Pawnee Montane Skipper Post-fire Habitat Assessment Survey – August/September 2009

Pawnee Montane Skipper
Post-fire Habitat Assessment
Survey – August/September 2009

Prepared For

U.S.
Forest Service
Pike and San Isabel National Forest
South Platte Ranger District
Morrison, Colorado

U.S. Fish and Wildlife Service
Lakewood, Colorado

And

Denver Water
Denver, Colorado

Prepared by:

John Sovell
Colorado Natural Heritage Program
Warner College of Natural Resources
Colorado State University
1474 Campus Delivery
Fort Collins, CO 80523-8002

http://www.cnhp.colostate.edu

March 2010

Cover photograph: View of the forest in 2002 after the fire with beetle shaving at the base of a burned tree, by John Sovell

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The Hayman, Schoonover, Buffalo Creek, and High Meadow fires burned 48.4% of the suitable habitat for the Pawnee montane skipper (PMS) butterfly (*Hesperia leonardus montana*) in the South Platte River Valley from 1996 to 2002. The Hayman and Schoonover fires burned habitat of the Cheesman and Mainstem South Platte populations of the PMS while the Buffalo Creek and High Meadow fires burned habitat of the North Fork PMS population. This project was established to implement a monitoring program to document PMS habitat condition and trends of population abundance, in both burned and unburned PMS habitat, on the Hayman and Schoonover fire areas in 2002 and subsequent years. Precipitation in the project area in 2009 was above or at the 100-year mean for four of the six months during the March to August growing season. In July, rainfall surpassed the 100-year mean by nearly three inches. The increased rainfall resulted in blooming prairie gayfeather (the primary adult PMS nectar source) with robust florets of healthy flowers and blue grama (the PMS larval foodplant) with great inflorescence height and density.

The USFS burn severity maps for the Hayman and Schoonover fires, combined with the map of occupied PMS habitat were used to define the sampling area for the project. Within this area sampling transects were randomly located within each of three burn classes (unburned, low severity burn, and moderate-to-high severity burn). The unit of sampling was a 40-acre habitat block within estimated suitable PMS habitat. At each 40-acre block a sub-sample was taken that consisted of an 800-meter (m) belt transect with four segments forming a diamond 200 m to a side. Each belt transect was 10 m in width (5 m on either side of the transect center line). The data collected from each transect included the numbers of skippers present (*H. L. montana* and *H. comma*), the number of blooming *Liatris* stems, the relative frequency of blue grama grass clumps, and the number of living and dead trees larger than 6” DBH.

For purposes of comparison, burn severity was used to examine skipper counts and each habitat variable. Each variable (e.g., blue grama frequency), and each transect group (unburned, low severity, and moderate-to-high severity) were analyzed using a two factorial design with eight levels of year (2002 through 2009), and three burn classes (unburned, low severity, and moderate-to-high severity).

Thirty-two transects were sampled between August 31 and September 4, 2009 and 56 PMS were recorded at the 32 sampled transects, comparable to the 62 that were observed in 2008. The mean total number of PMS recorded for 2009 was 0.89 per acre, which was similar to the number recorded for 2005, 2007, and 2008. This was also almost twice the 0.47 and 0.51 PMS per acre recorded in 2004 and 2006, 8.9 times the 0.10 PMS per acre recorded in 2003, and 44.5 times the 0.02 PMS per acre recorded in 2002. However, it is much lower than the 2.1 to 3.6 PMS per acre counted on unburned transects in the 1980s. Between 2002 and 2009, the general trend has been for increases and then stabilization in the counts of PMS per acre at transects of the unburned and low severity burn classes while counts at the moderate-to-high severity burn transects have lagged behind. In 2009, 1.52 PMS per acre were counted at unburned transects, which is near the high count for the eight years of monitoring, but it is still only about 40% of the maximum PMS per acre of 3.6 recorded in 1986.

PMS recovered quickly at unburned and low severity burn transects after the drought and fire with PMS counts between 2004 and 2009 ranging from 0.66 to 1.65 PMS per acre, but it wasn't until 2007 that PMS counts surpassed 0.5 per acre at moderate-to-high severity burn transects. Consistent occupation of the low severity burn transects by PMS occurred in 2003 and since then PMS counts at low severity burn transects have been similar to those at unburned transects. However, significantly more PMS have been recorded at low severity burn transects within 200 m of unburned PMS habitat than at distances greater than 200 m. One major vegetation difference between these two distance categories is that low severity burn transects within 200 m of unburned PMS habitat had significantly greater numbers of live trees. Consistent occupation by PMS of the moderate-to-high severity burn transects did not occur until 2005, and transects in close proximity to unburned or low severity burned habitat are more frequently occupied by PMS. In 2009, the furthest moderate-to-high severity burn transect occupied by PMS was 125 m from low severity burned PMS habitat. Over the eight years of monitoring significantly more PMS have been counted at moderate-to-high severity burn transects within 125 m, versus those greater than 125 m from low severity burned PMS habitat. In addition, significantly more PMS and common branded (*H. comma*) skippers have been counted at moderate-to-high severity burn transects within 500 m, versus those greater than 500 m from unburned PMS habitat.

The vegetation factors being investigated (live trees, dead trees, blue grama, and prairie gayfeather) did not differ between moderate-to-high severity burn transects with PMS versus those without PMS. The main difference was that unoccupied transects were significantly farther from both unburned and low severity burned PMS habitat.

These results suggest that PMS were eradicated from the moderate-to-high severity burn areas and as time passes, PMS populations surviving the fire in unburned and low severity burn areas have increased in size and are subsequently dispersing into the moderate-to-high severity burn areas of the fire. Tree cover is significantly lower at moderate-to-high severity burn transects, which may make these areas unsuitable for PMS and whether PMS are actually settling these areas is unknown. Egg laying by PMS has never been observed at a moderate-to-high severity burn transect, but oviposition flight behavior has. Documenting persistent occupation across years at individual moderate-to-high severity burn transects and observing egg laying by PMS at these transects will help clarify that these are permanent populations. This is important because viability of the PMS population may depend upon maintaining and increasing PMS populations in moderate-to-high severity burn areas.

It will be important to identify if PMS are persisting at the moderate-to-high severity burn transects and if overall numbers of PMS increase to the levels recorded in the 1980s. Continuing to monitor the dynamics of recolonization and the change in abundance of PMS in both burned and unburned areas over several more years should help answer these questions. Also, collecting additional information on burn intensity, shade, slope, aspect, and the cover of trees, shrubs, and host plants at moderate-to-high severity burn transects might identify additional ways that moderate-to-high severity burn transects occupied by PMS differ from their unoccupied counterparts.

1.0 INTRODUCTION

1.1 Background and Purpose

The Hayman and Schoonover forest fires burned across a large fraction of the historical habitat of the Pawnee montane skipper (PMS) butterfly (*Hesperia leonardus montana*) during the summer of 2002 in Jefferson and Douglas counties, Colorado. These fires burned approximately 40% of the PMS known habitat from southeast of Cheesman Reservoir, north around both sides of the reservoir, continuing north along the west side of the South Platte river to Oxyoke, and south of Deckers along Horse Creek for approximately six miles. The U.S. Forest Service (USFS), the U.S. Fish and Wildlife Service (USFWS), and Denver Water funded a post-fire habitat monitoring study within the range of this species, listed as threatened under the endangered species act, to understand how the fire influenced the dynamics of the PMS population. The multi-agency team (CNHP, Natural Perspectives, USFS, USFWS, and Denver Water) has collected samples from late August to early September from 2002 through 2009. The purpose of this monitoring effort is to document PMS habitat conditions in both burned and unburned PMS habitat, on the Hayman and Schoonover fires and to assess how PMS abundance responds to changes in habitat conditions. The results of this study will assist in understanding the conservation status of this butterfly in response to habitat alteration by fire and drought within the South Platte River Valley.

In early September 2003, the same transects sampled in 2002 were again sampled by the multi-agency team to gauge the rate of recovery of skipper populations (both *H. l. montana* and *H. comma* the common branded skipper) and their habitats.

A subset of the original 2002 transects were surveyed from 2004 through 2009 to continue assessing the rate of recovery of skipper populations and their habitat within the burn areas (Hayman and Schoonover). From 2007 through 2009, burned plots near unburned skipper habitat were prioritized for sampling in an effort to determine if patterns in the recovery of skipper abundance are influenced by the proximity of a high burn area to unburned or low severity burned suitable habitat presumably occupied by PMS.

In 2002, the South Platte River drainage received very little precipitation in fall, winter, and spring. The general trend in below normal amounts of precipitation, particularly within the spring through summer period (March through August), has persisted throughout the area during most of the years monitored with only 2005, 2007, and 2009 experiencing normal or above normal rates of precipitation during the spring and summer months. In 2009, spring and summer precipitation was about twice the normal average, with over one-half of the periods precipitation falling in July. The almost decade-long dry conditions of the area, provides an opportunity to study the influence that abnormally low precipitation levels have on PMS habitat and populations. It is likely that the PMS is adapted to both short- and longer-term droughts, but at small population sizes, like those exhibited by this threatened butterfly, stochastic abiotic factors such as fire and drought, can severely compromise population persistence and may lead to extinction. The current monitoring effort offers an opportunity to examine how the PMS population responds to the dual effects of both fire and drought.

1.2 Study area Conditions in 2009

In 2009, precipitation during the growing season as measured at the USGS Cheesman, Colorado weather station was above the 100-year mean for the region (Figure 6.1). Levels of precipitation in 2009 were above the 100-year mean for most of the months from March to August growing season with July rainfall surpassing the 100-year mean by nearly three inches (Figure 6.1). The increased rainfall resulted in blooming prairie gayfeather with robust florets of healthy flowers and blue grama with greater inflorescence height and density. The pattern of rainfall during the 2009 growing season was similar to that of 2007 with both years exhibiting at least 4 months of above average or average rainfall as compared to the 100-year mean. This is in contrast to 2008 when 4 of the months during the March to August period received below average rainfall and two months were at or above the 100-year mean. (Figure 6.1). This follows a period from 2001 through 2003 in which the area experienced a severe drought. Accumulated precipitation for the water year (Oct. 2001 to Sept. 2002) at the U.S.G.S. National Weather Service's Cheesman Weather Station was the lowest ever recorded (7.5 inches) during the period of record keeping (1902 to 2009) while the 2006 to 2007 water year was the third highest ever recorded (21.87 inches) (Western Regional Climate Center 2009). In 2002 and 2003, nine and eight months, respectively, experienced rainfall below their 100-year mean, while 2004 experienced nine months, 2005 experienced seven months, and 2009 experienced eight months with precipitation near, or above, the 100-year monthly mean (Figure 6-1). The winter and early spring of 2009 experienced near normal precipitation, but April through July experienced above normal levels of precipitation. The abundant summer moisture in the South Platte Valley produced a robust crop of prairie gayfeather and blue grama, the primary adult and larval foodplants, respectively, of the PMS.

Skippers' were counted on August 31st, and September 1st through the 4th from approximately 10 AM to 3 PM each day. Temperatures ranged from approximately 70ºF in morning to 88ºF in the afternoon for all of the five survey days. Performance of surveys occurred under low to medium wind conditions and most with cloud cover of less than 40 percent. On all five days of surveying the cloud cover reached 80% by early afternoon, consequently 12 of the 32 transects sampled were surveyed with cloud cover of between 60% and 80%.

2.0 PROJECT OBJECTIVES

This project was established to implement a monitoring program to document PMS habitat condition and trends of population abundance, in both burned and unburned PMS habitat, on the Hayman and Schoonover fire areas in 2002 and subsequent years. Assessing the habitat requirements, trends in abundance, and the recolonization dynamics of PMS in burned areas will reveal the conservation status of this butterfly over the entire extent of its known distribution within the South Platte River drainage, and are the purposes of this monitoring effort.

3.0 PROJECT AREA

For purposes of estimating fire-caused habitat reductions, skipper habitat burned by the Schoonover and Hayman fires within the known range of the Cheesman and Mainstem South Platte populations of the PMS was estimated. The Schoonover fire burned a small portion of PMS habitat in 2002, and monitoring transects were placed within its boundary, but the majority of transects were placed within suitable habitat burned by the Hayman Fire.

The USFS prepared burn severity maps for the Hayman Fire and Schoonover Fire, based on interpretation of aerial photography and satellite imagery (USFS 2002). These burn severity maps, combined with the map of occupied PMS habitat (Figure 3.1) were used to establish the 2002 sampling study area. The geographical area of the 2002 study encompassed the entirety of the Hayman Fire and Schoonover Fire within the estimated suitable PMS habitat, the global extent of which occurs in the South Platte River Valley, Jefferson, Douglas, Park, and Teller counties, Colorado. Sampling transects were randomly located within each of three burn classes (unburned, low severity burn, and moderate-to-high severity burn) within the project area. The sampling transects follow the South Platte drainage between the confluence of Wigwam Creek and the northern boundary of the Hayman Fire in the vicinity of Oxyoke, and continue on both sides of Cheesman Reservoir and in the Horse Creek drainage southeast of Deckers (Figure 3.2). Areas unburned by the Hayman fire within the South Platte drainage were sampled from south of Deckers, to Long Scraggy Peak on the north (Figure 3.2).

Figure 3.1. Skipper Habitat burned by the Hayman and Schoonover wildfires.

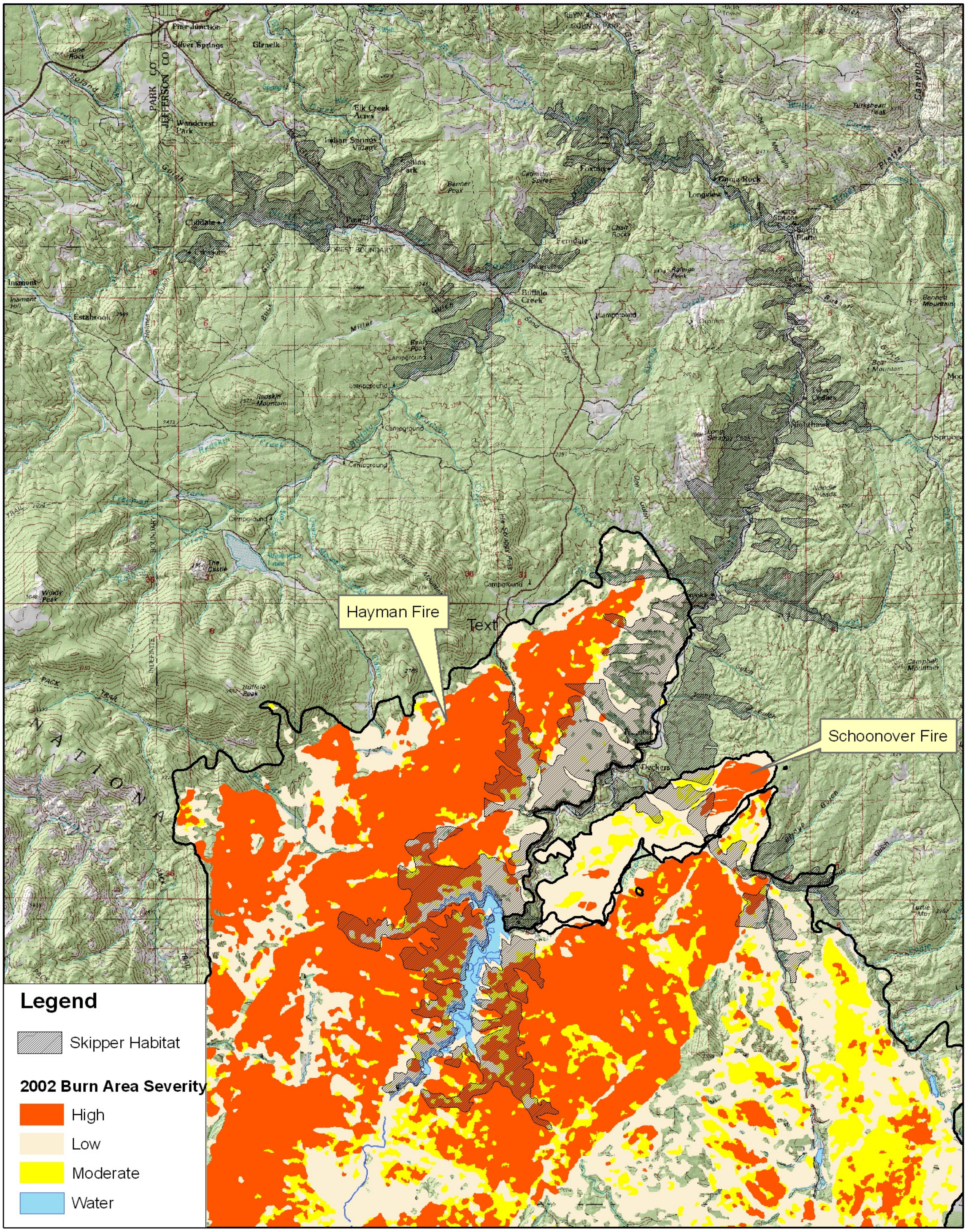
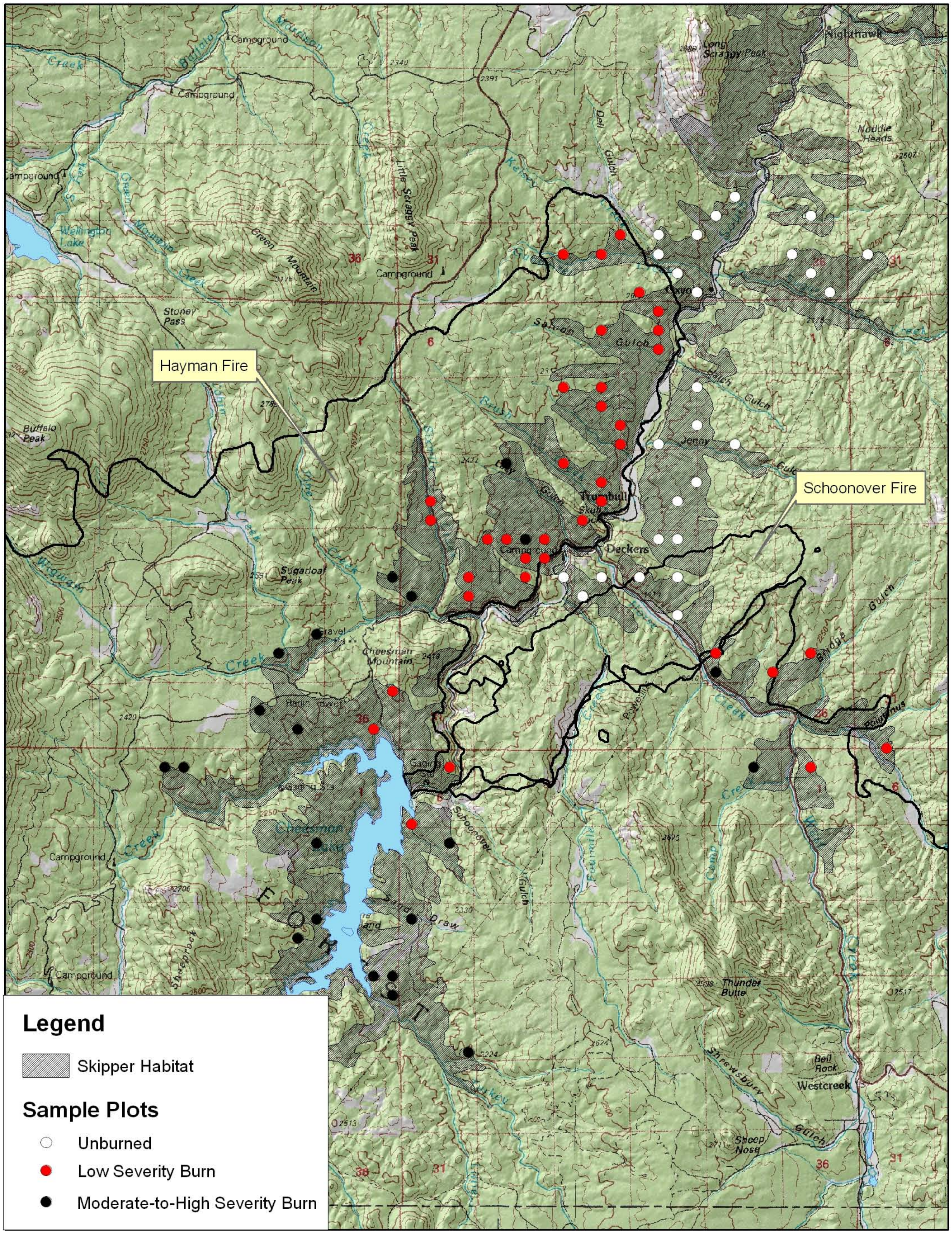


