenness	Simpson
Unburned 2004	52	0.542	4.75
Burned 2004	77	0.524	4.48
Unburned 2005	58	0.641	8.70
Burned 2005	57	0.598	5.51

DISSCUSSION

The nocturnal insect communities in burned and unburned habitats observed in this research exhibited a large degree of variability in species composition and abundance and generalizations are difficult to make with small sample sizes, a short time frame, and limited extent of area sampled. All insect traps produce some form of bias (Southwood 1978), and ultra-violet light traps are biased toward insects attracted to ultra-violet light. Despite this obvious bias, using this methodology permits comparison between burned and unburned sites and some interesting patterns can be discerned. The first year after fire nearly twice as many insects appeared in burned sites from the four main orders [Lepidoptera (moths), Diptera (flies), Coleoptera (beetles), and Trichoptera (caddisflies)], although the number of Diptera may be responsible for this difference. Eight of the 11 orders collected were more abundant in burned sites. The Coleopterans showed a marked first year post-fire difference, with an over 4-fold increase in total number of individuals in the burn compared to the unburned and nearly 12.5 times more beetles the first year after fire as opposed to the second year post-fire. Similarly, Dipterans showed over a 3-fold increase of individuals in the burn and nearly 3.5 times more flies the first year after fire. Caddisflies also showed increased numbers in the burn the first year after fire, only to reverse the trend the second year post-fire.

Lepidopterans consistently remained equally abundant in burned and unburned sites both years, however within this order some families (Arctiidae and Pyralidae) exhibited a 4-fold and nearly 3-fold increase in abundance at burned sites, respectively. Moth captures, including most families modeled with regression, did not significantly differ between burned and unburned sites. Typical oviposition sites for moths include leafy vegetation, and I assume there was little availability of this resource immediately after fire, despite some remaining streamside vegetation. Most moths overwinter as larvae or pupae, and some as eggs or adults (Triplehorn and Johnson 2005). The various overwintering positions (underground, under bark, or on vegetation) and timing would influence the survival of each insect in habitats affected by wildland fire. Considering the high severity and the assumed corresponding high intensity of these fires, pupae underground or on vegetation may not have survived the fire. After accounting for the lack of both oviposition sites and surviving larvae or pupae, moth captures in burned sites could have resulted from recolonizing adults, the first year post fire.

Some Coleopterans are widely known to travel large distances to locate fires (Hart 1998). The elevated first-year, post-fire numbers of adult beetles could result from this aptitude of locating large numbers of dead trees common after wildland fire, especially by the Cerambycidae. The evidence for the increased numbers of other beetle families as reported here, i.e., Nitidulidae, Melandryidae, and Mordellidae remains inconclusive as large numbers were captured in a single night, easily creating an "apparent" increase in one habitat versus another. However, all 3 of these families are associated with decaying wood, and the effects or increases may indeed be "real" as Nitidulids feed on sap, which may increase in availability in highly stressed trees trying to recover from the fire.

The highest family diversity, using the Simpson index, occurred on the unburned sites in 2005 (Table 1). This index measures richness and evenness simultaneously to provide an idea of the number of species present and how equitably individuals of the species are distributed. The Simpson index specifically measures if a particular family dominates a site. Burned forest the year after fire (2004) contained the highest family richness (n=77) and the lowest evenness corresponding to the lowest Simpson diversity index value. These indices provide a systematic way to compare the diversity but obviously do not capture all the important aspects of diversity. Twenty-eight families were only captured within the burn while 16 families were only found in the unburned sites. Despite low capture rates and the fact that some families are naturally rare, 26% of all families captured were restricted to sites within the burn suggesting a unique environment created only after fire.

Moths and flies probably comprise the majority of bat diets in Montana, and the overwhelming number of flies and presumed recolonizing moths after the two fires in this study may have supplied a superabundant food source. Burned forest provides highly productive insect habitat the first year after fire, and even the second year post-fire offers nearly equal insect productivity as unburned forest. This increased food quantity coupled with an increase in the number of standing dead trees after fire enhances the reproductive opportunities and success for some insectivorous birds (Sabb et al. 2005) and possibly for bats.

This research constitutes an exploratory effort to document the nocturnal insect community attracted to ultra-violet light in burned and unburned mid-elevation forests of Montana. In the future, more comprehensive surveys with multiple trapping techniques, applied at more sites, for more years, while combining nocturnal and diurnal sessions will be needed to understand the basic patterns of succession following a disturbance such as wildland fire.

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APPENDIX A

Table 1. Individuals from each insect order captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

Order	# Families	Unburned 2004	Burned 2004	Unburned 2005	Burned 2005	Total
Lepidoptera	12	1142	936	1107	677	3862
Diptera	31	1226	3750	1026	1300	7302
Coleoptera	27	52	199	103	42	396
Trichoptera	16	65	179	229	131	604
Ephemeroptera	2	2	16	0	89	107
Hymenoptera	10	8	17	32	15	72
Homoptera	7	18	71	69	25	183
Neuroptera	1	9	0	5	2	16
Pscoptera	1	1	3	2	1	7
Plecoptera	1	0	0	2	1	3
Thysanoptera	1	2	3	0	1	6
Totals	109	2525	5174	2575	2284	12558

Table 2. Multiple regression model for all insects captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana.