Figure 3.2. The location of the Pawnee montane skipper post-fire monitoring sampling blocks in the Hayman and Schoonover fire areas.



4.0 FIELD DATA COLLECTED AND PROJECT OUTPUTS

1. Data recorded from belt transects in the monitoring effort were
a) numbers of skippers present;
b) number of blooming *Liatris* stems (primary adult PMS nectar source);
c) the relative frequency of blue grama grass clumps (PMS larval foodplant);
d) number of living and dead trees larger than 6” DBH; and
e) records of BAER treatments (surface stabilization activities such as scarification) observed on transects.

The measurement of these parameters was not consistent across years (Table 4.1).

2. Photographic records were made of each transect sampled, and transect location coordinates (universal transverse mercator [UTM]) were recorded with Global Positioning System (GPS) instruments.

3. Assessments were made of habitat recovery and factors influencing skipper reoccupation of burned habitat including the spatial relationship between burned habitat and proximity to unburned or low severity burned mapped PMS habitat in areas that experienced different burn intensities.

Table 4.1. Parameters measured during the post-fire monitoring project (2002 to 2009).

Parameter	Year of Collection							
	2002	2003	2004	2005	2006	2007	2008	2009
Estimate of skipper numbers	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimate of blooming *Liatris* stems	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Frequency of blue grama grass clumps	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Living trees	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Standing dead trees[1]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BAER treatments[2]	Yes	Yes	No	No	No	No	No	No

[1]New to the 2003 sampling effort and continued through 2008 was a census of standing dead trees in the same larger size class used for live trees, as a means of better characterizing the forest structure of skipper habitat.
[2]Collection of data on the status of BAER treatments within sample plots was dropped from the 2004 and later field studies.

5.0 PROJECT DESIGN AND SAMPLING METHODS

5.1 Sampling Area Dimensions and Selection

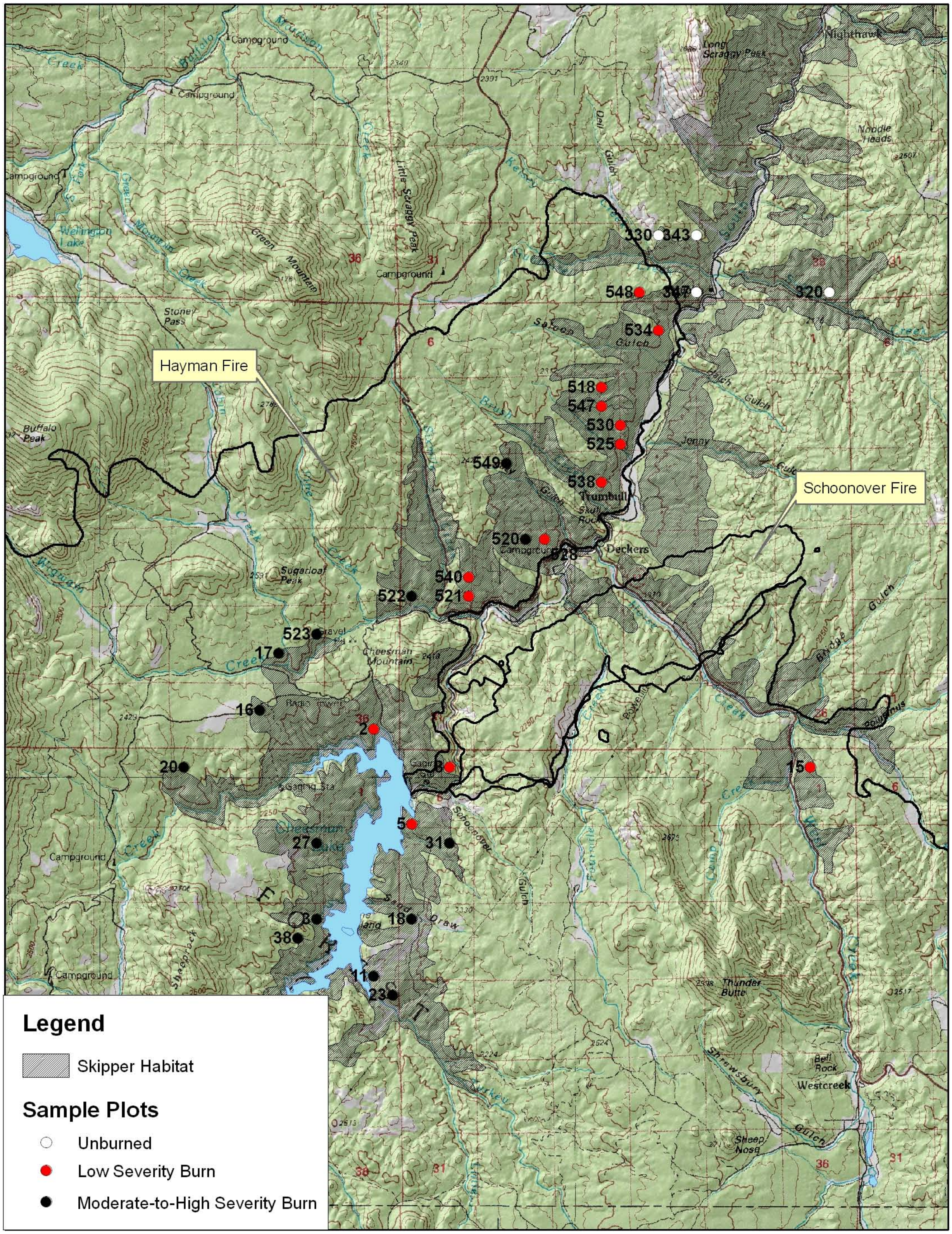
The field sampling methods used from 2002 to 2009 are similar to those used for rapid assessment sampling of skipper habitat and skipper occurrences developed for the 1986 Two Forks Dam field study program (Environmental Research and Technology [ERT] 1986).

The unit of sampling was a 40-acre habitat block within estimated suitable PMS habitat. The study area was divided into a grid of 40-acre blocks in Geographic Information System (GIS). A unique number was then assigned to each 40-acre unit within the grid. An overlay of the fire severity map (Hayman and Schoonover) was placed over the grid to establish the boundaries of burned versus unburned areas. Then the PMS habitat map was superimposed over the burn map to establish the location of burned versus unburned PMS habitat. The grid numbers that corresponded to locations within suitable PMS habitat (burned and unburned) were selected as a subset of the total grid. These grid numbers were reordered through a randomization routine in Microsoft Excel. The randomized 40-acre units were then listed as a sampling order for three subareas: 1) Cheesman Reservoir and Horse Creek; 2) burned areas between Cheesman Reservoir and the northern boundary of the Hayman Fire; and 3) unburned areas from the vicinity of Deckers northward to the northern boundary of the Hayman Fire. Eliminating blocks that were predominantly on private lands, and blocks where estimated habitat was less than 75 percent of the block further reduced potential sampling areas.

In each 40-acre block selected for sampling, a sub-sample was taken that consisted of an 800-meter (m) belt transect with four segments forming a diamond 200 m to a side. The survey area width for each belt transect was 10 m (5 m on either side of the transect center line). Thirty-two plots were sampled between August 31 and September 4, 2009 (Figure 5.1). The same transects were sampled from 2007 through 2009. Sampling was scaled back in 2007 and emphasis was placed on sampling burned plots, particularly those moderate-to-high severity burn areas that were near unburned PMS habitat. This will assist in identifying if patterns in recovery of PMS abundance are influenced by the proximity of a burned area to unburned or low severity burned suitable habitat that is presumably occupied by PMS.

The distance of each low severity and moderate-to-high severity burn plot to unburned mapped PMS habitat was estimated in ArcGIS 9.3 using the USFS burn severity map, the estimated habitat suitability map for the PMS, and the coordinates of the Universal Transverse Mercator center point of each sample block.

Figure 5.1. The location of the Hayman Fire sampling blocks surveyed during 2009.



5.2 Field Sampling Methods

To provide consistency in data collection a sampling protocol was provided to each sampling team (the protocol is attached as Appendix A). The following section outlines the methods for establishing transects and describes the parameters measured along each transect.

5.2.1 Sampling Site locations

The UTM coordinates for the center point of each 40-acre sampling plot were included in GPS units taken into the field by each field crew. Each crew used the GPS instrument to find this center point. Using the GPS the crew then located a spot 50 m due south of the plot center point and this location was used as the initial starting point for a diamond-shaped transect [200 m on a side] located within the designated 40-acre block. To complete the transect, an initial heading was established using a compass. The first 200-m leg was walked, and data were recorded for each of the10, 20-m sub-segments along each 200-m transect leg. Each sampling team established a new compass heading at the end of each 200-m leg by making a 90-degree turn. To walk each transect in a reasonable time frame, each 200-m leg of the transect was paced (each observer determined the number of paces needed to cover 200 m, based on the individual pace length of the observer). A GPS reading was taken at the beginning, and then at each 90-degree turning point along the transect. Digital photographs were taken forward and backward from each turning point along the axis of the transect (i.e., each 200-m segment was documented at both ends). The transect number and segment being photographed was indicated on a white board included in the foreground of each photograph.

5.2.2 Data Collection

The information collected and compiled on the data sheet is described here (Figure 5.2). Observations within the area of the belt transect (800 x 10 m) were recorded on the data sheets. Additional observations of PMS (off-transect) were written on the back of the data sheet.

- Observers, weather conditions, location. The following information was filled in at the top of the data sheet:

- The sample block # from the sampling order table.

- The UTM coordinate of the center point.

- The observers.

- The date and time of sampling.

- Weather conditions. The percent cloud cover, measured or estimated temperature, wind speed (L [low] = none to taller grass in motion; M [medium] = leaves and limbs of flexible shrubs in motion; H [high] = limbs of larger trees in motion), and the UTM coordinates for each corner of the diamond transect were recorded.

- BAER Treatments. If the transect intersects areas where surface stabilization activities were being undertaken, the type of activity (e.g., scarification), and the percentage of the 200-m segment that has been affected by these activities were indicated (recorded only in 2002 and 2003).

- Habitat measurements. The following data were collected in 20-m sub-segments along each 200-m leg of the overall transect:

  - Burn status. These data [percent of transect burned; type and amount of sprouting] were collected in 2002 and were not in subsequent years.

  - Tree counts. Live trees greater than 6 inches diameter at breast height (DBH) within the belt transect were counted to document the larger living trees along the transect in both burned and unburned areas. In 2002, the tree was scored as living if 25 percent or more of the needles remaining on the tree at the time of sampling were green. In subsequent years, a tree was scored as living if any green needles were present, regardless of the amount. Also from 2003 to 2008, dead standing trees greater than 6 inches DBH were counted and recorded in a separate category.

- Blue grama (Bogr) frequency. The presence or absence of blue grama (*Bouteloua gracilis*) was documented within a visually estimated 0.5-m-square rectangular quadrant that extended 0.5 m on either side of the observer's toe, and 0.5 m in front of the toe at the endpoint of each 20-m interval along the transect (10 recordings per 200-m segment). The observer marked + or √ for presence, 0 for absence in the appropriate space on the data sheet.

- Prairie gayfeather (*Liatris punctata*) (Lipu) stem counts. Stems of blooming Prairie gayfeather were counted in each 20-m segment within the 10-m wide survey area. Commonly there were multiple blooming stems emanating from the crown of an individual *Liatris* plant. Each stem was counted as a separate occurrence.

- Adult skipper butterfly counts (Hlm and Hco). Individual skipper butterflies of either the common branded skipper (*Hesperia comma*) or the PMS (*Hesperia leonardus montana*) were counted in each 20 m segment along the transect. The sex of the skipper was entered into the appropriate box (for each skipper species, male on left, female in the middle, and unknown on the right). If the skipper species was unknown, its occurrence was entered in the UNK box, and the sex (if it could be determined) was entered into the appropriate box. All skippers observed during transit between transects were recorded with GPS coordinates or with notes on the back side of the data sheets.

Figure 5.2. The 2008 Hayman Fire sampling block datasheet.

PAWNEE MONTANE SKIPPER SURVEY DATA SHEET 2008 --- Hayman Burn Area

DISTRIBUTION OF *Bouteloua gracilis* (**Bogr**), *Liatris punctata* (**Lipu**), *Hesperia comma* (**Hco**), *Hesperia leonardus montana* (**Hlm**) Date: ______________

Observers: ______________________________ Sample Block # _____ GPS Coordinates: ______________________

Cloud Cover (%): _____ Temp: _____ Wind (√): Low ___ Med ___ High ___ **COMPASS DECLINATION: +11° ❖ GPS: NAD27 CONUS**

First 200m leg (A) | Photos (√): ☐ start ☐ finish | **Start time:** _____ **End time:** _____

Compass bearing: ______

GPS Coordinates at start (UTM): ______________________________

Sample Segment	Trees > 6" DBH		plants		skippers								
	# live	# dead	Bogr	Lipu	Hlm			Hco			UNK		
meters					♂	♀	?	♂	♀	?	♂	♀	?
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
TOTALS													
record:	#	#	√	#	#	#	#	#	#	#	#	#	#

Second 200m leg (B) | Photos (√): ☐ start ☐ finish | **Start time:** _____ **End time:** _____

Compass bearing: ______

GPS Coordinates at start (UTM): ______________________________

Sample Segment	Trees > 6" DBH		plants		skippers								
	# live	# dead	Bogr	Lipu	Hlm			Hco			UNK		
meters					♂	♀	?	♂	♀	?	♂	♀	?
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
TOTALS													
record:	#	#	√	#	#	#	#	#	#	#	#	#	#

Third 200m leg (C) | Photos (√): ☐ start ☐ finish | **Start time:** _____ **End time:** _____

Compass bearing: ______

GPS Coordinates at start (UTM): ______________________________

Sample Segment	Trees > 6" DBH		plants		skippers								
	# live	# dead	Bogr	Lipu	Hlm			Hco			UNK		
meters					♂	♀	?	♂	♀	?	♂	♀	?
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
TOTALS													
record:	#	#	√	#	#	#	#	#	#	#	#	#	#

Fourth 200m leg (D) | Photos (√): ☐ start ☐ finish | **Start time:** _____ **End time:** _____

Compass bearing: ______

GPS Coordinates at start (UTM): ______________________________

Sample Segment	Trees > 6" DBH		plants		skippers								
	# live	# dead	Bogr	Lipu	Hlm			Hco			UNK		
meters					♂	♀	?	♂	♀	?	♂	♀	?
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
TOTALS													
record:	#	#	√	#	#	#	#	#	#	#	#	#	#

5.3 Data Management

The sponsoring agencies received copies of the data sheets. The USFS received all of the transect GPS location for entry into their GIS database. Transect photographs were compiled, labeled, and stored on compact disks and given to the USFS for storage on their internal file server. A data summary listing transects, burn classification, and values of parameters measured is included in Appendix B.