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-13.1917	1.6735	0.0000	-16.4955	-9.8880
year	-0.4089	0.1229	0.0011	-0.6516	-0.1660
Treat	0.0856	0.1195	0.4748	-0.1503	0.3215
logtemp	8.5322	1.0037	0.0000	6.5507	10.5137

Table 3. Number of individuals from each Lepidopteran family captured between 2004 and 2005 in Gold Creek and Boles Meadow, Montana.

Family	Unburned 2004	Burned 2004	Unburned 2005	Burned 2005
Arctiidae*	11	35	10	28
Drepanidae	0	0	2	0
Lasiocampidae	6	10	10	2
Lymantriidae	0	1	6	0
Geometridae	328	182	363	109
Noctuidae	404	293	374	308
Notodontidae	16	42	8	18
Saturnidae	1	1	0	0
Sphingidae	6	6	6	7
Thyatiridae	0	0	1	0
Microlepidoptera	322	234	233	106
Pyralidae*	29	97	94	99
Unknown	19	35	0	0
Total	1142	936	1107	677

***denotes significant difference of log captures between burned and unburned sites using independent samples t-test**

APPENDIX B

Table 1. Multiple regression model for Lepidoptera captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana.

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-15.0666	2.6289	0.0000	-20.3840	-9.7491
logtemp1	9.9339	1.5715	0.0000	6.7553	13.1125
Treat1	-0.2247	0.1905	0.2454	-0.6101	0.1607
Year1	-0.2524	0.1925	0.1974	-0.6418	0.1369

Table 2. Multiple regression model for log Microlepidoptera captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-16.3490	2.3299	0.0000	-21.0616	-11.6364
Year	-0.4387	0.1712	0.0144	-0.7849	-0.0925
Treatment	-0.0248	0.1663	0.8822	-0.3613	0.3116
logtemp	10.1876	1.3974	0.0000	7.3612	13.0141

Table 3. Multiple regression model for log Noctuidae captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-10.0289	2.3265	0.0001	-14.7310	-5.3269
Treatment	-0.2079	0.1717	0.2331	-0.5550	0.1391
logtemp	6.6640	1.3807	0.0000	3.8736	9.4544

Table 4. Multiple regression model for log Geometridae captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-13.8015	2.2947	0.0000	-18.4429	-9.1601
Treatment	-0.3755	0.1638	0.0274	-0.7068	-0.0441
logtemp	8.9462	1.3763	0.0000	6.1624	11.7299
Year	-0.4169	0.1686	0.0179	-0.7579	-0.0759

APPENDIX C

Table 1. Number of individuals from each Dipteran family captured between 2004 and 2005 in Gold Creek and Boles Meadow, Montana.

Family	Unburned 2004	Burned 2004	Unburned 2005	Burned 2005
Acalypterate muscoid	0	0	12	7
Anisopodidae	0	3	0	1
Anthomyiidae*	1	10	3	24
Athericidae	0	1	0	0
Bibionidae	1	1	0	0
Bombyliidae	0	0	0	2
Canthyloscelididae	0	0	1	0
Cecidomyiidae	12	50	18	0
Ceratopongidae*	75	229	148	149
Chironomidae*	962	2137	549	829
Culicidae*	19	2	10	4
Dixidae	0	3	0	1
Dolichopidae	0	1	1	0
Empididae	10	43	14	18
Fanniidae	0	1	0	1
Heleomyzidae	0	4	0	0
Hippoboscidae	0	1	0	1
Lonchopteridae	0	1	1	0
Muscidae	0	1	0	0
Mycetophilidae*	37	100	84	126
Phoridae	2	2	2	3
Psychodidae	0	8	5	0
Ptychopteridae	1	0	0	0
Scathophagidae	0	3	3	1
Scatopsidae	0	15	5	1
Scenopnidae	2	0	0	0
Sciaridae	45	173	34	48
Sciomyzidae	0	0	0	1
Simulidae*	2	15	7	28
Tachnidae	1	1	0	0
Tipulidae*	37	871	111	50
Unknown	19	74	3	5
Total*	1226	3750	1011	1300

***denotes significant difference of log captures between burned and unburned sites using independent samples t-test**

Table 2. Multiple regression model for Diptera captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-13.1965	2.3107	0.0000	-17.8703	-8.5227
logtemp1	8.8066	1.3813	0.0000	6.0128	11.6005
Treat1	0.5038	0.1675	0.0046	0.1650	0.8425
Year1	-0.5475	0.1692	0.0025	-0.8897	-0.2053

APPENDIX D

Table 1. Multiple regression model for log Chironomidae captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-15.0917	3.3891	0.0001	-21.9469	-8.2365
Year	-0.5908	0.2490	0.0227	-1.0945	-0.0872
Logtemp	9.6963	2.0327	0.0000	5.5848	13.8078
Treatment	0.6519	0.2420	0.0104	0.1625	1.1413

Table 2. Multiple regression model for log Tipulidae captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-13.6312	3.4810	0.0004	-20.6723	-6.5902
Year	-0.9366	0.2557	0.0007	-1.4538	-0.4193
Logtemp	8.2178	2.0878	0.0003	3.9948	12.4407
Treatment	0.6298	0.2485	0.0154	0.1271	1.1325

Table 3. Multiple regression model for log Ceratopongidae captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-18.4737	2.8740	0.0000	-24.2870	-12.6604
Year	-0.6928	0.2111	0.0022	-1.1199	-0.2658
Logtemp	11.1317	1.7237	0.0000	7.6451	14.6182
Treatment	0.6535	0.2052	0.0028	0.2385	1.0686

Table 4. Multiple regression model for log Sciaridae captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-15.9467	2.8388	0.0000	-21.6888	-10.2046
Year	-0.8535	0.2086	0.0002	-1.2753	-0.4316
Logtemp	9.6786	1.7026	0.0000	6.2348	13.1225
Treatment	0.2905	0.2027	0.1598	-0.1195	0.7004

APPENDIX E

Table 1. Number of individuals from each Coleopteran family captured between 2004 and 2005 in Gold Creek and Boles Meadow, Montana.

Family	**Unburned 2004**	**Burned 2004**	**Unburned 2005**	**Burned 2005**
Anobidae	0	3	0	0
Byrrhidae	0	2	1	1
Cantharidae	14	9	11	4
Carabidae	0	1	0	1
Cerambycidae*	5	20	0	12
Chrysomelidae	1	1	0	0
Ciidae	0	1	0	0
Colydiidae	0	0	1	0
Corylophidae*	0	6	0	2
Cryptophagidae	0	1	0	0
Cucujidae	0	1	0	0
Elateridae	2	4	0	1
Erotyllidae	0	1	0	0
Halipidae	0	0	1	0
Hydrophillidae	0	3	0	1
Heteroceridae	0	4	0	0
Leiodidae	0	4	0	0
Lyctidae	1	0	0	0
Melandryidae	11	32	69	9
Mordellidae	6	23	1	1
Nitidulidae*	1	57	5	3
Phalacridae	0	1	0	0
Ptilodactylidae	0	1	0	0
Rhizophagidae	3	0	0	0
Scarabidae	0	0	1	0
Scolytinae	2	4	0	0
Staphylinidae	5	15	10	6
Unknown	1	5	3	1
Total	52	199	103	42

***denotes significant difference between burned and unburned sites using rank-sum test**

Table 2. Multiple regression model for Coleoptera captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-15.1039	2.8926	0.0000	-20.9596	-9.2482
Logtemp1	9.1071	1.7275	0.0000	5.6099	12.6042
treat1	0.6423	0.2967	0.0367	0.0418	1.2429
Year1	0.0453	0.2981	0.8801	-0.5582	0.6487
treat1 x year1	-1.1368	0.4125	0.0089	-1.9719	-0.3017

APPENDIX F

Table 1. Re-parameterized model for Coleoptera captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-15.5531	2.9759	0.0000	-21.5775	-9.5288
Logtemp1	9.1071	1.7275	0.0000	5.6099	12.6042
Treat2	0.4945	0.2913	0.0978	-0.0952	1.0842
Year2	1.0915	0.2929	0.0006	0.4986	1.6845
treat_x year2	-1.1368	0.4125	0.0089	-1.9719	-0.3017

Table 2. Number of individuals from each Trichopteran family captured between 2004 and 2005 in Gold Creek and Boles Meadow, Montana.

Family	**Unburned 2004**	**Burned 2004**	**Unburned 2005**	**Burned 2005**
Brachycentridae	0	30	12	8
Calamoceratidae	3	8	0	0
Glossosomatidae	0	0	1	1
Goeridae	0	1	0	0
Hydropsychidae	2	32	8	24
Hydroptilidae	2	0	0	0
Lepidostomatidae	0	4	1	0
Leptoceridae	3	18	151	21
Limnephilidae	17	38	49	60
Molannidae	0	1	0	0
Odontoceridae	1	2	1	0
Philopotamidae	0	0	0	12
Phryganeidae	35	29	0	0
Polycentropodidae	0	0	1	0
Psychomyiidae	1	0	3	0
Rhyacophilidae	0	1	1	5
Unknown	1	15	1	0
Total	65	177	229	131

Table 3. Multiple regression model for Trichoptera captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-20.8445	2.9756	0.0000	-26.8630	-14.8260
logtemp1	12.5868	1.7787	0.0000	8.9890	16.1847
Treat1	0.1534	0.2157	0.4813	-0.2829	0.5896
Year1	-0.6255	0.2179	0.0066	-1.0662	-0.1848

APPENDIX G

Table 1. Multiple regression model for log Limnephilidae captured between 2004 and 2005, in Gold Creek and Boles Meadow, Montana

	Unstandardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
(Constant)	-11.8767	3.4318	0.0013	-18.8182	-4.9351
Logtemp	6.9155	2.0583	0.0018	2.7522	11.0788
Year	-0.0200	0.2521	0.9372	-0.5300	0.4900
Treatment	-0.0430	0.2450	0.8615	-0.5386	0.4525

Table 2. Number of individuals from each Homopteran family captured between 2004 and 2005 in Gold Creek and Boles Meadow, Montana.

Family	**Unburned 2004**	**Burned 2004**	**Unburned 2005**	**Burned 2005**
Aphidae	4	23	6	11
Cicadellidae	13	8	58	9
Corixidae	1	36	3	2
Oxycarenidae	0	1	0	0
Psyllidae	0	1	1	2
Reduvidae	0	1	0	0
Total	18	70	68	24

Table 3. Number of individuals from each Hymenopteran family captured between 2004 and 2005 in Gold Creek and Boles Meadow, Montana.