5.3.1 Transect Grouping for Analysis

USFS delineated the burn severity classes on the appearance of the burned and unburned trees on satellite and aerial photo imagery and through subsequent field assessments of the imagery based mapping efforts accuracy. The skipper habitat sampling data collected in 2002 verified the USFS burn severity map. The map was quite accurate in depicting the condition of the overstory trees. Since stands classified as high or moderate burn severity were associated with an understory that was nearly always 100 percent burned, it seemed most appropriate to analyze these transects together because in 2002 there was no skipper occupancy of these areas, and overstory recovery will require many years. The low severity burn category included a mosaic of unburned and partially to completely burned trees, with both burned and unburned understory patches. Because there is potential that some skippers still occupied these low severity burn areas immediately following the burn in 2002, and some overstory trees remain, it is likely that skipper abundance will differ from that in high or moderate severity burn areas. Consequently, transects located within low burn severity areas mapped by the USFS were analyzed as a single group. Thus, in the Hayman fire area, there were transects distributed among three burn classification categories: unburned, low severity burn, and moderate-to-high severity burn.

5.3.2 Statistical Analysis

As indicated above, the burn severity classification and its mapping accuracy was biologically useful in evaluating skipper habitat condition and the potential for skipper re-occupancy. The effects of the fire on forest vegetation were relatively similar in the high and moderate severity burn areas, and highly variable in the low severity areas, depending on the local behavior of the fire. As was done from 2002 through 2008, data analysis in 2009 used burn severity to examine each skipper habitat variable. For purposes of comparison, the means and standard deviations were computed for each parameter (e.g., blue grama frequency), and for each transect group (unburned, low severity, and moderate-to-high severity). Data were analyzed using a two factorial design with eight levels of year (2002 through 2009), and three burn classes (unburned, low severity, and moderate-to-high severity). Multiple comparisons among pairs of means of different treatments (burn severity and year), were performed using least square means, the Tukey-Kramer method for unequal sample sizes, and using a significant level of $P=0.05$. All analyses were conducted using software from the R Project for Statistical Computing (R Development Core Team 2009).

Setting a level of significance in statistics determines the likelihood of committing a Type I Error, or in our study, the probability of declaring a significant difference between sample means when no difference exits. Such errors can occur, because some samples will show a relationship just by chance. When performing many tests comparing differences between multiple sample means (post-hoc tests), as in this study, the tendency is to inflate the overall Type I Error rate, and it is advisable to set a lower significance level. Although assignment of significance level is somewhat arbitrary, levels of 0.05 and 0.01 are most commonly used.

The possibility also exists of missing a difference between compared means, when a difference actually exists (a Type II Error). Sample sizes have the largest influence on Type II Error rates, with small sample sizes equating to larger Type II Error rates. To a lesser extent, the probability associated with a Type I Error will inversely affect Type II Error rate. By relaxing your restriction on commission of a Type I Error you can decrease your likelihood of a Type II Error, and increase statistical power, or the ability to detect the smallest worthwhile difference between compared means.

6.0 RESULTS AND DISCUSSION

6.1 Post-fire Habitat Conditions and Skipper Abundance on the Hayman Transect

6.1.1 Current versus Historic Habitat Use

The three populations of the PMS distinguished in the Recovery Plan occupies approximately 25,044 acres of ponderosa pine forests between 6,000 and 8,000 feet in the South Platte River Valley (ENSR 2003). Between 1996 and 2002, four separate fires burned approximately 48.4 percent (12,026 acres) of the habitat: the Buffalo Creek, High Meadow, Schoonover, and Hayman fires. The U. S. Forest Services burn severity maps for these four fires show that over 65% of the burned habitat for the Cheesman, Mainstem South Platte, and North Fork populations of the PMS experienced moderate-to high intensity fire. See ENSR (2003) for an in-depth discussion of changes to historic skipper habitat resulting from these four fires. Determining the conservation status of the PMS, a species listed as threatened under the Endangered Species Act, over its entire range requires measuring the recolonization dynamics of burned areas and monitoring changes in population abundance. This research is studying the abundance and change in abundance of the Pawnee montane and common branded (*Hesperia comma*) skippers in the Hayman Fire area.

Cheesman, Mainstem South Platte, and North Fork

6.1.2 Pawnee Montane Skipper (*Hesperia leonardus montana*) Occurrence

In 2009, 56 PMS were recorded from the Hayman Fire transects, comparable to the 62 that were observed in 2008. There were 12 PMS recorded from 4 of 4 (100%) unburned transects, 30 from 10 of 14 (71%) low severity burn transects, and 14 from 7 of 14 (50%) moderate-to-high severity burn transects. The mean total number of PMS recorded for 2009 was 0.89 per acre for 32 sampled transects. This was similar to the number recorded for 2005, 2007, and 2008 and almost twice the 0.47 and 0.51 PMS per acre recorded from 46 and 31 transects in 2004 and 2006 (Table 6.1). The 0.89 PMS per acre recorded in 2009 was also 8.9 times the 0.10 PMS per acre recorded from 56 transects in 2003, and 44.5 times the 0.02 PMS per acre recorded from 55 transects immediately following the fire and during the drought that co-occurred in 2002 (Table 6-1). Through nine years of monitoring, counts of PMS per acre have been highest at the unburned transects and lowest at the moderate-to-high severity burn transects except for in 2008 (Table 6-1). In 2008, the counts were slightly higher at the moderate-to-high severity burn transects than at the low severity burn transects (Table 6.1). The number of PMS counted at the moderate-to-high severity burn transects has lagged behind counts in the other two burn severity classes, increasing from a low of zero PMS per acre in 2002 to a high of 0.90 per acre in 2008 (Table 6-1). From 2004 to 2008 PMS counts at moderate-to-high severity burn transects increased by over 1000 percent (Table 6.1) However, PMS counts dropped sharply to 0.51 PMS per acre at moderate-to-high severity burn transects in 2009. The numerous PMS observed at the moderate-to-high severity burn transects in 2007 and 2008 indicates that populations are returning to transects of this burn class. Maintaining and increasing butterfly populations in moderate-to-high severity burn areas is central to maintaining the population viability of the PMS. The decline in abundance observed in 2009 in this burn class is not only contrary to this goal, but suggests PMS populations are variable and possibly unstable at moderate-to-high severity burn transects. This is in stark contrast to the unburned areas where PMS counts have been consistently above or near 1.0 per acre since 2005 and at the low severity burn transects where they have been around 1.0 per acre since 2005 (Table 6.1).

Table 6-1. The number of Pawnee montane skippers (*Hesperus leonardus montana*) counted per acre from 2002 through 2009 within the burn classes (unburned, low, and moderate-to-high severity burns) of the Hayman Fire and the total number of Pawnee montane skippers counted per acre on all transects in each year.

Year	Burn Severity			Total Pawnee montane skipper/Acre
	Unburned	Low	Moderate-to-High	
2009	1.52	1.08	0.51	0.89
2008	1.64	0.87	0.90	0.98
2007	1.64	0.83	0.61	0.84
2006	1.01	0.67	0.12	0.51
2005	1.65	1.23	0.08	0.94
2004	0.83	0.66	0	0.47
2003	0.18	0.08	0.03	0.10
2002	0.08	0	0	0.02

Combining counts for all the years of monitoring (2002 through 2009) and comparing between burn classes indicate the number of PMS at moderate-to-high severity burn transects have been significantly lower than at the two other burn classes (Table 6.2). This might suggest that the moderate-to-high severity burn transects are marginal habitat for PMS relative to the unburned and low severity burn transects. However, PMS have been reported from some moderate-to-high severity burn transects. Comparing the moderate-to-high severity burn transects where PMS have been reported to their counterparts without PMS indicates there are no significant differences between the two groups for any of the vegetation factors being investigated (live trees, dead trees, blue grama, and prairie gayfeather) (One-way ANOVA, df = 1, largest F = 2.25, lowest P = 0.13).

Table 6.2. Pawnee montane skipper (*Hesperia leonardus montana*) abundance on Hayman Fire transects. Pawnee montane skippers per acre among habitat burn classes (unburned, low, and moderate-to-high severity burns) from 2002 through 2009 for all Hayman transects.

Burn Severity	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (p=0.05)[1]
unburned	71	0.88	1.35	A
low	143	0.60	1.13	A

moderate-to-high	123	0.26	0.82	B

During the first three years of monitoring (2002 to 2004), PMS counts within years recorded from unburned and low severity burn transects were not significantly different from counts at the moderate-to-high severity burn transects (Table 6-3). In 2005, PMS counted at unburned transects (1.65 per acre) were significantly greater than that at the moderate-to-high severity burn transects (0.08 per acre) (Table 6-3). This suggests that between 2004 and 2005 PMS habitat quality improved at the unburned transects and low severity burn transects as the effects of drought became less pronounced in the region. By 2005, however, this same recovery from drought did not positively influence PMS numbers at the moderate-to-high severity burn transects.

Table 6-3. Pawnee montane skipper (*Hesperia leonardus montana*) abundance on Hayman Fire transects. Pawnee montane skippers per acre among habitat burn classes (unburned, low, and moderate-to-high severity burns) and within sample years (2002 through 2009) for all Hayman transects.

Year	Burn Severity	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (p=0.05)[1]
2009	unburned	4	1.52	0.41	A
	low	14	1.08	1.07	A
	moderate-to-high	14	0.51	0.67	A
2008	unburned	4	1.64	0.86	A
	low	14	0.87	0.93	A
	moderate-to-high	14	0.90	1.38	A
2007	unburned	4	1.64	2.28	A
	low	14	0.83	0.71	A
	moderate-to-high	14	0.61	1.66	A
2006	unburned	6	1.01	1.15	A
	low	12	0.67	1.15	A
	moderate-to-high	13	0.12	0.30	A
2005	unburned	15	1.65	2.09	A
	low	19	1.22	1.92	AB
	moderate-to-high	19	0.08	0.35	B
2004	unburned	11	0.83	0.88	A
	low	20	0.66	1.42	A
	moderate-to-high	15	0	0	A
2003	unburned	14	0.18	0.38	A
	low	35	0.08	0.24	A

Year	Burn Severity	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (p=0.05)[1]
	moderate-to-high	17	0.03	0.12	A
2002	unburned	13	0.08	0.28	A
	low	25	0	0	A
	moderate-to-high	17	0	0	A

[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown.

Between 2002 and 2009, the general trend has been for increases and then stabilization in the counts of PMS per acre at transects of the unburned and low severity burn classes, but counts at the moderate-to-high severity burn transects have lagged behind. Among individual burn classes, the only significant differences in counts per acre occurred between the year 2005 and the years 2002 and 2003 within both the unburned and low severity burn transects (Table 6-4). Between 2002 and 2006, the increase in PMS was largely confined to the unburned and low severity burn transects, but since 2006 PMS counts per acre have greatly increased at the moderate-to-high severity burn transects as well, although the increases were not significant (Table 6-4). Maintaining permanent populations of PMS at moderate-to high severity burn transects will be important to conserving the Cheesman, Mainstem South Platte, and North Fork populations of this species in the South Platte River Valley because this burn class comprises such a large percentage (65%) of the PMS habitat that was burned.

Table 6-4. Pawnee montane skipper (*Hesperia leonardus montana*) abundance on Hayman Fire transects. Pawnee montane skippers per acre among sample years (2002 through 2009) and within burn classes (unburned, low, and moderate-to-high severity burns) for all Hayman transects.

Year	Burn Severity						
	Unburned			Low			Moderate-to-high	
	Means	Homogenous Groups (P=0.05)[1]		Means	Homogenous Groups (P=0.05)[1]		Means	Homogenous Groups (P=0.05)[1]
2009	1.52	AB		1.08	AB		0.51	A
2008	1.64	AB		0.87	AB		0.90	A
2007	1.64	AB		0.83	AB		0.61	A
2006	1.01	AB		0.67	AB		0.12	A
2005	1.65	A		1.22	A		0.08	A
2004	0.83	AB		0.66	AB		0	A
2003	0.18	B		0.08	B		0.03	A

Year	Burn Severity							
	Unburned			Low			Moderate-to-high	
	Means	Homogenous Groups (P=0.05)[1]		Means	Homogenous Groups (P=0.05) [1]		Means	Homogenous Groups (P=0.05)[1]
2002	0.08	B		0	B		0	A

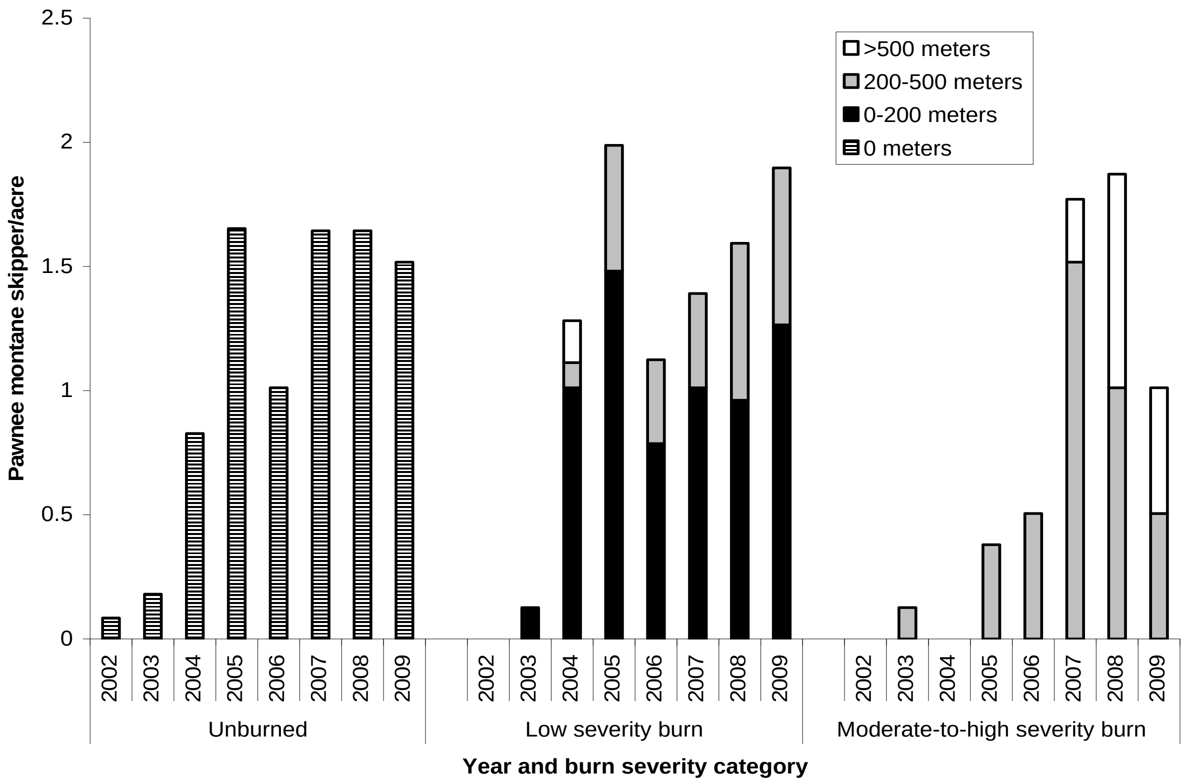
[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown

PMS recovered quickly at unburned transects after the drought and fire with PMS counts between 2003 and 2009 ranging from 0.5 to 1.65 PMS per acre (Figure 6.1). Counts of PMS also recovered quickly on the low severity burn transects, however, it wasn't until 2007 that PMS counts surpassed 0.5 per acre at moderate-to-high severity burn transects (Table 6.4). Despite large increases in PMS counts to approximately 1.0 per acre for all burn classes, they are still lower than densities recorded in the 1980's, when 2.1 to 3.6 PMS per acre were counted at unburned transects (ERT 1986, 1988, 1989). A multiyear comparison of PMS densities on unburned transects reveals that, although the count recorded in 2009 (1.52 per acre) was near the high count for the period of monitoring, it is still only about 40% of the maximum PMS per acre of 3.6 recorded in 1986.

Consistent occupation of the low severity burn transects by PMS occurred in 2003, one year after the Hayman Fire. In 2003, PMS were originally recorded only from low severity burn transects within 200 m of unburned PMS habitat, but by 2004 PMS were recorded at transects 200-500 m and over 500 m from unburned suitable PMS habitat (Figure 6.1). Since 2003, PMS counts at low severity burn transects have been similar to those at unburned transects, but significantly more PMS have been recorded at transects within 200 m of unburned PMS habitat than at distances greater than 200 m (Figure 6.1) (Two Sample t-test, $t = 3.56$, $df = 129$, $P = 0.0003$). In fact, only 27 PMS have ever been recorded at low severity burn transects greater than 200 m from unburned PMS habitat, while 142 PMS have been counted at transects within 200 m of unburned PMS habitat. This suggests that after the fire proximity to relatively intact unburned PMS habitat was important to occupation of low severity burn areas by PMS. One major vegetation difference between these two distance categories is that low severity burn transects within 200 m of unburned PMS habitat had significantly greater numbers of live trees ($t = 5.97$, $df = 132$, $P = 0.00000001$). All other vegetation factors being investigated (dead trees, blue grama, and prairie gayfeather) were statistically similar between the two distance categories. The intensity of the Hayman Fire increased from its outer edges to its inner center (Figure 3.1). At the fringes of the fire in the low severity burn areas the fire probably burned less intensely while at the boundary between the high-to-moderate and low severity burn areas the fire was probably more intense. This could explain why low severity burn transects nearest the outer edge of the fire (i. e. within 200 m of unburned habitat) support greater numbers of live trees per acre compared to their counterparts farther from unburned habitat that are nearer to the moderate-to-high severity fire boundary. The combination of lowered fire intensity, greater survival of trees, and proximity to surviving PMS populations in unburned areas that are subsequently dispersing into adjacent low severity burn areas are probably all interacting to increase PMS counts at low severity burn transects within 200 m of unburned PMS habitat. It is possible that populations of

PMS persisted in the low severity burn areas within 200m of unburned habitat after the fire, have continued to persist since the fire, and have added to their populations from 2003 to 2009 while also adding recruits from PMS populations located in adjacent unburned habitat. On the other hand, PMS populations in low severity burned habitat near the boundary with moderate-to-high intensity burn areas may have suffered greater declines or even extirpation and are then recovering at slower rates compared to their counterparts near unburned PMS habitat, yet at faster rates than populations in areas suffering moderate-to-high intensity fire.

Figure 6.1. The number of Pawnee montane skippers (*Hesperia leonardus montana*) counted per acre at 0-200 m, 200-500 m, and greater than 500 m from unburned mapped skipper habitat at both low severity and high-to-moderate severity burn transects from 2002 through 2009 (unburned transects are shown for comparison).



Consistent occupation by PMS of the moderate-to-high severity burn transects did not occur until 2005, three years after the Hayman Fire. PMS were originally recorded from moderate to high severity burn transects in close proximity to unburned habitat (CNHP 2006, Figure 6.1). This suggests that proximity to relatively intact PMS habitat may be crucial to the rate at which reoccupation occurs. Between 2002 and 2006 PMS were only recorded from moderate-to-high severity burn transects that were within 500 m of an unburned or low severity burn area as mapped by the U.S. Forest Service (Figure 6.1, Table 6-5). It was not until 2007, five years post-fire, that PMS were recorded at moderate-to-high severity burn transects greater than 500m from unburned PMS habitat (Table 6.5). In 2008, eight moderate-to-high severity burn transects greater than 1000 m from unburned habitat contained PMS, however, most of them were within 125 m of low severity burn transects except for transects 16, 18, and 20, which were 136 m, 604 m, and 416 m from low severity burned PMS habitat, respectively (Table 6.5). In 2009, the furthest moderate-to-high severity burn transect inhabited by PMS was 125 m from low severity burned PMS habitat. In total, only five PMS have ever been recorded at moderate-to-high severity burn transects greater than 125 m from low severity burned PMS habitat, while 59 PMS have been counted at transects within 125 m of low severity burned PMS habitat (Table 6.5). In fact, significantly more PMS were counted at moderate-to-high severity burn transects within 125 m, versus those greater than 125 m from low severity burned PMS habitat (Two Sample t-test, $t = 2.65$, $df = 85$, $P = 0.005$). In addition, significantly more PMS were counted at moderate-to-high severity burn transects within 500 m, versus those greater than 500 m from unburned PMS habitat (Two Sample t-test, $t = 1.67$, $df = 30$, $P = 0.05$). This was true even though 78 percent ($n = 96$) of the moderate-to-high severity burn transects sampled from 2002 through 2009 were greater than 500 m from unburned mapped PMS habitat. This percentage results from patterns in the distribution of the Hayman Fire across the landscape, which caused the moderate-to-high severity burn transects to fall at great distance from unburned mapped PMS habitat. A secondary effect of this pattern is that only one moderate-to-high severity burn transects less than 200 m from unburned PMS habitat was sampled in eight years of monitoring and no PMS were recorded from that single sampling event, which occurred in 2005 at transect 49 (Table 6.5).

The low numbers of PMS counted at the moderate-to-high severity burn transects in the first five years after the Hayman Fire have given way to increased numbers of PMS in subsequent years (Figure 6.1). This suggests that PMS are returning to the moderate-to-high severity transects, but it is unclear whether these returning individuals are transients out foraging or if they are members of self-sustaining local populations. Egg laying by PMS has never been observed at a moderate-to-high severity burn transect, but oviposition flight behavior has been observed three times, once each at different transects in the years 2006, 2007, and 2008. Documenting persistent occupation across years at individual moderate-to-high severity burn transects and observing egg laying by PMS at these transects will help clarify that these are permanent populations.

There were no significant differences in any of the vegetation factors being investigated (live trees, dead trees, blue grama, and prairie gayfeather) among transects with PMS versus those without PMS (Two sample t-test, $df = 121$, largest $t = -1.505$, lowest $P = 0.07$) (Table 6.5). However, moderate-to-high severity burn transects never having PMS recorded at them were significantly farther from both unburned PMS habitat (Two sample t-test, $t = 1.88$, $df = 121$, $P = 0.03$) and low severity burned PMS habitat (Two sample t-test, $t = 1.74$, $df = 121$, $P = 0.04$) (Table 6.5). All of this suggests that as years since the burn and drought increase, PMS are able to disperse farther into the moderate-to-high severity burn areas of the Hayman Fire. See Appendix C for the distance that every burned transect monitored between 2002 and 2009 is from unburned suitable PMS habitat and the number of PMS counted at each transect.

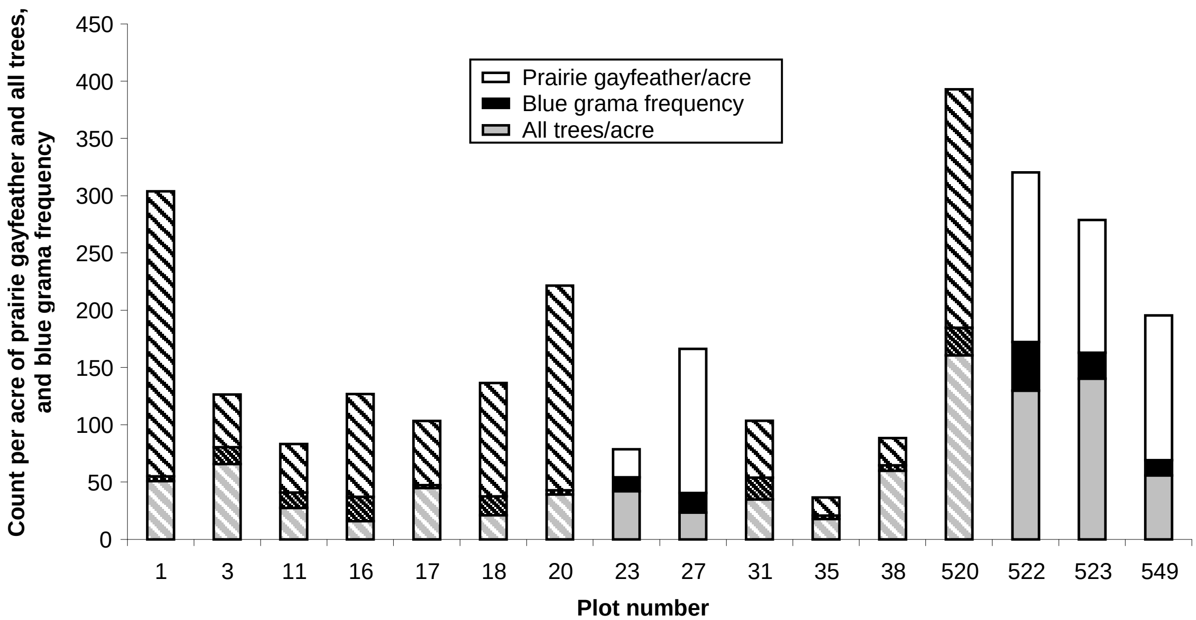
Table 6-5. Habitat condition at moderate-to-high severity burn transects both occupied and unoccupied by Pawnee montane skippers (*Hesperia leonardus montana*) from 2002 to 2009, their distances to unburned and low severity burn transects, and the number of skippers recorded at each transect (no skippers were recorded from moderate-to-high severity burn transects in 2002).

Year	Transect number	# of flowering gayfeather stems	# of live trees	# of dead trees	Blue grama frequency (%)	Distance (m) to unburned/low severity burn PMS habitat	# of Pawnee montane skippers
Transects occupied by Pawnee montane skipper							
2003	523	42	0	191	4	233/28	1
2005	549	502	2	137	11	283/54	3
2006	522	106	0	157	26	376/37	2
	523	65	0	83	8	223/28	1
2007	17	57	0	82	3	2675/104	1
	27	102	0	38	8	1192/125	4
	522	119	0	81	27	376/37	12
2008	16	100	0	37	16	1747/136	1
	18	132	0	35	21	1007/604	1
	20	800	0	66	10	1422/416	3
	23	108	0	66	25	1158/13	2
	27	205	0	30	11	1192/125	10
	520	246	0	96	0	285/32	3
	522	52	0	58	26	376/37	1
	523	115	0	69	8	233/28	4
2009	3	118	0	119	15	787/10	3
	23	23	0	62	17	1158/13	2
	27	405	0	14	10	1192/125	4
	38	36	0	113	5	1290/103	1
	522	203	0	69	24	376/37	2
	523	256	0	130	11	233/28	1
	549	636	0	69	46	283/54	1
Transects that remained unoccupied by Pawnee montane skipper from 2002-2009							
2002	1	3	13	na	3	570/51	0
	11	0	0	na	15	792/10	0
	21	0	0	na	0	4006/644	0
	31	0	0	na	0	918/297	0
	35	0	0	na	0	294/353	0
2003	1	119	1	87	5	570/51	0
	11	36	0	74	7	792/10	0
	21	0	0	96	5	4006/644	0
	31	24	0	117	6	918/297	0
	35	8	0	27	5	294/353	0
2004	1	1062	0	138	8	570/51	0
	11	115	0	45	12	792/10	0

Year	Transect number	# of flowering gayfeather stems	# of live trees	# of dead trees	Blue grama frequency (%)	Distance (m) to unburned/low severity burn PMS habitat	# of Pawnee montane skippers
	31	11	0	30	11	918/297	0
	35	15	0	71	3	294/353	0
2005	1	783	0	163	1	570/51	0
	11	22	0	45	11	792/10	0
	21	0	0	101	0	4006/644	0
	31	373	0	85	18	918/297	0
	35	101	0	43	4	294/353	0
	49	858	0	136	2	176/30	0
	568	220	13	442	16	934/305	0
2006	11	105	0	78	12	792/10	0
	31	40	0	71	30	918/297	0
2007	11	21	0	86	18	792/10	0
	31	80	0	121	16	918/297	0
2008	11	27	0	71	15	792/10	0
	31	70	0	64	23	918/297	0
2009	11	142	0	35	18	792/10	0
	31	188	0	63	48	918/297	0

As previously mention, analysis of data from moderate-to-high severity burn transects unoccupied by PMS suggest that these transects did not differ in any of the vegetation factors being investigated (live trees, dead trees, blue grama, and prairie gayfeather) (One-way ANOVA, df = 1, largest F = 2.25, lowest P = 0.13). The main difference is that unoccupied moderate-to-high severity burn transects tend to be located at greater distances from unburned and low severity burn habitat that is suitable for PMS (Appendix D). Moderate-to-high severity burn transects surveyed multiple times and that were consistently occupied, sometimes with numerous PMS, including transects 27, 522, and 523 did tend to have high counts for blue grama, prairie gayfeather, and trees (both live and dead) (Table 6.5, Figure 6.2), although these differences are not statistically significant. This pattern, however, is inconsistent as transect 27 and 23 were occupied in multiple years, but have low counts of trees, and other transects without consistent occupation by PMS have high numbers of either blue grama, prairie gayfeather, and/or trees including transects 1, 20, and 520 (Figure 6.2). There is probably a complex interaction among multiple factors including burn intensity, shade, slope, aspect, and cover of host plants, trees, and shrubs among other factors that are determining occupation of the moderate-to-high severity burn transects. The most important factor, however, probably is the distance to unburned and low severity burned suitable PMS habitat.

Figure 6.2. The average count per acre of prairie gayfeather and all trees, and blue grama frequency at high-to-moderate severity burn transects that were surveyed multiple times from 2002 through 2009 (cross-hatched bars indicate transects where *Hesperia leonardus montana* have never been recorded or where they were recorded in only one of the eight monitored years).



6.1.3 Skipper (*Hesperia*) Occurrence

Between 2002 and 2005, counts of *Hesperia* skippers per acre (*H. l. montana* and *H. comma*) exhibited an increasing trend, reaching a peak of 4.66 per acre throughout the project area in 2005 (Table 6-6). Since 2005, counts of *Hesperia* skippers have remained above 1.0 per acre (Table 6.6). Among burn classes, the 2009 skipper counts are higher than those of 2008 except for at the moderate-to-high severity burn transects (Table 6.7). There were significant differences between all of the burn severity classes in 2005 with counts ranging from a low of 1.07 skippers per acre at the moderate-to-high severity burn transects to a high of 8.50 skippers per acre at the unburned transects (Table 6-7). Since 2005, however, increases in skipper counts at the moderate-to-high severity burn transects and decreases at low severity burn transects and unburned transects has resulted in all burn classes having statistically similar numbers of skippers per acre within years (Table 6.7).

The difference in skipper counts among fire classes observed in 2005, and to a lesser extent in 2004, might result from changes of population densities of plants important in the skipper life cycle. For *Hesperia* in the South Platte River drainage these include the larval foodplant, blue grama, and the primary adult nectar plant, prairie gayfeather (For a discussion of the populations of these two plants in the Hayman Fire transects see sections 6.1.4 and 6.1.5).

Table 6-6. Hesperia skippers (*Hesperia comma* and *Hesperia leonardus montana*) per acre among sample years (2002 through 2009) for all Hayman transects.

Year	Sample Size (# of Transects	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2009	32	1.79	1.74	B
2008	32	2.13	2.48	B
2007	32	1.41	1.83	BC
2006	32	1.31	2.09	BC
2005	53	4.66	5.14	A
2004	46	1.76	3.45	B
2003	56	0.18	0.40	C
2002	55	0.02	0.14	C

[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown.

Table 6-7. *Hesperia* skippers (*Hesperia comma* and *Hesperia leonardus montana*) per acre compared among burn classes (unburned, low, and moderate-to-high) and within sample years (2002 through 2009) for all Hayman transects.

Year	Burn Intensity	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2009	unburned	4	2.53	1.43	A
	low	14	2.49	2.04	A
	moderate-to-high	14	0.87	1.0	A
2008	unburned	4	2.40	1.12	A
	low	14	1.85	1.83	A
	moderate-to-high	14	2.35	3.29	A
2007	unburned	4	2.78	2.91	A
	low	14	1.45	1.40	A
	moderate-to-high	14	0.98	1.82	A
2006	unburned	6	2.45	3.03	A
	low	12	1.60	2.22	A
	moderate-to-high	13	0.51	1.07	A
2005	unburned	15	8.50	4.97	A
	low	19	5.22	5.14	B
	moderate-to-high	19	1.07	2.10	C
2004	unburned	11	4.78	5.52	A
	low	20	1.37	2.08	B
	moderate-to-high	15	0.07	0.26	B

Year	Burn Intensity	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2003	unburned	14	0.40	0.57	A
	low	25	0.10	0.25	A
	moderate-to-high	17	0.12	0.39	A
2002	unburned	13	0.08	0.28	A
	low	25	0	0	A
	moderate-to-high	17	0	0	A

[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown.
[2]Two skippers of unknown identify were recorded from one moderate-to-high severity burn transect in 2004. No PMS were identified from moderate-to-high severity burn transects in 2004.

The number of *Hesperia* skippers counted at moderate-to-high severity burn transects was significantly greater at transects within 500 m versus those greater than 500 m from a low severity burn area (Two Sample t-test, t = 3.99, df = , P = 0.00006). These results are consistent with those for PMS counted at moderate-to-high severity transects and support the previously mentioned conclusion that as years since the burn and drought increase, PMS are able to disperse further and further into moderate-to-high severity burn areas from recovering populations that survived the fire and drought in unburned and low severity burn areas. This pattern is also true for counts of the common branded skipper (*H. comma*) with significantly greater numbers occurring at moderate-to-high severity burn transects within 500 m of low severity burn areas, lending further support to the dispersal hypothesis (Two sample t-test, t = 2.66, df = 114, P = 0.004).

The low numbers of *Hesperia* skippers observed at the moderate-to-high severity burn transects in the first three years after the Hayman Fire have given way to increased numbers of skippers in subsequent years (Table 6.7). This suggests that skippers are returning to the moderate-to-high severity transects, but it is unclear whether these returning individuals are transients out foraging or if they are members of self-sustaining local populations. Documenting persistent occupation across years at individual moderate-to-high severity burn transects and observing egg laying by skippers at these transects will help clarify that these are permanent populations.

6.1.4 Post-fire Changes in Forest Structure

Overall tree stem densities (live trees and dead trees combined) in the three burn classes were very different in 2009, with unburned, low severity burn, and moderate-to-high severity transects having 56.8, 74.7, and 36.0 stems per acre, respectively. Overall stem densities of ponderosa pine and Douglas fir appear to be changing among the burn classes over the long-term. Probably because in each year since the fire some of the burned trees on transects within the Hayman Fire area are falling to the ground. In terms of apparent habitat structure and microclimate, the difference between the moderate-to-high severity burn transects and the other two burn classes (unburned and low severity burn) is dramatic. The lack of canopy foliage in the former areas results in more sun, less shade, and lower soil moisture (for already scorched topsoil). The challenge is to determine the relative importance of these forest characteristics to skipper recolonization and survival.

Counts of standing live trees at the Hayman transects in 2002 showed significant differences among all three burn classes: unburned, low severity, and moderate-to-high severity, with the greatest density of trees occurring in the unburned transects (Table 6-8). From 2003 to 2009, the unburned and low severity transects were statistically indistinguishable form each other, but both had significantly higher numbers of live trees than did the moderate-to-high severity burn transects; except for in 2008. In 2008, the low severity and moderate-to-high severity burn transects were statistically indistinguishable from one another although the mean number of dead trees between the two burn types was greatly different (Table 6-8). As it takes many years for ponderosa pine to reach the 6-inch diameter size class, this difference between unburned and low severity burn transects and the moderate-to-high severity burn transects is expected to continue for decades if no other source of catastrophic mortality (e.g., fire, bark beetles) occurs in the region.

Table 6-8. Standing live trees on Hayman Fire transects. Live tree stems (>6 inches DBH) per acre compared among burn classes (unburned, low, and moderate-to-high severity burns) and within sample years (2002 through 2009) for all Hayman transects.