Family	**Unburned 2004**	**Burned 2004**	**Unburned 2005**	**Burned 2005**
Apidae	0	0	1	1
Diapriidae	0	0	1	2
Frigitidae	0	0	1	0
Ichneumonidae	3	4	20	6
Mymaridae	0	0	0	1
Siridae	0	0	2	0
Braconidae	2	7	3	3
Torymidae	0	4	0	0
Formicidae	**3**	**2**	**4**	1
Xiphydriiade	0	0	0	1
Total	8	17	32	15

APPENDIX H- Mean and standard error for Lepidoptera family captures in burned sites.

Boles Meadow 2004-2005

Site	**b1**		**b2**		**b3**	**b4**		**b5**	
# of trap nights	**5**		**5**		**1**	**3**		**4**	
Family	**Mean**	S.E.	**Mean**	S.E.	**Mean**	**Mean**	S.E.	**Mean**	S.E.
Arctiidae	**3.00**	1.64	**1.80**	**0.58**	**3.00**	**3.67**	1.45	**3.25**	2.02
Drepanidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Lasiocampidae	**0.60**	0.40	**0.40**	0.40	**0.00**	**1.00**	0.58	**0.75**	0.48
Lymantriidae	**0.00**	0.00	**0.20**	0.20	**0.00**	**0.00**	0.00	**0.00**	0.00
Geometridae	**11.40**	4.86	**11.40**	2.01	**1.00**	**28.67**	14.17	**15.25**	8.31
Noctuidae	**22.60**	8.98	**30.60**	9.00	**3.00**	**64.67**	26.43	**21.25**	12.26
Notodontidae	**0.00**	0.00	**3.40**	1.08	**0.00**	**6.67**	1.76	**5.50**	2.96
Saturnidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.33**	0.33	**0.00**	0.00
Sphingidae	**0.20**	0.20	**0.20**	0.20	**0.00**	**1.00**	0.58	**0.50**	0.29
Thyatiridae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Microlepidoptera	**23.40**	12.94	**5.40**	1.29	**0.00**	**44.33**	30.87	**7.75**	3.79
Pyralidae	**11.80**	4.88	**9.40**	3.09	**0.00**	**21.33**	14.97	**2.75**	0.63

Gold Creek 2005

Site	**gb1**		**gb2**	
# of trap nights	**2**		**2**	
Family	**Mean**	S.E.	**Mean**	S.E.
Arctiidae	**5.50**	0.50	**0.50**	0.50
Drepanidae	**0.00**	0.00	**0.00**	0.00
Lasiocampidae	**0.50**	0.50	**0.00**	0.00
Lymantriidae	**0.00**	0.00	**0.00**	0.00
Geometridae	**14.50**	2.50	**0.00**	0.00
Noctuidae	**25.50**	4.50	**1.00**	1.00
Notodontidae	**0.50**	0.50	**0.00**	0.00
Saturnidae	**0.00**	0.00	**0.00**	0.00
Sphingidae	**3.00**	3.00	**0.00**	0.00
Thyatiridae	**0.00**	0.00	**0.00**	0.00
Microlepidoptera	**15.50**	13.50	**0.50**	0.50
Pyralidae	**7.50**	5.50	**0.00**	0.00

APPENDIX I- Mean and standard error for Lepidoptera family captures in unburned sites.

Boles Meadow 2004-2005

Site	**u1**		**u2**		**u3**		**u4**		**u5**	
# of trap nights	**4**		**5**		**2**		**4**		**2**	
Family	**Mean**	S.E.	**Mean**	S.E.	**Mean**	S.E.	**Mean**	S.E.	**Mean**	S.E.
Arctiidae	**1.75**	1.11	**0.40**	0.40	**1.50**	0.50	**0.50**	0.50	**0.00**	0.00
Drepanidae	**0.00**	0.00	**0.20**	0.20	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Lasiocampidae	**0.50**	0.29	**0.60**	0.40	**0.00**	0.00	**0.50**	0.29	**1.00**	1.00
Lymantriidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**1.50**	0.96	**0.00**	0.00
Geometridae	**51.00**	25.78	**32.00**	19.18	**37.00**	9.00	**37.50**	20.26	**18.50**	18.50
Noctuidae	**50.25**	37.90	**30.40**	13.41	**83.50**	51.50	**52.00**	20.55	**6.50**	6.50
Notodontidae	**0.75**	0.48	**1.80**	1.32	**2.50**	0.50	**0.00**	0.00	**0.50**	0.50
Saturnidae	**0.00**	0.00	**0.00**	0.00	**0.50**	0.50	**0.00**	0.00	**0.00**	0.00
Sphingidae	**0.00**	0.00	**0.80**	0.58	**2.50**	2.50	**0.25**	0.25	**0.50**	0.50
Thyatiridae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.25**	0.25	**0.00**	0.00
Microlepidoptera	**73.50**	64.28	**23.40**	23.40	**7.00**	4.00	**23.75**	15.86	**11.50**	11.50
Pyralidae	**5.25**	4.92	**1.80**	1.36	**4.00**	4.00	**20.75**	14.16	**0.00**	0.00