Year	Burn Severity	Sample Size (# of Transects)	Mean (stems per acre)	Standard Deviation	Homogenous Groups (p=0.05)[1]
2009	unburned	4	53.24	15.38	A
	low	14	56.98	31.23	A
	moderate-to-high	14	1.99	7.44	B
2008	unburned	4	89.16	61.39	A
	low	14	46.72	40.56	AB
	moderate-to-high	14	0.18	0.68	B
2007	unburned	4	95.10	11.18	A
	low	14	53.30	31.84	A
	moderate-to-high	14	0.72	2.71	B
2006	unburned	6	77.06	31.38	A
	low	12	54.68	29.63	A
	moderate-to-high	13	0.27	0.98	B
2005	unburned	15	73.42	28.50	A
	low	19	53.12	35.44	A
	moderate-to-high	19	1.33	2.68	B
2004	unburned	11	84.07	56.94	A
	low	20	67.43	50.01	A

Year	Burn Severity	Sample Size (# of Transects)	Mean (stems per acre)	Standard Deviation	Homogenous Groups (p=0.05)[1]
	moderate-to-high	15	2.13	5.03	B
2003	unburned	14	79.53	58.02	A
	low	25	47.73	40.83	A
	moderate-to-high	17	0.30	0.76	B
2002	unburned	13	127.84	58.61	A
	low	25	80.69	63.40	B
	moderate-to-high	17	NA[2]	NA	NA

[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown.
[2]NA= not applicable; dead trees were not counted in 2002.

When counts of live trees were compared within burn classes across all eight years (Table 6-9), no significant differences were found within two of the burn classes. At the unburned transects, however, there was a significant difference in the density of live trees between the years 2002 and 2005. However, from 2006 through 2008 the number of live trees in unburned transects did not differ from the 2002 sample suggesting that live trees did not decline in the unburned transects, but rather that the decline in live trees observed between 2002 and 2005 was a result of sampling bias. This could have occurred because the transects sampled each year were not always the same and no area was sampled in exactly the same location twice.

Table 6-9. Standing live trees on Hayman Fire transects. Live tree stems (>6 inches DBH) per acre compared among sample years (2002 through 2009) and within burn classes (unburned, low, and moderate-to-high severity burns) for all Hayman transects.

Year	Burn Severity							
	Unburned			Low			Moderate-to-high	
	Means	Homogenous Groups (P=0.05)[1]		Means	Homogenous Groups (P=0.05)[1]		Means	Homogenous Groups (P=0.05)[1]
2009	53.24	AB		56.98	A		1.99	A
2008	89.16	AB		46.72	A		0.18	A
2007	95.10	AB		53.30	A		0.72	A
2006	77.06	AB		54.68	A		0.27	A
2005	73.42	A		53.12	A		1.33	A
2004	84.07	AB		67.43	A		2.13	A
2003	79.53	AB		47.73	A		0.30	A
2002	127.84	B		80.69	A		0.92	A

[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown.

Standing dead trees were not counted during the first year of the post-fire study, but data from 2003 through 2009 show statistical similarities within years between the unburned and low severity burn transects for most of the years of monitoring while the moderate-to-high severity burn transects generally had greater numbers of dead trees (Table 6-10). In 2008 and 2009, there were no significant differences in the number of dead trees among any of the burn classes and in general the numbers of dead trees in the moderate-to-high severity burn transects have declined during the eight years of monitoring. This decline may result from some dead trees left standing after the 2002 Hayman Fire falling to the ground in each of the subsequent years since the fire. This has probably led to the lack of statistical significance in the number of dead trees at the moderate-to-high severity burn transects in 2008 and 2009.

Table 6-10. Standing dead trees on Hayman Fire transects. Standing dead tree stems (>6 inches DBH) per acre compared among burn classes (unburned, low, and moderate-to-high severity burns) and within sample years (2003 through 2009) for all Hayman transects.

Year	Burn Severity	Sample Size (# of Transects)	Mean (trees per acre)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2009	unburned	4	3.54	3.76	A
	low	14	17.67	13.57	A
	moderate-to-high	14	34.37	18.62	A
2008	unburned	4	2.53	3.74	A
	low	14	20.16	10.15	A
	moderate-to-high	14	34.94	13.63	A
2007	unburned	4	3.54	4.09	A
	low	14	26.99	18.29	AB
	moderate-to-high	14	55.18	30.79	B
2006	unburned	6	2.19	2.84	A
	low	12	26.43	20.10	AB
	moderate-to-high	13	44.01	16.01	B
2005	unburned	15	2.90	3.44	A
	low	19	24.41	22.91	A
	moderate-to-high	19	56.44	45.31	B
2004	unburned	11	5.38	8.53	A
	low	20	35.54	26.01	B
	moderate-to-high	15	58.48	32.93	B

Year	Burn Severity	Sample Size (# of Transects)	Mean (trees per acre)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2003	unburned	14	2.64	2.96	A
	low	25	27.40	24.08	A
	moderate-to-high	17	62.16	29.19	B

[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown.

Comparing counts within burn classes among the years shows no statistically significant differences from 2003 through 2009 (Table 6-11). The number of standing dead trees in the moderate-to-high burn transects has decreased in most every year as weakened stems have fallen to the ground. (Table 6-11).

Table 6-11. Standing dead trees on Hayman Fire transects. Standing dead tree stems (>6 inches DBH) per acre compared among sample years (2003 through 2009) and within burn classes (unburned, low, and moderate-to-high severity burns) for all Hayman transects.

Year	Burn Severity							
	Unburned			Low			Moderate-to-high	
	Means	Homogenous Groups (P=0.05)[1]		Means	Homogenous Groups (P=0.05)[1]		Means	Homogenous Groups (P=0.05)[1]
2009	3.54	A		17.67	A		34.37	A
2008	2.53	A		20.16	A		34.94	A
2007	3.54	A		26.99	A		55.18	A
2006	2.19	A		26.43	A		44.01	A
2005	2.90	A		24.41	A		56.44	A
2004	5.38	A		35.54	A		58.48	A
2003	2.64	A		27.40	A		62.16	A

[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown.

6.1.5 Blue Grama (Bouteloua gracilis) Occurrence

Blue grama frequencies in 2009 were similar in the three burn classes with all being near 14% (Table 6-12). This continues the pattern of the previous seven years, which saw no significant differences in the frequency of blue grama among the burn classes. Only in 2002 was the frequency of blue grama significantly less at the moderate-to-high burn transects compared to the other two burn classes. Thus, it appears that the severe effects of the 2002 fire suppressed blue grama growth significantly that year but not in subsequent years.

Table 6-12. Blue grama (*Bouteloua gracilis*) frequency on Hayman Fire transects. Blue grama frequency compared among burn classes (unburned, low, and moderate-to-high severity burns) and within sample years (2002 through 2009) for all Hayman transects.

Year	Burn Severity	Sample Size (# of Transects)	Mean (% frequency)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2009	unburned	4	13.50	2.38	A
	low	14	11.74	5.25	A
	moderate-to-high	14	16.93	14.51	A
2008	unburned	4	15.50	7.59	A
	low	14	12.36	10.44	A
	moderate-to-high	14	13.93	8.40	A
2007	unburned	4	15.25	7.81	A
	low	14	9.79	4.74	A
	moderate-to-high	14	10.29	7.53	A
2006	unburned	6	12.33	6.50	A
	low	12	11.83	3.04	A
	moderate-to-high	13	13.23	9.49	A
2005	unburned	15	9.73	6.84	A
	low	19	9.47	5.72	A
	moderate-to-high	19	9.58	5.74	A
2004	unburned	11	11.82	7.61	A
	low	20	11.20	8.64	A
	moderate-to-high	15	16.00	24.48	A
2003	unburned	14	8.29	6.68	A
	low	25	7.72	4.60	A
	moderate-to-high	17	5.76	3.29	A
2002	unburned	13	23.31	12.10	A
	low	25	23.48	9.83	A
	moderate-to-high	17	9.35	9.87	B

[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown.

The drought of 2002 and 2003 reduced frequency of blue grama in 2003 to levels below that observed in 1986 (ENSR 2003) or in any other year of this study. A modest increase in blue grama in 2004 across all burn classes (CNHP 2005) was reversed in 2005. In 2005 blue grama frequency dropped slightly in all three burn classes, but rebounded again in 2006 and then remained fairly consistent through 2009 (Table 6-13). There has been no consistent significant difference among years within any burn class since 2002 when the unburned and low severity burn transects had the highest frequencies observed during the study (Table 6-13). Thus, blue grama frequencies have been roughly equal in all three burn classes for all years studied except 2002 (Table 6.13). None of the three burn classes has returned to the high frequency levels of 2002, but it is difficult to say why this is so with any certainty. It may be related to the generally lower than normal precipitation levels observed during the eight years of monitoring.

Table 6-13. Blue grama (*Bouteloua gracilis*) frequency on Hayman Fire transects. Blue grama frequency compared among sample years (2002 through 2009) and within burn classes (unburned, low, and moderate-to-high severity burns) for all Hayman transects.

Year	Burn Severity							
	Unburned			Low			Moderate-to-high	
	Means	Homogenous Groups (P=0.05)[1]		Means	Homogenous Groups (P=0.05)[1]		Means	Homogenous Groups (P=0.05)[1]
2009	13.50	AB		11.74	A		16.93	A
2008	15.50	AB		13.31	AB		13.93	A
2007	15.25	AB		9.79	A		10.29	A
2006	12.33	AB		11.83	A		13.23	A
2005	9.73	A		9.47	A		9.58	A
2004	11.82	AB		11.20	A		16.00	A
2003	8.29	A		7.72	A		5.76	A
2002	23.31	B		23.48	B		9.35	A

[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown.

6.1.6 Prairie Gayfeather (Liatris punctata) Occurrence

There have been no consistent significant differences in the stem counts per acre of gayfeather within years among the burn classes. Once again, the stem counts per acre did not differ in 2009 (Table 6-14). Counts among the burn classes differed only in 2005, when counts per acre ranged from 111 to 212 flowering stems per acre (Table 6-14) with significantly greater counts recorded at the moderate-to-high severity burn transects compared to the low severity burn transects. The 2005 counts represent a range of increase over 2004 of 39% to 169%, respectively. As stated in previous reports, this perennial plant is well adapted for such a response, with its massive subterranean crown and deep root system that allow gayfeather to survive both drought and fire (ENSR 2003). Indeed, from 2002 through 2005 the above-ground densities of gayfeather, as measured by the number of flowering stems, increased by a factor of 30 at the unburned transects, by a factor of 617 at low severity burn areas, and by a factor of 142 at the moderate-to-high severity burn transects. Counts of gayfeather have declined from the 2005 highs and in 2009 they ranged from 81 to 142 stems per acre with the greatest values recorded at the low severity burn transects. The extremely low count of 11 stems per acre recorded at the unburned transects in 2007 may result from the small number of unburned transects sampled that year (n = 4). From 2007 through 2009, effort has focused on sampling low severity and moderate-to-high severity burn transects. The intent was to determine patterns of recolonization of these transects by PMS.

Table 6-14. Prairie gayfeather (*Liatris punctata*) flowering stems on Hayman Fire transects. Gayfeather flowering stems compared among burn classes (unburned, low, and moderate-to-high severity burns) and within sample years (2002 to 2009) and for all Hayman transects.

Year	Burn Severity	Sample Size (# of Transects)	Mean (stems per acre)	Standard Deviation	Homogenous Groups (P=0.05)1
2009	unburned	4	80.93	28.15	A
	low	14	169.93	145.45	A
	moderate-to-high	14	142.47	113.04	A
2008	unburned	4	58.81	70.78	A
	low	14	69.88	75.35	A
	moderate-to-high	14	79.20	98.91	A
2007	unburned	4	10.88	12.14	A
	low	14	52.03	47.20	A
	moderate-to-high	14	36.96	34.08	A
2006	unburned	6	48.31	56.77	A
	low	12	50.00	43.75	A
	moderate-to-high	13	45.37	30.92	A
2005	unburned	15	146.83	173.86	AB
	low	19	111.21	86.13	B
	moderate-to-high	19	212.81	161.83	A
2004	unburned	11	71.65	83.42	A
	low	20	79.85	63.63	A
	moderate-to-high	15	79.69	135.64	A
2003	unburned	14	27.97	25.68	A
	low	25	12.89	14.17	A
	moderate-to-high	17	20.50	17.68	A
2002	unburned	13	4.63	7.40	A
	low	25	0.18	0.44	A
	moderate-to-high	17	1.43	4.57	A

[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown.

When comparing among the burn classes within the years, the stem counts per acre of gayfeather were extremely low in 2002 and 2003 at the height of the drought and directly following the Hayman Fire. This is in contrast to 2005 and 2009 when the stem counts per acre where extremely high (Table 6.15). Abnormally high rainfall in April and May appears linked to increases in prairie gayfeather stem counts during these years (Table 6.16). Together, these two factors influence the statistical analysis resulting in a complex mix of significant differences in the counts per acre for gayfeather within the burn classes and among the study years (Table 6-15). Yet, these differences in gayfeather stem counts are weakly correlated with *Hesperia* skipper counts (Spearman rank-order, $r_s = 0.45$, Regression $r^2 = 0.07$). It was in 2005 that gayfeather counts were at there highest and in that year the counts were greatest at the moderate-to-high severity burn transects (Table 6-15). The 2005 counts of gayfeather were significantly greater than the counts for all other years except 2009 at the moderate-to-high severity transects. The 2005 counts were also significantly greater than those of 2002 and 2003 for the low severity burn class and those of 2002 for the unburned class (Table 6-15). Favorable moisture conditions in the area in 2005 and again in 2009 appear to have resulted in greater stem densities of flowering gayfeather in those years. The extremely dense numbers of gayfeather recorded at the moderate-to-high severity burn transects in 2005, compared to areas where fire was absent or less severe, probably reflects either the availability of abundant nutrients released into the soil after the fire or a release from competition from other plants for moisture and resources. These two factors also could be interacting to result in greater recruitment of new individuals into the population. Unlike 2005, significantly more gayfeather were not recorded in the moderate-to-high severity burn transects in 2009, probably reflecting an increase in the plant population at moderate-to-high severity burn transects since 2005, which has both increased competition and depleted nutrients released into the soil by the fire.

The year 2007 also received significant rainfall during late spring, but gayfeather did not respond to this increase in precipitation (Table 6.16). It is not known why this is so, but the precipitation data presented here is from the Cheesman weather station and rainfall can exhibit great variation across small distances within the project area. Without having rain gauges at each individual transect it is difficult to state with certainty that patterns of rainfall recorded at Chessman match patterns occurring at the surveyed transects. If rainfall at Cheesman was greater than rainfall at the surveyed transects in 2007 it might explain why prairie gayfeather counts were not higher in that year. Many other factors may also be affecting prairie gayfeather growth including nutrient availability, the timing and intensity of rainfall events, temperature extremes, and soil moisture content among others, all of which could have influenced the 2007 counts.

Table 6-15. Prairie gayfeather (*Liatris punctata*) flowering stems on Hayman Fire transects. Gayfeather flowering stems compared among sample years (2002 through 2009) and within burn classes (unburned, low, and moderate-to-high severity burns) for all Hayman transects.

Year	Burn Severity				
	Unburned		Low		Moderate-to-high

	Means	Homogenous Groups (P=0.05)1		Means	Homogenous Groups (P=0.05)1		Means	Homogenous Groups (P=0.05)1
2009	80.94	AB		169.93	A		142.47	AB
2008	58.81	AB		69.88	ABC		79.20	BC
2007	10.88	AB		52.03	BC		36.96	BC
2006	48.31	AB		50.00	BC		45.37	BC
2005	146.83	A		111.21	AB		212.81	A
2004	71.65	AB		79.85	ABC		79.69	BC
2003	27.97	AB		12.89	C		20.50	C
2002	4.63	B		0.18	C		1.43	C

[1]Tukey's pairwise comparison test of means. Means followed by the same letter are not significantly different from one another; means followed by different letters are significantly different at the level of probability shown.

Table 6-16. Total precipitation in inches for 2002 through 2009 for April and May and the mean stem counts per acre for prairie gayfeather at all surveyed transects. Precipitation was recorded at the U.S.G.S. National Weather Service, Cheesman Weather Station.

Year	April-May precipitation	Mean stems per acre (all burn classes)	Total annuall precipitation
2002	0.99	1.62	8.27
2006	1.17	47.73	19.25
2003	1.33	18.97	11.95
2008	2.02	72.57	11.96
2007	3.86	40.29	17.79
2004	3.93	77.84	18.44
2005	4.26	157.71	14.64
2009	4.62	146.79	18.79

7.0 CONCLUSIONS

Current monitoring still indicates that the Hayman Fire and the mosaic of varying burn severity it has created across the landscape of suitable PMS habitat, has influenced the abundance of PMS within the project area. Over nine years of monitoring, counts of PMS have consistently been highest at the unburned transects and lowest at the moderate-to-high severity burn transects; with counts at the low severity burn transects falling between the two. For the last three years monitoring has documented moderate numbers of PMS at moderate-to-high severity burn transects, and since monitoring began in 2002, PMS counts at moderate-to-high severity burn transects have increased by over 1000 percent. PMS have clearly begun to reoccupy the high severity burned areas of the Hayman Fire, but how persistent the populations are is unknown. The mean per acre number of PMS recorded per moderate-to-high severity burn transect decreased from 0.9 in 2008, to 0.51 in 2009, which is only about 15% of the 3.6 PMS per acre recorded in 1986 at unburned habitat. These low numbers and the decrease observed in 2009 raises questions about stability of PMS populations in this burn class. In addition, since 2005 PMS counts have ranged from 0.67 to 1.64 per acre at unburned and low severity burn transects, which is far less than the 2.1 to 3.6 PMS per acre recorded in the 1980's (ERT 1986, 1988, 1989). Consequently, the continued resurgence of PMS numbers within moderate-to-high severity burn areas would enhance the potential for conserving all three populations of PMS in the South Platte River Valley. This becomes more evident when considering that moderate-to-high severity fire has burned approximately 57% of the habitat mapped as suitable for the Cheesman and Mainstem South Platte populations of the PMS. In addition, it is reasonable to suspect that the High Meadow and Buffalo Creek fires have similarly affected the North Fork populations of PMS. When also considering these two fires, a total of 65% of the suitable habitat in the South Platte River Valley has been burned by moderate-to-high severity fire.

At unburned transects, counts of PMS for 2009 (1.52 PMS per acre) were only 40% of the 1986 counts and counts have never been higher than 1.64 PMS per acre at unburned transects. Why current counts at unburned transects are lower than historic counts is unknown, but it may result from the average to lower than average levels of rainfall that have fallen in six of the eight monitored years within the project area. This taken in combination with the effect fire has had on the PMS population explains how central it is to the viability of PMS in the South Platte River Valley to maintain and increase PMS populations in moderate-to-high severity burn areas.

The Hayman Fire essentially eradicated PMS from moderate-to-high severity burn transects. In 2005, PMS began to appear at transects within this burn class, but it is unclear if these individuals are actually resettling these areas. The pattern of occurrence at the moderate-to-high severity burn transects is very distinct with PMS occurring at transects that are within 125 m of low severity burned habitat. It appears that proximity to relatively intact PMS habitat may be crucial to the rate of occurrence of PMS at these transects. This suggests that as time passes, PMS populations in the unburned and low severity burn areas that survived the drought and fire have increased in size and are subsequently dispersing into the moderate-to-high severity burn areas of the Hayman Fire. Further support for this conclusion comes from the fact that vegetation is not significantly affecting the recovery of PMS at the moderate-to-high severity burn transects. None of the vegetation factors being investigated (live trees, dead trees, blue grama, and prairie gayfeather) differ between occupied and unoccupied moderate-to-high severity burn transects.

This pattern also holds true for the common branded skipper with significantly greater numbers occurring at moderate-to-high severity burn transects within 500 m of low severity burn areas, lending further support to the dispersal hypothesis. Whether the PMS that have reached the moderate-to-high severity burn areas are actually settling those areas is unknown. The PMS observed at moderate-to-high severity burn transects may represent transients out foraging or they could be members of self-sustaining local populations. Egg laying by PMS has never been observed at a moderate-to-high severity burn transect, but oviposition flight behavior has. Documenting persistent occupation across years at individual moderate-to-high severity burn transects and observing egg laying by PMS at these transects will help clarify that these are permanent populations.

Parameters of skipper habitat quality measured in this study show that the habitats of all three burn severity classes currently support equal frequencies of blue grama, the larval foodplant, and all support abundant prairie gayfeather, the favored adult nectar source. What distinguishes the moderate-to-high severity burn transects from the unburned and low severity burn transects is the dearth of live trees on the former. Consequently, the moderate-to-high severity burn transects have less canopy cover, more sun, less shade, and greatly reduced spatial heterogeneity, including patterns of light and dark, which may impact the suitability of these areas for PMS. The intense crown fire experienced on these transects probably killed all skipper life stages (eggs, larvae, and adults) and it appears recolonization of moderate-to high severity transects requires dispersal from unburned or low severity burn transects, settlement, and subsequent dispersal of resettled populations further into the moderate-to-high severity burn transects. Movement patterns of PMS are unknown (Opler 1998), but maximum movements of approximately one kilometer are probable (NatureServe 2008). Whether the individual PMS will resettle and persist at the moderate-to-high severity burn transects is yet to be determined. The fact that PMS populations at moderate-to-high severity burn transects appear variable may indicate that these populations are unstable, but more data is needed across time to make this determination. Alternatively, the lack of canopy cover in this burn class may make moderate-to-high severity burn transects unsuitable for PMS and they may never resettle in this burn class. Whether this is true or not is an important piece of the puzzle that will require further monitoring to verify.

8.0 FUTURE RESEARCH

The major questions remaining are if PMS will continue to persist at the moderate-to-high severity transects and if the overall numbers of PMS counted will increase to the counts recorded in the 1980s. In 2009, there were 0.89 PMS recorded from all study plots and counts per acre have ranged from 0.02 ($\pm$ 0.14) in 2002 to 0.98 ($\pm$ 1.15) in 2008 compared to 2.1 to 3.6 per acre recorded in the 1980s. Monitoring should continue to determine if PMS populations will persist and increase in size at the moderate-to-high severity burn transects. Although focused on moderate-to-high severity burn areas, such survey work should also include some low severity burn plots and some unburned plots to determine the extent of their recovery in relation to abundances observed in the 1980s. To increase the survey of moderate-to-high severity transects within 200 m of unburned PMS habitat transect 49 could be added to the survey list for 2010. No other moderate-to-high severity burn transects are within 200 m of unburned suitable PMS habitat. Additional plots could be added within 200 m of unburned PMS habitat near transects 1, 331, 523, 542, or 549 to boost the number of transects being surveyed for this combination of burn severity class and distance category.

The occupancy survey should continue over several years to monitor the dynamics of recolonization and the change in abundance of PMS in both burned and unburned areas. Also, additional information on burn intensity, shade, slope, aspect, and the cover of trees, shrubs, and host plants could be collected on moderate-to-high severity burn transects to try and understand how occupied transects like 27, 522, and 523 might differ from their unoccupied counterparts.

9.0 LITERATURE CITED

Colorado Natural Heritage Program (CNHP). 2005. Pawnee montane skipper post-fire habitat assessment survey. September 2004. CNHP, Colorado State University.

Colorado Natural Heritage Program (CNHP). 2006. Pawnee montane skipper post-fire habitat assessment survey - September 2006. CNHP, Colorado State University.

ENSR International 2003. Pawnee montane skipper monitoring post-fire habitat assessment survey – September 2003. Final Report to U.S. Forest Service South Platte Ranger District, U.S. Fish and Wildlife Service, and Denver Water. ENSR Corporation, Fort Collins, Colorado. Document Number 09090-045-200.

Environmental Research and Technology (ERT). 1986. 1986 Pawnee Montane skipper field studies. Prepared for the Denver Water Department, Denver, Colorado. 40 pp.

_____. 1988. Pawnee Montane skipper - 1987 field studies. Prepared for the Denver Water Department, Denver, Colorado. 14 pp.

_____.1989. Pawnee montane skipper – 1988 field studies. Prepared for the Denver Water Department, Denver, Colorado. 23 pp.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://ww.natureserve.org/explorer.

Opler, P. 1998. Biodiversity tracking and conservation system. Colorado Natural Heritage Program, Fort Collins, Colorado. (Accessed: February 7, 2005). SAS 2004. SAS Institute Inc. version 9.1. Cary, North Carolina, USA.

R Development Core Team. 2009. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

U.S. Forest Service (USFS). 2002 Hayman and Schoonover Burn Intensity Map (Pawnee Montane skipper habitat as an overlay).

Western Regional Climate Center. 2008. Climate of Colorado. [*website*]. Available at: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?cochee.

APPENDIX A

PAWNEE MONTANE SKIPPER (*Hesperia leonardus montana*) POST-FIRE HABITAT MONITORING PROTOCOL: YEAR 8 SEPTEMBER 2009

Prepared by: Boyce A. Drummond, Ph.D.
Natural Perspectives, Fort Collins, Colorado
and
John Sovell
Colorado Natural Heritage Program Colorado State Uniuversity

Adult Skipper and Skipper Habitat Monitoring in the Burn Areas of the Hayman/Schoonover Forest Fires

1. Study Purpose and Scope

The Hayman and Schoonover forest fires burned across a large fraction of the suitable Pawnee Montane Skipper habitat during the summer of 2002. The primary purpose of this monitoring program is to document skipper survival and habitat condition in both burned and unburned skipper habitat in 2009, the <u>eigth</u> flight season for this butterfly species after the fire. Thus, a secondary purpose is to continue the sampling program begun in 2002 as the next step in a long-term monitoring program that can be repeated regularly as the habitat recovers from the fires. The geographical area of this study includes both sides of Cheesman Reservoir, the South Platte drainage between the confluence of Wigwam Creek and the northern boundary of the Hayman Fire in the vicinity of Oxyoke, and the Horse Creek drainage southeast of Deckers. Unburned areas within the South Platte drainage to be sampled extend from Trumbull on the south to Long Scraggy Peak on the north.

The USFS has prepared a burn severity map for the study area outlined above. This burn severity map, combined with the map of skipper habitat suitability, has been used to establish the sampling study area.

The field sampling methods and sampling units are the same as those used for rapid assessment sampling of skipper habitat and occurrence developed for the 1986 Two Forks Dam field study program (ERT 1986). Sample sites were selected randomly so that comparative statistical analyses can be conducted. Because many of the sites are located within burn areas, other parameters (ground stratum burn percentage, number of live and standing dead trees greater than 6 inches DBH, evidence of BAER treatment work) were added to the data collection program in previous years. The sampling methods to be used in 2009 are modifications of those used in previous years.

The primary outputs of this 2009 program will be a quantitative estimate of skipper numbers[both *Hesperia leonardus Montana* (Pawnee Montane Skipper) and *Hesperia comma* (Common Branded Skipper)] based on belt transect counts, an estimate of the number of blooming *Liatris punctata* (prairie gayfeather) stems (primary adult skipper nectar source), the frequency of *Bouteloua gracilis* (Blue Grama) grass clumps (skipper larval foodplant), and both living and standing dead trees within the study area outlined above. Other outputs will a revised revised map of suitable skipper habitat in the upper South Platte drainage and estimates of recolonization rates of burn sites by *Hesperia* skippers.

Sampling Design and Sampling Order

The unit of sampling is a 40-acre habitat block. In 2002 the study area was divided into a grid of 40-acre blocks in GIS. A unique number was then assigned to each 40-acre unit within the grid. An overlay of the fire intensity maps (Hayman and Schoonover) was placed over the grid to establish the boundaries of burned versus unburned areas. Then the skipper habitat suitability map layer was placed over the burn map to establish the location of burned versus unburned skipper habitat. The grid numbers that corresponded to locations within suitable skipper habitat (burned and unburned) were selected as a subset of the total grid. These grid numbers were reordered through a randomization program in Microsoft Excel. The randomized 40-acre units were then listed as a sampling order for three sub-areas: (1) Cheesman Reservoir and Horse Creek, (2) burned areas between Cheesman Reservoir and the northern boundary of the Hayman Fire, and (3) unburned areas from the vicinity of Deckers northward to the northern boundary of the Hayman Fire. Potential sampling areas were further reduced by eliminating blocks that were predominantly on private lands, and blocks where estimated suitable habitat was less than 75 percent of the block. The following maps are to be used in this protocol:

- An index map showing the 40-acre blocks proposed for sampling (plus some extra sites);

- The numbered sampling sites over: (a) topography and legal land base; (b) land ownership; and (c) skipper suitable habitat polygons;

- The numbered sampling sites over: (a) fire intensity map; and (b) skipper suitable habitat polygons.

The number of habitat blocks sampled each year has varied between 31 and 68, depending on the number of the field crew personnel available, the weather, and the available budget to support the project. The numbers in each year were: 2002 (55), 2003 (68), 2004 (58), 2005 (65), 2006, (31), and 2007 (32). For 2009, a target of 32 habitat blocks will be sampled if weather and personnel permit. With a couple of exception, the blocks sampled this year (in 2009) will be the same as those sampled over the past two years (2007 – 2008).

Field teams will consist of a minimum of 2 persons each. The number of field teams to participate during 2009 study will depend on the availability of agency personnel and volunteers.

After consultation with Denver Water, one day will be chosen for teams to work in the restricted Cheesman Resevoir area. One or two crews will need boat suppor; the other crews will work north of the dam and will not require vehicle or boat support.

2. Field Sampling Methods

Sampling site locations. The UTM coordinates for the center point of each sampling site are indicated on the sampling order lists located behind the Sampling Order table in the protocol. Each team will use GPS to find this center point, and then start the diamond-shaped transect at a point 50 m south of the center point. Each team will sample the transect in a clockwise direction, starting on a compass bearing of 315^{o}, and completing four 200-meter legs at 90^{o}-angles to create the diamond-shaped transect within the 40-acre block.

Sampling Transect. The attached protocol ***Pawnee Montane Skipper: 2005 Instructions for Post Fire Transects*** provides guidance for establishing the 800-meter belt sampling transect (four 200-meter legs), establishing the intermediate sampling intervals along the transect, and taking documentary photographs.

Data Collection. This section provides guidance for filling in information on the data sheet **"PAWNEE MONTANE SKIPPER SURVEY DATA SHEET 2009 --- Hayman Burn Area."** The width of the belt transect is 10 m (5 m on each side of the center line). All data will be taken within this area with the exception of other observations that would be useful in analyzing habitat conditions. These additional observations should be written on the back of the data sheet.

➢ **Heading (top of data sheet): Observers, weather conditions, etc.**

- Record the date and the names of members of the survey team, fill in the sample block # from the sampling order table, and record the UTM coordinates of the center point in the upper right-hand corner of the data sheet (you should also enter this coordinate into your team's GPS unit if it has not already been inputted; also, ***be certain*** that your GPS unit is set to map datum **NAD27 CONUS** and that you adjust your compass use to an **+11^{o} declination**).
- When you are ready to start the transect, record the prevailing weather conditions: estimate Cloud Cover to the nearest 10%, actual (or estimated) Temperature, and relative Wind speed (L = none to taller grass in motion; M = leaves and limbs of flexible shrubs in motion; H = limbs of larger trees in motion).

➢ **At the top of the individual form for each 200-meter leg, record:**

- The starting compass bearing (should be 315^{o})
- Start and end times for the leg.
- After taking the requisite two photographs at each corner of the transect diamond, check the photo boxes for start and finish photos.
- Record the GPS coordinates at the beginning point of each leg (i.e., the four corners of the diamond transect).

➢ **In the body of the form for each 200-meter leg, record data by 20-meter segments along each 200-meter leg of the overall transect.**

- **Trees**: Count only those trees over 6" DBH (diameter at breast height). A tree is scored as living if there are green needles remaining on the tree at the time of sampling, even though the tree may be partially or mostly burned, or may be dying for other reasons. Dead trees should meet the same diameter criteria and should be standing or leaning, even if supported by other trees. Do not count trees lying on the ground. (The purpose of recording both dead and live trees is to characterize the forest architecture of the skipper habitat.)
- **Bogr:** At the start of each 20-meter segment, document the presence or absence of Blue Grama (*Bouteloua gracilis*) within a visually estimated 0.5 meter-square rectangular quadrat that extends 0.5 m on either side of the observer's toe, and 0.5 meter in front of the toe. Mark √ for presence in the appropriate space on the data sheet.
- **Lipu:** Stems of blooming Prairie Gayfeather (*Liatris punctata*) will be counted in each 20-meter segment within the 10-meter wide survey area. Commonly there will be multiple blooming stems emanating from the crown of an individual *Liatris* plant. Count all flowering stems, but only those stems that have open flowers.
- **Skipper butterflies (Hlm and Hco**): Individual skipper butterflies of either the Common Branded Skipper (*Hesperia comma*) or the Pawnee Montane Skipper (*Hesperia leonardus montana*) should be counted as they are encountered in each 20-meter segment along the transect. The sex of the skipper (if determined) should be entered into the appropriate box (for each skipper species, male on left, female in the middle, and unknown on the right). If the skipper species is unknown, it should be entered in the UNK column, where the sex (if it can be determined) will be entered into the appropriate box. All skippers observed during transit <u>between transects</u> should be recorded with GPS coordinates on the back of a data sheet. **Study the color illustrations of these two species to learn how to tell them apart and to learn to tell males from females.**

3. Program Coordination and Safety

Field teams will meet at the Trumbull public park (Dott Park) at 9:00 AM each day of sampling to review procedures, receive block assignments, and coordinate transportation. The field teams will meet back at Dott Park at the end of field sampling to insure that all teams are safely out of the field, and that all data sheets are turned over to the field coordinator (John Sovell: 970-449-2362, cell; Boyce Drummond: 970-690-7455, cell). SDenny Bohan (303-862-2595, cell) of USFS will have the overall responsibility for insuring team compliance with fire-related access restrictions and worker safety requirements. Craig Hansen (303-862-2595, cell) is equipment coordinator.

Much of the terrain to be sampled is quite steep and rocky; participants should have sturdy footwear with ankle support. Each participant must take adequate water to prevent dehydration and should have sunscreen/sunblock to prevent sunburn.

4. Equipment List

The following is the minimum equipment needed by each team:

- GPS unit (preferably Garmin with a minimum of 5-10 meter accuracy) set to map datum NAD27 CONUS.

- Compass (rotating dial required for changing bearings), with declination set to 11^o east ($+11^o$).

- Digital Camera (film camera is ok, but digital prints on CD must be ordered at the time of processing).

- Clipboard and 2009 Hayman Burn data sheets

- Two hand counters for counting trees and *Liatris* stems

- Thermometer

- White board and marking pen

- Walking stick with a ½ meter/ meter interval to check Blue Grama quadrat size. A short meter tape is also acceptable, and may be easier to carry.

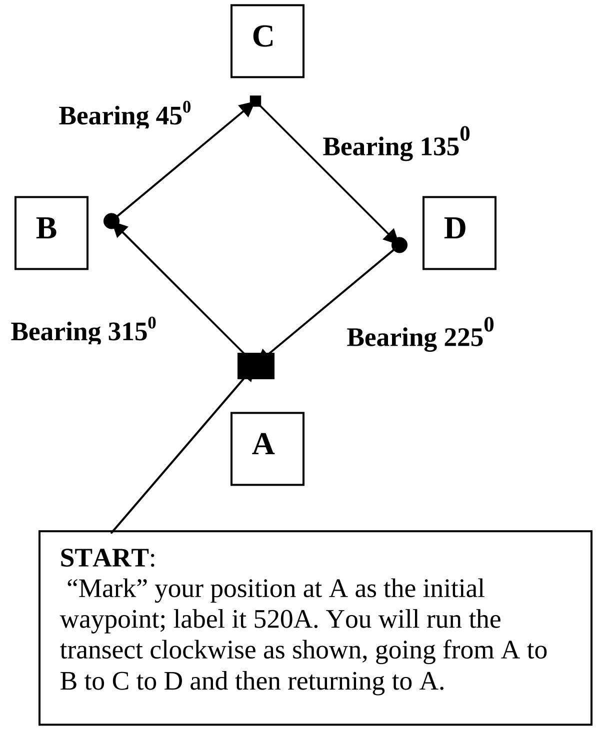
- 5-meter length of string to illustrate extent of transect on either side of center line. (alternately, teams can rely on calibrated paces to check transect widths).