Gold Creek 2005

Site	**gu1**		**gu2**	
# of trap nights	**2**		**2**	
Family	**Mean**	S.E.	**Mean**	S.E.
Arctiidae	**3.50**	2.50	**0.00**	0.00
Drepanidae	**0.00**	0.00	**0.50**	0.50
Lasiocampidae	**0.00**	0.00	**3.50**	3.50
Lymantriidae	**0.00**	0.00	**0.00**	0.00
Geometridae	**5.00**	5.00	**28.00**	27.00
Noctuidae	**10.00**	7.00	**8.50**	7.50
Notodontidae	**1.50**	1.50	**1.50**	1.50
Saturnidae	**0.00**	0.00	**0.00**	0.00
Sphingidae	**0.00**	0.00	**0.50**	0.50
Thyatiridae	**0.00**	0.00	**0.00**	0.00
Microlepidoptera	**0.50**	0.50	**5.50**	3.50
Pyralidae	**1.00**	1.00	**0.00**	0.00

APPENDIX J- Mean and standard error for Diptera family captures in burned sites, 2004.

Boles Meadow 2004

Site	b1		b2		b3	b4		b5	
# of trap nights	3		2		1	2		2	
Family	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**Mean**	**S.E.**	**Mean**	**S.E.**
Chironomidae	**122.00**	73.49	**199.00**	81.00	**129.00**	**315.50**	6.50	**306.50**	102.50
Simulidae	**0.33**	0.33	**3.00**	2.00	**2.00**	**2.50**	0.50	**0.50**	0.50
Mycetophilidae	**5.00**	2.89	**1.50**	0.50	**28.00**	**8.00**	2.00	**19.00**	6.00
Sciaridae	**27.67**	17.48	**4.50**	1.50	**3.00**	**17.50**	6.50	**21.50**	13.50
Acalypterate muscoid	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Tipulidae	**3.33**	1.45	**22.50**	9.50	**1.00**	**381.50**	373.50	**26.00**	2.00
Ceratopongidae	**23.33**	20.41	**23.00**	15.00	**3.00**	**32.50**	26.50	**22.50**	1.50
Empididae	**3.00**	2.52	**0.50**	0.50	**0.00**	**14.00**	14.00	**2.50**	1.50
Anthomyiidae	**2.00**	1.15	**1.00**	1.00	**0.00**	**0.50**	0.50	**0.50**	0.50
Bombyliidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Cecidomyoidae	**5.33**	3.93	**1.00**	0.00	**0.00**	**10.50**	9.50	**5.50**	3.50
Anisopodidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**1.50**	1.50	**0.00**	0.00
Lonchopteridae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.50**	0.50
Scathophagidae	**0.67**	0.67	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.50**	0.50
Fanniidae	**0.33**	0.33	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Scatopsidae	**1.33**	1.33	**0.00**	0.00	**0.00**	**5.50**	5.50	**0.00**	0.00
Muscidae	**0.33**	0.33	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Athericidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.50**	0.50	**0.00**	0.00
Dolichopidae	**0.33**	0.33	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Heleomyzidae	**1.33**	1.33	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Ptychopteridae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Dixidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**1.50**	0.50
Tachnidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.50**	0.50	**0.00**	0.00
Psychodidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**3.00**	2.00	**1.00**	1.00
Phoridae	**0.33**	0.33	**0.00**	0.00	**0.00**	**0.50**	0.50	**0.00**	0.00
Bibionidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.50**	0.50	**0.00**	0.00
Scenopnidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Culicidae	**0.00**	0.00	**0.50**	0.50	**0.00**	**0.00**	0.00	**0.50**	0.50
Hippoboscidae	**0.00**	0.00	**0.50**	0.50	**0.00**	**0.00**	0.00	**0.00**	0.00
Canthyloscelididae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Sciomyzidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00

APPENDIX K- Mean and standard error for Diptera family captures in unburned sites, 2004.

Boles Meadow 2004

Site	u1		u2		u3		u4	u5	
# of trap nights	3		2		2		1	2	
Family	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**Mean**	**S.E.**
Chironomidae	**254.0**	149.4	**1.5**	1.5	**10.5**	1.5	**1.0**	**87.5**	83.5
Simulidae	**0.0**	0.0	**0.0**	0.0	**0.5**	0.5	**0.0**	**0.5**	0.5
Mycetophilidae	**6.0**	4.2	**2.0**	1.0	**2.0**	1.0	**0.0**	**5.5**	5.5
Sciaridae	**10.0**	9.0	**0.5**	0.5	**2.5**	2.5	**0.0**	**4.5**	3.5
Acalypterate muscoid	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Tipulidae	**3.3**	2.0	**0.0**	0.0	**13.0**	8.0	**1.0**	**0.0**	0.0
Ceratopongidae	**21.7**	16.1	**1.5**	0.5	**2.5**	2.5	**0.0**	**1.0**	1.0
Empididae	**1.0**	0.6	**0.0**	0.0	**1.5**	0.5	**0.0**	**2.0**	2.0
Anthomyiidae	**0.3**	0.3	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Bombyliidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Cecidomyoidae	**1.7**	0.9	**0.5**	0.5	**2.5**	2.5	**0.0**	**0.5**	0.5
Anisopodidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Lonchopteridae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Scathophagidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Fanniidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Scatopsidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Muscidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Athericidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Dolichopidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Heleomyzidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Ptychopteridae	**0.0**	0.0	**0.0**	0.0	**0.5**	0.5	**0.0**	**0.0**	0.0
Dixidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Tachnidae	**0.0**	0.0	**0.5**	0.5	**0.0**	0.0	**0.0**	**0.0**	0.0
Psychodidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Phoridae	**0.7**	0.7	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Bibionidae	**0.0**	0.0	**0.0**	0.0	**0.5**	0.5	**0.0**	**0.0**	0.0
Scenopnidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**1.0**	1.0
Culicidae	**3.3**	3.3	**2.0**	1.0	**2.5**	2.5	**0.0**	**0.0**	0.0
Hippoboscidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Canthyloscelididae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0
Sciomyzidae	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0

APPENDIX L- Mean and standard error of the mean for Diptera family captures in burned sites, 2005.

	Boles Meadow								Gold Creek		
Site	b1		b2		b4	b5		gb1		gb2	
# of trap nights	2		3		1	2		2		2	
Family	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**
Chironomidae	**123.0**	48.0	**93.0**	48.9	**73.0**	**21.5**	7.5	**90.0**	14.0	**4.0**	2.0
Simulidae	**0.0**	0.0	**0.7**	0.7	**0.0**	**0.5**	0.5	**12.0**	1.0	**0.5**	0.5
Mycetophilidae	**11.5**	7.5	**18.0**	10.0	**8.0**	**4.0**	3.0	**15.0**	11.0	**1.5**	0.5
Sciaridae	**8.0**	8.0	**0.7**	0.3	**1.0**	**4.0**	2.0	**10.5**	9.5	**0.0**	0.0
Acalypterate muscoid	**1.0**	1.0	**0.3**	0.3	**2.0**	**1.0**	1.0	**0.0**	0.0	**0.0**	0.0
Tipulidae	**5.0**	1.0	**4.7**	4.7	**6.0**	**8.0**	5.0	**2.0**	2.0	**0.0**	0.0
Ceratopongidae	**37.0**	7.0	**8.0**	4.0	**18.0**	**8.0**	7.0	**8.0**	2.0	**0.5**	0.5
Empididae	**1.0**	1.0	**0.3**	0.3	**7.0**	**0.0**	0.0	**4.0**	3.0	**0.0**	0.0
Anthomyiidae	**2.0**	0.0	**0.7**	0.3	**11.0**	**1.5**	0.5	**1.5**	1.5	**0.5**	0.5
Bombyliidae	**0.5**	0.5	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.5**	0.5	**0.0**	0.0
Cecidomyoidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Anisopodidae	**0.5**	0.5	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Lonchopteridae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Scathophagidae	**0.0**	0.0	**0.3**	0.3	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Fanniidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.5**	0.5	**0.0**	0.0
Scatopsidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.5**	0.5	**0.0**	0.0	**0.0**	0.0
Muscidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Athericidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Dolichopidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Heleomyzidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Ptychopteridae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Dixidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.5**	0.5	**0.0**	0.0
Tachnidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Psychodidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Phoridae	**0.0**	0.0	**0.3**	0.3	**0.0**	**1.0**	1.0	**0.0**	0.0	**0.0**	0.0
Bibionidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Scenopnidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Culicidae	**0.0**	0.0	**0.0**	0.0	**3.0**	**0.0**	0.0	**0.0**	0.0	**0.5**	0.5
Hippoboscidae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.5**	0.5	**0.0**	0.0
Canthyloscelididae	**0.0**	0.0	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0
Sciomyzidae	**0.5**	0.5	**0.0**	0.0	**0.0**	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0

APPENDIX M- Mean and standard error for Diptera family captures in unburned sites, 2005.

	Boles Meadow					Gold Creek			
Site	u1	u2		u4		gu1		gu2	
# of trap nights	1	3		3		2		2	
Family	**Mean**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**
Chironomidae	**6.00**	**64.00**	62.51	**109.33**	60.92	**3.50**	1.50	**8.00**	7.00
Simulidae	**0.00**	**1.33**	1.33	**0.33**	0.33	**0.00**	0.00	**1.00**	1.00
Mycetophilidae	**4.00**	**8.67**	7.17	**4.00**	2.31	**1.00**	1.00	**20.00**	18.00
Sciaridae	**0.00**	**7.00**	5.57	**1.67**	1.20	**0.00**	0.00	**4.00**	3.00
Acalypterate muscoid	**0.00**	**3.00**	2.52	**0.67**	0.67	**0.50**	0.50	**0.00**	0.00
Tipulidae	**0.00**	**36.00**	35.50	**0.67**	0.67	**0.00**	0.00	**0.50**	0.50
Ceratopongidae	**0.00**	**45.33**	44.83	**3.67**	2.33	**0.50**	0.50	**0.00**	0.00
Empididae	**0.00**	**4.00**	4.00	**0.33**	0.33	**0.00**	0.00	**0.50**	0.50
Anthomyiidae	**0.00**	**0.67**	0.67	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00
Bombyliidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Cecidomyoidae	**2.00**	**5.00**	5.00	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00
Anisopodidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Lonchopteridae	**0.00**	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Scathophagidae	**0.00**	**0.67**	0.67	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00
Fanniidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Scatopsidae	**0.00**	**0.67**	0.67	**0.00**	0.00	**0.00**	0.00	**1.50**	0.50
Muscidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Athericidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Dolichopidae	**0.00**	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Heleomyzidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Ptychopteridae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Dixidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Tachnidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Psychodidae	**0.00**	**1.67**	1.67	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Phoridae	**0.00**	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00	**0.50**	0.50
Bibionidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Scenopnidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Culicidae	**1.00**	**1.33**	0.33	**0.00**	0.00	**0.50**	0.50	**2.00**	2.00
Hippoboscidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Canthyloscelididae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.50**	0.50
Sciomyzidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00

APPENDIX N- Mean and standard error for Coleoptera family captures in burned sites, 2004.