- USFS radio for inter-team communication

- Color photographs for identifying and distinguishing *Hesperia comma* and *Hesperia leonardus montana.*

- Copy of ***Pawnee Montane Skipper: 2009 Instructions for Post-fire Transects*** (blue double-sided sheet)

Pawnee Montane Skipper
2008 Instructions for Post-fire Transects



How to use a GPS Unit and Orienteering Compas to navigate the diamond-shaped transects for post-fire habitat monitoring of the Pawnee Montane Skipper (*Hesperia leonardus montana*)

[Instructions are based on the Garmin GS12, and use Sample Block 520 as an example]

BEFORE YOU START:

1) Make sure your GPS Unit is set to MAP DATUM "NAD 83" and the display units are set to display position in UTM coordinates (see your manual for how to do this).
2) Adjust your compass use to accommodate the 11° East declination in our area.

- ❖ If you have a declination adjustmanet on Your compass, set it to 11° (so that the North Alignment arrow points 11°, not 0°.
  Then use your compass to follow the bearings in the diagram above.
- ❖ If you do NOT have a declination on your compass, you will need to add 11° to each of the bearings in the above diagram when you use your compass to orient to the next point (*e.g.* A to B will be on a bearing of 326° in stead of 315°).

FIND THE SAMPLE BLOCK CENTER POINT:

Use your map, compass, and GPS unit (programmed with the Sample Block's UTM coordinates to locate the center point of the block. Start your diamond transect 50 m due south of the center point. If necessary, offset your starting point in any direction other than south to accommodate difficult or unsuitable terrain, but DO NOT start your transect more than 50 m from the Center Point.. After you have arrived at the starting point (A), use the following procedure to record your position.

STEP ONE: At the starting point (A), record the GPS coordinates in the appropriate place on the data sheet.

[*Optional: Enter your starting point into the GPS unit as a waypoint, labeled as the plot number (e.g. 520 if you are sampling Plot 520). You can use this saved start waypoint as a way of checking your accuracy at the end of the diamond transect. See below*.]

STEP TWO: You are now ready to begin your diamond transect. Use your compass to select your starting direction (e.g., 315⁰⁾. Record this as the Compass Bearing on the data sheet for "First 200m leg (A)."

STEP THREE: Take a digital photograph from point 520A along the bearing you will be walking (A→B). Be sure that the reference whiteboard (with the Sample Block Number, Transect leg, compass bearing of the picture, and date written on it) is in the picture. (For the first leg of our example, the whiteboard should show "520A→B, BRG 315⁰ 19AUG09"). Place a check in the <u>start</u> box for Photos on the data sheet for Leg A.

STEP FOUR: Take the *Bouteloua gracilus* presence or absence measure (i.e., put one foot forward and measure (or imagine) a rectangle one meter wide that is bisected by your foot and that extends forward from your foot one half meter --- does **Bogr** exist in this space? If so, record a ☑ the data sheet. If not, record a "0".

STEP FIVE: Pace off 20 m by walking along the compass bearing (= compass direction) that you chose in Step Two. Enter the required data on your record sheet (number of live and dead trees, number of *Liatris* stems, and all skippers observed in the 20-meter segment; repeat the **Bogr** presence test), and then continue along the leg of the transect, repeating these observations every 20 m. Continue until you reach the end of the leg (in this case = 520B). [*Tip: Use of one or more had-counters may simplify the counting process*].

STEP SIX: Take a digital photograph from point 520B back along the way you just walked, i.e., from B→A. (In this case, toward 520A along bearing 135^0 [= 315^0 + 180^0]). Be sure to change the entry on the whiteboard for the photograph (in this example, to "520B→A, BRG 135^0 29AUG09"). Place a check in the <u>finish</u> box for Photos on the data sheet for Leg A.

STEP SEVEN: Repeat the procedures in **Steps ONE – SIX**, to complete leg B (from 520B to 520C). Your new compass bearing will be 90^0 greater than leg A (in this example, the new bearing will be 45^0 [315^0 + 90^0]. Note that you will MARK and LABEL your GPS position at B and record the UTM coordinates of point B on the data sheet before pacing off leg B→C. [*Optional: Create a waypoint of your position at B*]

STEP EIGHT: Repeat the procedures in **Steps ONE – SIX**, to complete leg C (from 520C to 520D). Your new compass bearing will be 90^0 greater than leg B (in this example, the new bearing will be 135^0 [135^0 + 90^0]. Note that you will record the UTM coordinates of point C on the data sheet before pacing off leg D→A. [*Optional: Create a waypoint of your position at B*].

STEP NINE: Repeat the procedures in **Steps ONE – SIX**, to complete leg D (from 520D back to 520A). Your new compass bearing will be 90^0 greater than leg C (in this example, the new bearing will be 225^0 [135^0 + 90^0]. Note that you will record the UTM coordinates of point D on the data sheet before pacing off leg D→A. [*Optional: Create a waypoint of your position at B*].

You're done!!! If you were careful to keep to your compass bearings throughout the diamond transect, and you were accurate in pacing off the four 200-meter legs, (*or used the GPS "GO TO" function between points*) you should end up very close to your starting point (in this case: 520A. If you end up more than 10 m from your starting point, take a GPS reading and record your endpoint and record your estimate of the distance to your original starting point.

[*Optional: If you created a start waypoint (520A) during STEP ONE, you can use this waypoint to see how accurate your transect was. Select GOTO and enter 520A (which you programmed into your GPS unit at the strt of this transect); the distance displayed is the amount by which you "missed" hitting your start position*.]

APPENDIX B

HAYMAN PLOT DATA FROM 2002 THROUGH 2009.

Burn intensity[1]	Plot #	Year	Live trees	Live Trees/ac[2]	Dead Trees	Dead Trees/ac	All Trees/ac	Bogr freq	Lipu[4]	Lipu /ac	Hlm[5]	Hlm /ac	Hco[6]	Hco /ac	Unk[7]	Unk /ac	Total skippers	Total skippers\ac
0	317	2002	288	145.75	0	0.00	145.75	25	25	12.65	0	0.00	0	0.00	0	0.00	0	0.00
0	318	2002	201	101.72	0	0.00	101.72	23	2	1.01	0	0.00	0	0.00	0	0.00	0	0.00
0	324	2002	337	170.55	0	0.00	170.55	13	23	11.64	2	1.01	0	0.00	0	0.00	2	1.01
0	327	2002	469	237.35	0	0.00	237.35	8	1	0.51	0	0.00	0	0.00	0	0.00	0	0.00
0	330	2002	121	61.23	0	0.00	61.23	45	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
0	335	2002	292	147.77	0	0.00	147.77	18	2	1.01	0	0.00	0	0.00	0	0.00	0	0.00
0	339	2002	377	190.79	0	0.00	190.79	15	4	2.02	0	0.00	0	0.00	0	0.00	0	0.00
0	343	2002	120	60.73	0	0.00	60.73	30	49	24.80	0	0.00	0	0.00	0	0.00	0	0.00
0	345	2002	178	90.08	0	0.00	90.08	10	8	4.05	0	0.00	0	0.00	0	0.00	0	0.00
0	347	2002	246	124.49	0	0.00	124.49	35	2	1.01	0	0.00	0	0.00	0	0.00	0	0.00
0	348	2002	384	194.33	0	0.00	194.33	38	1	0.51	0	0.00	0	0.00	0	0.00	0	0.00
0	175	2002	156	78.95	0	0.00	78.95	33	2	1.01	0	0.00	0	0.00	0	0.00	0	0.00
0	185	2002	115	58.20	0	0.00	58.20	10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	337	2002	260	131.58	0	0.00	131.58	43	1	0.51	0	0.00	0	0.00	0	0.00	0	0.00
1	2	2002	41	20.75	0	0.00	20.75	30	1	0.51	0	0.00	0	0.00	0	0.00	0	0.00
1	5	2002	303	153.34	0	0.00	153.34	25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	12	2002	36	18.22	0	0.00	18.22	5	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	13	2002	45	22.77	0	0.00	22.77	25	1	0.51	0	0.00	0	0.00	0	0.00	0	0.00
1	14	2002	48	24.29	0	0.00	24.29	23	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	15	2002	99	50.10	0	0.00	50.10	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	26	2002	88	44.53	0	0.00	44.53	20	4	2.02	0	0.00	0	0.00	0	0.00	0	0.00
1	518	2002	155	78.44	0	0.00	78.44	28	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	521	2002	91	46.05	0	0.00	46.05	23	1	0.51	0	0.00	0	0.00	0	0.00	0	0.00
1	525	2002	81	40.99	0	0.00	40.99	10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	527	2002	91	46.05	0	0.00	46.05	25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	528	2002	58	29.35	0	0.00	29.35	15	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	530	2002	161	81.48	0	0.00	81.48	23	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	532	2002	260	131.58	0	0.00	131.58	30	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	534	2002	494	250.00	0	0.00	250.00	15	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	536	2002	75	37.96	0	0.00	37.96	28	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	538	2002	298	150.81	0	0.00	150.81	25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	539	2002	175	88.56	0	0.00	88.56	20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	540	2002	73	36.94	0	0.00	36.94	38	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	541	2002	318	160.93	0	0.00	160.93	28	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	542	2002	60	30.36	0	0.00	30.36	38	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	544	2002	88	44.53	0	0.00	44.53	30	1	0.51	0	0.00	0	0.00	0	0.00	0	0.00
1	547	2002	404	204.45	0	0.00	204.45	25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	548	2002	184	93.12	0	0.00	93.12	15	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	1	2002	13	6.58	0	0.00	6.58	3	3	1.52	0	0.00	0	0.00	0	0.00	0	0.00
2	3	2002	0	0.00	0	0.00	0.00	10	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	11	2002	0	0.00	0	0.00	0.00	15	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	16	2002	1	0.51	0	0.00	0.51	25	37	18.72	0	0.00	0	0.00	0	0.00	0	0.00
2	17	2002	0	0.00	0	0.00	0.00	3	8	4.05	0	0.00	0	0.00	0	0.00	0	0.00
2	18	2002	0	0.00	0	0.00	0.00	13	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	20	2002	0	0.00	0	0.00	0.00	3	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	21	2002	0	0.00	0	0.00	0.00	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	27	2002	0	0.00	0	0.00	0.00	28	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	31	2002	0	0.00	0	0.00	0.00	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	35	2002	0	0.00	0	0.00	0.00	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	38	2002	0	0.00	0	0.00	0.00	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	23	2002	0	0.00	0	0.00	0.00	3	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Burn intensity[1]	Plot #	Year	Live trees	Live Trees/ac[2]	Dead Trees	Dead Trees/ ac	All Trees/ac	Bogr freq	Lipu[4]	Lipu /ac	Hlm[5]	Hlm /ac	Hco[6]	Hco /ac	Unk[7]	Unk /ac	Total skippers	Total skippers\ac
2	520	2002	1	0.51	0	0.00	0.51	23	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	522	2002	0	0.00	0	0.00	0.00	5	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	523	2002	16	8.10	0	0.00	8.10	23	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	549	2002	0	0.00	0	0.00	0.00	5	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
0	317	2003	22	11.13	3	1.52	12.65	5	127	64.24	0	0.00	0	0.00	0	0.00	0	0.00
0	318	2003	130	65.76	3	1.52	67.28	5	53	26.81	0	0.00	0	0.00	0	0.00	0	0.00
0	324	2003	164	82.96	0	0.00	82.96	2	11	5.56	0	0.00	0	0.00	0	0.00	0	0.00
0	327	2003	126	63.74	0	0.00	63.74	4	100	50.59	0	0.00	0	0.00	0	0.00	0	0.00
0	330	2003	49	24.79	5	2.53	27.32	23	14	7.08	0	0.00	0	0.00	0	0.00	0	0.00
0	335	2003	173	87.51	21	10.62	98.14	3	1	0.51	0	0.00	0	0.00	0	0.00	0	0.00
0	339	2003	464	234.72	5	2.53	237.25	0	52	26.30	1	0.51	0	0.00	0	0.00	1	0.51
0	343	2003	100	50.59	11	5.56	56.15	10	145	73.35	2	1.01	0	0.00	0	0.00	2	1.01
0	345	2003	73	36.93	0	0.00	36.93	15	123	62.22	2	1.01	0	0.00	1	0.51	3	1.52
0	347	2003	278	140.63	7	3.54	144.17	2	27	13.66	0	0.00	1	0.51	0	0.00	1	0.51
0	348	2003	115	58.17	9	4.55	62.73	16	13	6.58	0	0.00	3	1.52	0	0.00	3	1.52
0	320	2003	132	66.77	1	0.51	67.28	12	81	40.97	0	0.00	0	0.00	1	0.51	1	0.51
0	326	2003	99	50.08	8	4.05	54.13	13	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
0	342	2003	276	139.62	0	0.00	139.62	6	27	13.66	0	0.00	0	0.00	0	0.00	0	0.00
1	337	2003	322	162.89	71	35.92	198.80	15	31	15.68	0	0.00	0	0.00	0	0.00	0	0.00
1	2	2003	12	6.07	147	74.36	80.43	9	69	34.90	0	0.00	0	0.00	0	0.00	0	0.00
1	5	2003	66	33.39	9	4.55	37.94	14	11	5.56	0	0.00	0	0.00	0	0.00	0	0.00
1	12	2003	0	0.00	110	55.64	55.64	5	1	0.51	0	0.00	0	0.00	0	0.00	0	0.00
1	13	2003	40	20.23	40	20.23	40.47	16	63	31.87	0	0.00	1	0.51	0	0.00	1	0.51
1	14	2003	30	15.18	54	27.32	42.49	10	47	23.78	0	0.00	0	0.00	0	0.00	0	0.00
1	15	2003	53	26.81	46	23.27	50.08	2	4	2.02	0	0.00	0	0.00	0	0.00	0	0.00
1	26	2003	99	50.08	14	7.08	57.16	10	13	6.58	0	0.00	0	0.00	0	0.00	0	0.00
1	518	2003	145	73.35	13	6.58	79.93	7	3	1.52	0	0.00	0	0.00	0	0.00	0	0.00
1	521	2003	16	8.09	82	41.48	49.57	3	34	17.20	0	0.00	0	0.00	0	0.00	0	0.00
1	525	2003	82	41.48	14	7.08	48.56	8	20	10.12	0	0.00	0	0.00	0	0.00	0	0.00
1	527	2003	79	39.96	41	20.74	60.70	1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	528	2003	112	56.66	117	59.19	115.84	4	28	14.16	0	0.00	0	0.00	0	0.00	0	0.00
1	530	2003	119	60.20	1	0.51	60.70	13	75	37.94	0	0.00	0	0.00	0	0.00	0	0.00
1	532	2003	105	53.12	52	26.30	79.42	4	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	534	2003	290	146.70	55	27.82	174.52	1	2	1.01	0	0.00	0	0.00	0	0.00	0	0.00
1	536	2003	42	21.25	32	16.19	37.43	8	15	7.59	0	0.00	0	0.00	0	0.00	0	0.00
1	538	2003	168	84.98	3	1.52	86.50	6	7	3.54	0	0.00	0	0.00	0	0.00	0	0.00
1	539	2003	70	35.41	3	1.52	36.93	7	2	1.01	1	0.51	0	0.00	0	0.00	1	0.51
1	540	2003	12	6.07	109	55.14	61.21	7	33	16.69	0	0.00	0	0.00	0	0.00	0	0.00
1	541	2003	115	58.17	56	28.33	86.50	5	15	7.59	0	0.00	0	0.00	0	0.00	0	0.00
1	542	2003	49	24.79	7	3.54	28.33	17	3	1.52	0	0.00	0	0.00	0	0.00	0	0.00
1	544	2003	43	21.75	61	30.86	52.61	8	57	28.83	0	0.00	0	0.00	0	0.00	0	0.00
1	547	2003	95	48.06	36	18.21	66.27	10	100	50.59	2	1.01	0	0.00	0	0.00	2	1.01
1	548	2003	195	98.64	181	91.56	190.20	3	4	2.02	1	0.51	0	0.00	0	0.00	1	0.51
2	1	2003	1	0.51	87	44.01	44.52	5	119	60.20	0	0.00	0	0.00	0	0.00	0	0.00
2	3	2003	2	1.01	180	91.05	92.07	14	45	22.76	0	0.00	0	0.00	0	0.00	0	0.00
2	11	2003	0	0.00	74	37.43	37.43	7	36	18.21	0	0.00	0	0.00	1	0.51	1	0.51
2	16	2003	0	0.00	62	31.36	31.36	2	38	19.22	0	0.00	0	0.00	0	0.00	0	0.00
2	17	2003	0	0.00	147	74.36	74.36	2	7	3.54	0	0.00	0	0.00	0	0.00	0	0.00
2	18	2003	0	0.00	53	26.81	26.81	11	44	22.26	0	0.00	0	0.00	0	0.00	0	0.00
2	20	2003	0	0.00	116	58.68	58.68	7	78	39.46	0	0.00	0	0.00	0	0.00	0	0.00
2	21	2003	0	0.00	96	48.56	48.56	5	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	27	2003	0	0.00	66	33.39	33.39	6	94	47.55	0	0.00	0	0.00	0	0.00	0	0.00
2	31	2003	0	0.00	117	59.19	59.19	6	24	12.14	0	0.00	0	0.00	0	0.00	0	0.00
2	35	2003	0	0.00	27	13.66	13.66	5	8	4.05	0	0.00	0	0.00	0	0.00	0	0.00
2	38	2003	6	3.04	200	101.1	104.21	6	4	2.02	0	0.00	0	0.00	0	0.00	0	0.00
2	23	2003	0	0.00	115	58.17	58.17	9	23	11.63	0	0.00	0	0.00	0	0.00	0	0.00
2	520	2003	1	0.51	163	82.46	82.96	5	24	12.14	0	0.00	0	0.00	0	0.00	0	0.00