Boles Meadow

Site	b1-3		b2-2		b3-1	b4-2		b5-2	
# of trap nights	3		2		1	2		2	
Family	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**Mean**	**S.E.**	**Mean**	**S.E.**
Nitidulidae	11.67	6.01	4.00	3.00	0.00	5.00	1.00	2.00	2.00
Staphylinidae	1.67	0.88	1.00	1.00	0.00	3.00	1.00	1.00	0.00
Cantharidae	1.00	0.58	0.00	0.00	0.00	2.50	1.50	0.50	0.50
Cerambycidae	4.00	2.65	2.00	2.00	0.00	1.50	0.50	0.50	0.50
Melandryidae	2.67	2.67	1.50	1.50	0.00	5.50	4.50	5.00	5.00
Corylophidae	1.00	0.58	1.00	1.00	0.00	0.50	0.50	0.00	0.00
Scolytinae	0.33	0.33	0.00	0.00	1.00	1.00	0.00	0.00	0.00
Ptilodactylidae	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00
Anobidae	0.67	0.67	0.00	0.00	0.00	0.50	0.50	0.00	0.00
Byrrhidae	0.00	0.00	0.00	0.00	1.00	0.50	0.50	0.00	0.00
Leiodidae	1.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Halipidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colydiidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elateridae	1.33	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mordellidae	5.33	4.84	1.00	1.00	0.00	0.00	0.00	2.50	2.50
Hydrophillidae	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scarabidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phalacridae	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00
Erotyllidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50
Ciidae	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00
Rhizophagidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chrysomelidae	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lyctidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heteroceridae	1.33	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cryptophagidae	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carabidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50
Cucujidae	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX O- Mean and standard error for Coleoptera family captures in unburned sites, 2004.

Site	u1		u2		u3		u4	u5	
# of trap nights	3		2		2		1	2	
Family	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**Mean**	**S.E.**
Nitidulidae	**0.00**	0.00	**0.00**	0.00	**0.50**	0.50	**0.00**	**0.00**	0.00
Staphylinidae	**0.33**	0.33	**0.00**	0.00	**0.50**	0.50	**0.00**	**1.50**	1.50
Cantharidae	**3.33**	2.40	**0.50**	0.50	**1.00**	1.00	**0.00**	**0.50**	0.50
Cerambycidae	**1.67**	1.67	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Melandryidae	**3.00**	2.52	**0.00**	0.00	**0.50**	0.50	**0.00**	**0.50**	0.50
Corylophidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Scolytinae	**0.00**	0.00	**0.00**	0.00	**0.50**	0.50	**0.00**	**0.50**	0.50
Ptilodactylidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Anobidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Byrrhidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Leiodidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Halipidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Colydiidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Elateridae	**0.67**	0.67	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Mordellidae	**2.00**	2.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Hydrophillidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Scarabidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Phalacridae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Erotyllidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Ciidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Rhizophagidae	**1.00**	1.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Chrysomelidae	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Lyctidae	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Heteroceridae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Cryptophagidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Carabidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Cucujidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00

APPENDIX P- Mean and standard error for Coleoptera family captures in burned sites, 2005.

	Boles Meadow							Gold Creek			
Site	b1		b2		b4	b5		gb1		gb2	
# of trap nights	2		3		1	2		2		2	
Family	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**
Nitidulidae	**0.50**	0.50	**0.33**	0.33	**0.00**	**0.50**	0.50	**0.00**	0.00	**0.00**	0.00
Staphylinidae	**1.00**	0.00	**0.33**	0.33	**0.00**	**0.50**	0.50	**0.50**	0.50	**0.50**	0.50
Cantharidae	**0.50**	0.50	**0.00**	0.00	**0.00**	**0.00**	0.00	**1.50**	1.50	**0.00**	0.00
Cerambycidae	**4.00**	4.00	**0.00**	0.00	**2.00**	**1.00**	1.00	**0.00**	0.00	**0.00**	0.00
Melandryidae	**1.00**	0.00	**1.00**	0.58	**3.00**	**0.00**	0.00	**0.50**	0.50	**0.00**	0.00
Corylophidae	**0.00**	0.00	**0.33**	0.33	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.50**	0.50
Scolytinae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Ptilodactylidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Anobidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Byrrhidae	**0.00**	0.00	**0.33**	0.33	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Leiodidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Halipidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Colydiidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Elateridae	**0.00**	0.00	**0.33**	0.33	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Mordellidae	**0.50**	0.50	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Hydrophillidae	**0.50**	0.50	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Scarabidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Phalacridae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Erotyllidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Ciidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Rhizophagidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Chrysomelidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Lyctidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Heteroceridae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Cryptophagidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Carabidae	**0.00**	0.00	**0.33**	0.33	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Cucujidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00

APPENDIX Q- Mean and standard error for Coleoptera family captures in unburned sites, 2005.

	Boles Meadow					Gold Creek			
Site	u1	u2		U4		gu1		gu2	
# of trap nights	1	3		3		2		2	
Family	**Mean**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**
Nitidulidae	**0.00**	**1.67**	1.67	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Staphylinidae	**0.00**	**1.00**	1.00	**0.67**	0.33	**1.50**	1.50	**1.00**	1.00
Cantharidae	**0.00**	**2.67**	2.67	**0.33**	0.33	**0.00**	0.00	**1.00**	1.00
Cerambycidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Melandryidae	**9.00**	**7.33**	6.36	**12.67**	6.36	**0.00**	0.00	**0.00**	0.00
Corylophidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Scolytinae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Ptilodactylidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Anobidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Byrrhidae	**0.00**	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Leiodidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Halipidae	**0.00**	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Colydiidae	**0.00**	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Elateridae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Mordellidae	**0.00**	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Hydrophillidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Scarabidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.50**	0.50	**0.00**	0.00
Phalacridae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Erotyllidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Ciidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Rhizophagidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Chrysomelidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Lyctidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Heteroceridae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Cryptophagidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Carabidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00
Cucujidae	**0.00**	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00

APPENDIX R- Mean and standard error for Trichoptera family captures in 2004.

Burned sites

Site	b1		b2		b3	b4		b5	
#of trap nights	2		2		1	2		2	
Family	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**Mean**	**S.E.**	**Mean**	**S.E.**
Limnephilidae	**2.67**	2.67	**14.50**	12.50	**0.00**	**0.50**	0.50	**0.00**	0.00
Hydropsychidae	**8.67**	8.17	**3.00**	2.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Phryganeidae	**0.33**	0.33	**3.50**	0.50	**0.00**	**5.50**	5.50	**5.00**	5.00
Molannidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.50**	0.50	**0.00**	0.00
Goeridae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.50**	0.50	**0.00**	0.00
Lepidostomatidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**2.00**	2.00	**0.00**	0.00
Calamoceratidae	**1.67**	1.67	**0.00**	0.00	**0.00**	**1.50**	1.50	**0.00**	0.00
Odontoceridae	**0.33**	0.33	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.50**	0.50
Leptoceridae	**6.00**	6.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Brachycentridae	**0.00**	0.00	**14.50**	14.50	**0.00**	**0.00**	0.00	**0.50**	0.50
Philopotamidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Glossosomatidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Rhyacophilidae	**0.00**	0.00	**0.50**	0.50	**0.00**	**0.00**	0.00	**0.00**	0.00
Psychomyiidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Polycentropodidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00
Hydroptilidae	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00	**0.00**	0.00

Unburned sites

Site	u1		u2		u3		u4	u5	
#of trap nights	3		2		2		1	2	
Family	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**Mean**	**S.E.**
Limnephilidae	**2.00**	2.00	**0.50**	0.50	**4.50**	2.50	**0.00**	**0.50**	0.50
Hydropsychidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**1.00**	1.00
Phryganeidae	**7.67**	7.17	**0.50**	0.50	**5.50**	5.50	**0.00**	**0.00**	0.00
Molannidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Goeridae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Lepidostomatidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Calamoceratidae	**1.00**	1.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Odontoceridae	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Leptoceridae	**1.00**	1.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Brachycentridae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Philopotamidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Glossosomatidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Rhyacophilidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Psychomyiidae	**0.33**	0.33	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Polycentropodidae	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00
Hydroptilidae	**0.67**	0.67	**0.00**	0.00	**0.00**	0.00	**0.00**	**0.00**	0.00

APPENDIX S- Mean and standard error for Trichoptera family captures in 2005.

Burned sites

	Boles Meadow							Gold Creek			
Site	b1		b2		b4	b5		gb1		gb2	
#of trap nights	2		3		1	2		2		2	
Family	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**
Limnephilidae	4.50	4.50	0.67	0.33	3.00	2.00	0.00	21.00	17.00	0.00	0.00
Hydropsychidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	12.00	0.00	0.00
Phryganeidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Molannidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goeridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lepidostomatidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calamoceratidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Odontoceridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptoceridae	8.50	8.50	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00
Brachycentridae	0.00	0.00	0.33	0.33	0.00	3.50	3.50	0.00	0.00	0.00	0.00
Philopotamidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	1.00	0.00	0.00
Glossosomatidae	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00
Rhyacophilidae	0.00	0.00	0.00	0.00	0.00	2.50	2.50	0.00	0.00	0.00	0.00
Psychomyiidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polycentropodidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroptilidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Unburned sites

	Boles Meadow					Gold Creek			
Site	u1	u2		u4		gu1		gu2	u1
#of trap nights	1	3		3		2		2	1
Family	**Mean**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**	**Mean**	**S.E.**
Limnephilidae	0.00	11.33	8.84	5.00	4.04	0.00	0.00	0.00	0.00
Hydropsychidae	0.00	2.33	2.33	0.00	0.00	0.00	0.00	0.50	0.50
Phryganeidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Molannidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goeridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lepidostomatidae	0.00	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00
Calamoceratidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Odontoceridae	0.00	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00
Leptoceridae	0.00	2.00	2.00	48.33	44.88	0.00	0.00	0.00	0.00
Brachycentridae	0.00	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00
Philopotamidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glossosomatidae	0.00	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00
Rhyacophilidae	0.00	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00
Psychomyiidae	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Polycentropodidae	0.00	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00
Hydroptilidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00