Burn intensity[1]	Plot #	Year	Live trees	Live Trees/ac[2]	Dead Trees	Dead Trees/ ac	All Trees/ac	Bogr freq	Lipu[4]	Lipu /ac	Hlm[5]	Hlm /ac	Hco[6]	Hco /ac	Unk[7]	Unk /ac	Total skippers	Total skippers\ac
2	522	2003	0	0.00	181	91.56	91.56	1	89	45.02	0	0.00	0	0.00	0	0.00	0	0.00
2	523	2003	0	0.00	191	96.62	96.62	4	42	21.25	1	0.51	1	0.51	1	0.51	3	1.52
2	549	2003	0	0.00	214	108.2	108.25	3	14	7.08	0	0.00	0	0.00	0	0.00	0	0.00
0	317	2004	33	16.69	3	1.52	18.21	10	494	249.89	0	0.00	0	0.00	0	0.00	0	0.00
0	318	2004	122	61.71	0	0.00	61.71	5	38	19.22	1	0.51	0	0.00	0	0.00	1	0.51
0	320	2004	255	128.99	8	4.05	133.04	18	101	51.09	4	2.02	6	3.04	2	1.01	12	6.07
0	324	2004	93	47.04	4	2.02	49.07	26	32	16.19	0	0.00	0	0.00	3	1.52	3	1.52
0	330	2004	66	33.39	1	0.51	33.89	23	28	14.16	3	1.52	1	0.51	0	0.00	4	2.02
0	335	2004	377	190.71	58	29.34	220.05	1	7	3.54	0	0.00	4	2.02	2	1.01	6	3.04
0	339	2004	98	49.57	1	0.51	50.08	8	172	87.01	5	2.53	13	6.58	10	5.06	28	14.16
0	342	2004	265	134.05	8	4.05	138.10	8	153	77.40	0	0.00	1	0.51	2	1.01	3	1.52
0	343	2004	136	68.80	13	6.58	75.37	13	85	43.00	2	1.01	1	0.51	0	0.00	3	1.52
0	345	2004	85	43.00	1	0.51	43.50	8	417	210.94	1	0.51	1	0.51	30	15.18	32	16.19
0	347	2004	298	150.75	20	10.12	160.86	10	31	15.68	2	1.01	5	2.53	5	2.53	12	6.07
1	2	2004	0	0.00	111	56.15	56.15	8	257	130.01	0	0.00	0	0.00	0	0.00	0	0.00
1	5	2004	17	8.60	25	12.65	21.25	3	5	2.53	0	0.00	0	0.00	0	0.00	0	0.00
1	12	2004	0	0.00	205	103.7	103.70	5	36	18.21	0	0.00	0	0.00	0	0.00	0	0.00
1	13	2004	72	36.42	74	37.43	73.86	8	68	34.40	0	0.00	0	0.00	2	1.01	2	1.01
1	14	2004	32	16.19	97	49.07	65.26	8	357	180.59	1	0.51	0	0.00	0	0.00	1	0.51
1	15	2004	183	92.57	92	46.54	139.11	9	173	87.51	0	0.00	1	0.51	0	0.00	1	0.51
1	26	2004	161	81.44	4	2.02	83.47	9	166	83.97	1	0.51	2	1.01	1	0.51	4	2.02
1	337	2004	185	93.58	13	6.58	100.16	9	38	19.22	0	0.00	0	0.00	2	1.01	2	1.01
1	518	2004	114	57.67	47	23.78	81.44	43	99	50.08	1	0.51	2	1.01	3	1.52	6	3.04
1	521	2004	176	89.03	55	27.82	116.85	15	285	144.17	0	0.00	1	0.51	1	0.51	2	1.01
1	525	2004	172	87.01	85	43.00	130.01	4	298	150.75	0	0.00	0	0.00	0	0.00	0	0.00
1	527	2004	379	191.72	154	77.90	269.62	15	14	7.08	0	0.00	2	1.01	1	0.51	3	1.52
1	528	2004	242	122.42	63	31.87	154.29	10	91	46.03	0	0.00	0	0.00	0	0.00	0	0.00
1	530	2004	158	79.93	5	2.53	82.46	19	300	151.76	11	5.56	0	0.00	0	0.00	11	5.56
1	534	2004	249	125.96	27	13.66	139.62	6	228	115.34	0	0.00	0	0.00	0	0.00	0	0.00
1	538	2004	205	103.70	12	6.07	109.77	10	28	14.16	3	1.52	0	0.00	0	0.00	3	1.52
1	540	2004	6	3.04	57	28.83	31.87	12	423	213.98	0	0.00	0	0.00	0	0.00	0	0.00
1	544	2004	67	33.89	92	46.54	80.43	15	112	56.66	1	0.51	1	0.51	0	0.00	2	1.01
1	547	2004	103	52.10	84	42.49	94.60	13	121	61.21	7	3.54	6	3.04	3	1.52	16	8.09
1	548	2004	145	73.35	103	52.10	125.45	3	58	29.34	1	0.51	0	0.00	0	0.00	1	0.51
2	1	2004	0	0.00	138	69.81	69.81	8	1062	537.22	0	0.00	0	0.00	2	1.01	2	1.01
2	3	2004	0	0.00	185	93.58	93.58	12	13	6.58	0	0.00	0	0.00	0	0.00	0	0.00
2	11	2004	0	0.00	45	22.76	22.76	12	115	58.17	0	0.00	0	0.00	0	0.00	0	0.00
2	16	2004	10	5.06	20	10.12	15.18	94	152	76.89	0	0.00	0	0.00	0	0.00	0	0.00
2	17	2004	0	0.00	130	65.76	65.76	0	285	144.17	0	0.00	0	0.00	0	0.00	0	0.00
2	18	2004	0	0.00	90	45.53	45.53	14	49	24.79	0	0.00	0	0.00	0	0.00	0	0.00
2	20	2004	0	0.00	196	99.15	99.15	1	2	1.01	0	0.00	0	0.00	0	0.00	0	0.00
2	23	2004	0	0.00	84	42.49	42.49	6	61	30.86	0	0.00	0	0.00	0	0.00	0	0.00
2	27	2004	18	9.11	56	28.33	37.43	48	321	162.38	0	0.00	0	0.00	0	0.00	0	0.00
2	31	2004	0	0.00	30	15.18	15.18	11	11	5.56	0	0.00	0	0.00	0	0.00	0	0.00
2	35	2004	0	0.00	71	35.92	35.92	3	15	7.59	0	0.00	0	0.00	0	0.00	0	0.00
2	38	2004	0	0.00	106	53.62	53.62	8	52	26.30	0	0.00	0	0.00	0	0.00	0	0.00
2	520	2004	35	17.71	192	97.12	114.83	2	62	31.36	0	0.00	0	0.00	0	0.00	0	0.00
2	522	2004	0	0.00	195	98.64	98.64	17	37	18.72	0	0.00	0	0.00	0	0.00	0	0.00
2	523	2004	0	0.00	196	99.15	99.15	4	126	63.74	0	0.00	0	0.00	0	0.00	0	0.00
0	317	2005	66	33.39	16	8.09	41.48	21	1284	649.52	0	0.00	2	1.01	9	4.55	11	5.56
0	318	2005	173	87.51	7	3.54	91.05	24	643	325.27	0	0.00	0	0.00	4	2.02	4	2.02
0	320	2005	210	106.23	2	1.01	107.24	5	48	24.28	8	4.05	2	1.01	2	1.01	12	6.07
0	324	2005	112	56.66	4	2.02	58.68	1	64	32.37	0	0.00	6	3.04	8	4.05	14	7.08
0	326	2005	164	82.96	5	2.53	85.49	8	0	0.00	3	1.52	5	2.53	5	2.53	13	6.58
0	327	2005	118	59.69	0	0.00	59.69	3	424	214.48	0	0.00	4	2.02	17	8.60	21	10.62
0	330	2005	69	34.90	0	0.00	34.90	10	0	0.00	0	0.00	2	1.01	7	3.54	9	4.55
0	333	2005	159	80.43	0	0.00	80.43	13	263	133.04	4	2.02	0	0.00	5	2.53	9	4.55

Burn intensity[1]	Plot #	Year	Live trees	Live Trees/ac[2]	Dead Trees	Dead Trees/ ac	All Trees/ac	Bogr freq	Lipu[4]	Lipu /ac	Hlm[5]	Hlm /ac	Hco[6]	Hco /ac	Unk[7]	Unk /ac	Total skippers	Total skippers\ac
0	335	2005	206	104.21	21	10.62	114.83	5	24	12.14	4	2.02	12	6.07	13	6.58	29	14.67
0	339	2005	133	67.28	2	1.01	68.29	3	374	189.19	1	0.51	15	7.59	15	7.59	31	15.68
0	342	2005	246	124.44	6	3.04	127.48	5	60	30.35	0	0.00	2	1.01	3	1.52	5	2.53
0	343	2005	72	36.42	17	8.60	45.02	14	320	161.87	12	6.07	4	2.02	16	8.09	32	16.19
0	345	2005	89	45.02	2	1.01	46.03	6	360	182.11	7	3.54	9	4.55	16	8.09	32	16.19
0	347	2005	175	88.53	0	0.00	88.53	16	473	239.27	10	5.06	7	3.54	0	0.00	17	8.60
0	348	2005	185	93.58	4	2.02	95.61	12	17	8.60	0	0.00	10	5.06	3	1.52	13	6.58
1	2	2005	25	12.65	88	44.52	57.16	0	563	284.80	0	0.00	0	0.00	4	2.02	4	2.02
1	5	2005	27	13.66	40	20.23	33.89	9	256	129.50	0	0.00	0	0.00	0	0.00	0	0.00
1	15	2005	133	67.28	57	28.83	96.11	7	128	64.75	0	0.00	3	1.52	0	0.00	3	1.52
1	518	2005	136	68.80	14	7.08	75.88	4	275	139.11	7	3.54	3	1.52	20	10.12	30	15.18
1	521	2005	74	37.43	33	16.69	54.13	12	484	244.84	3	1.52	3	1.52	3	1.52	9	4.55
1	525	2005	44	22.26	13	6.58	28.83	6	206	104.21	2	1.01	0	0.00	8	4.05	10	5.06
1	527	2005	253	127.98	169	85.49	213.47	8	18	9.11	0	0.00	0	0.00	1	0.51	1	0.51
1	528	2005	131	66.27	50	25.29	91.56	12	108	54.63	0	0.00	0	0.00	4	2.02	4	2.02
1	530	2005	294	148.72	157	79.42	228.14	10	155	78.41	4	2.02	2	1.01	10	5.06	16	8.09
1	532	2005	123	62.22	9	4.55	66.77	9	52	26.30	0	0.00	0	0.00	0	0.00	0	0.00
1	534	2005	95	48.06	37	18.72	66.77	3	397	200.83	4	2.02	3	1.52	1	0.51	8	4.05
1	538	2005	101	51.09	7	3.54	54.63	4	86	43.50	0	0.00	0	0.00	4	2.02	4	2.02
1	539	2005	68	34.40	14	7.08	41.48	8	73	36.93	1	0.51	1	0.51	1	0.51	3	1.52
1	540	2005	38	19.22	55	27.82	47.04	17	176	89.03	0	0.00	0	0.00	3	1.52	3	1.52
1	541	2005	76	38.45	35	17.71	56.15	11	18	9.11	3	1.52	4	2.02	1	0.51	8	4.05
1	542	2005	102	51.60	19	9.61	61.21	24	77	38.95	2	1.01	4	2.02	10	5.06	16	8.09
1	544	2005	79	39.96	52	26.30	66.27	18	495	250.40	2	1.01	6	3.04	12	6.07	20	10.12
1	547	2005	138	69.81	27	13.66	83.47	12	381	192.73	16	8.09	5	2.53	13	6.58	34	17.20
1	548	2005	58	29.34	41	20.74	50.08	6	229	115.84	2	1.01	1	0.51	20	10.12	23	11.63
2	1	2005	0	0.00	163	82.46	82.46	1	783	396.09	0	0.00	0	0.00	0	0.00	0	0.00
2	3	2005	4	2.02	122	61.71	63.74	9	366	185.14	0	0.00	0	0.00	3	1.52	3	1.52
2	11	2005	0	0.00	45	22.76	22.76	11	222	112.30	0	0.00	0	0.00	0	0.00	0	0.00
2	16	2005	0	0.00	21	10.62	10.62	9	694	351.07	0	0.00	1	0.51	5	2.53	6	3.04
2	17	2005	18	9.11	116	58.68	67.79	5	221	111.79	0	0.00	0	0.00	0	0.00	0	0.00
2	18	2005	0	0.00	42	21.25	21.25	14	708	358.15	0	0.00	0	0.00	0	0.00	0	0.00
2	20	2005	0	0.00	47	23.78	23.78	3	1110	561.50	0	0.00	0	0.00	0	0.00	0	0.00
2	21	2005	0	0.00	101	51.09	51.09	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	23	2005	0	0.00	127	64.24	64.24	13	67	33.89	0	0.00	0	0.00	0	0.00	0	0.00
2	27	2005	0	0.00	82	41.48	41.48	18	841	425.43	0	0.00	0	0.00	0	0.00	0	0.00
2	31	2005	0	0.00	85	43.00	43.00	18	373	188.69	0	0.00	0	0.00	0	0.00	0	0.00
2	35	2005	0	0.00	43	21.75	21.75	4	101	51.09	0	0.00	0	0.00	0	0.00	0	0.00
2	38	2005	2	1.01	75	37.94	38.95	8	245	123.94	0	0.00	0	0.00	0	0.00	0	0.00
2	49	2005	0	0.00	136	68.80	68.80	2	858	434.03	0	0.00	0	0.00	0	0.00	0	0.00
2	520	2005	0	0.00	139	70.31	70.31	12	186	94.09	0	0.00	2	1.01	3	1.52	5	2.53
2	522	2005	0	0.00	114	57.67	57.67	16	369	186.66	0	0.00	2	1.01	6	3.04	8	4.05
2	523	2005	11	5.56	83	41.99	47.55	12	127	64.24	0	0.00	1	0.51	1	0.51	2	1.01
2	549	2005	2	1.01	137	69.30	70.31	11	502	253.94	3	1.52	1	0.51	12	6.07	16	8.09
2	568	2005	13	6.58	442	223.5	230.17	16	220	111.29	0	0.00	0	0.00	0	0.00	0	0.00
0	320	2006	219	110.78	2	1.01	111.79	8	60	30.35	6	3.04	3	1.52	7	3.54	16	8.09
0	330	2006	83	41.99	2	1.01	43.00	23	4	2.02	0	0.00	0	0.00	0	0.00	0	0.00
0	339	2006	133	67.28	6	3.04	70.31	11	154	77.90	1	0.51	0	0.00	0	0.00	1	0.51
0	342	2006	239	120.90	0	0.00	120.90	4	7	3.54	3	1.52	2	1.01	0	0.00	5	2.53
0	343	2006	122	61.71	15	7.59	69.30	15	52	26.30	0	0.00	1	0.51	0	0.00	1	0.51
0	347	2006	118	59.69	1	0.51	60.20	13	296	149.73	2	1.01	0	0.00	4	2.02	6	3.04
1	2	2006	27	13.66	87	44.01	57.67	11	10	5.06	0	0.00	1	0.51	0	0.00	1	0.51
1	15	2006	126	63.74	46	23.27	87.01	16	13	6.58	1	0.51	0	0.00	0	0.00	1	0.51
1	518	2006	126	63.74	28	14.16	77.90	15	164	82.96	3	1.52	0	0.00	2	1.01	5	2.53
1	521	2006	69	34.90	70	35.41	70.31	9	108	54.63	1	0.51	0	0.00	0	0.00	1	0.51
1	525	2006	113	57.16	10	5.06	62.22	13	31	15.68	1	0.51	0	0.00	1	0.51	2	1.01
1	528	2006	79	39.96	147	74.36	114.32	8	90	45.53	1	0.51	1	0.51	3	1.52	5	2.53

Burn intensity[1]	Plot #	Year	Live trees	Live Trees/ac[2]	Dead Trees	Dead Trees/ ac	All Trees/ac	Bogr freq	Lipu[4]	Lipu /ac	Hlm[5]	Hlm /ac	Hco[6]	Hco /ac	Unk[7]	Unk /ac	Total skippers	Total skippers\ac
1	530	2006	169	85.49	6	3.04	88.53	17	138	69.81	8	4.05	3	1.52	5	2.53	16	8.09
1	534	2006	146	73.86	32	16.19	90.04	9	315	159.35	0	0.00	0	0.00	0	0.00	0	0.00
1	538	2006	241	121.91	22	11.13	133.04	14	14	7.08	1	0.51	0	0.00	3	1.52	4	2.02
1	540	2006	59	29.85	63	31.87	61.71	10	82	41.48	0	0.00	1	0.51	0	0.00	1	0.51
1	547	2006	62	31.36	38	19.22	50.59	10	142	71.83	0	0.00	0	0.00	1	0.51	1	0.51
1	548	2006	80	40.47	78	39.46	79.93	10	79	39.96	0	0.00	1	0.51	0	0.00	1	0.51
2	3	2006	7	3.54	96	48.56	52.10	23	16	8.09	0	0.00	0	0.00	0	0.00	0	0.00
2	11	2006	0	0.00	78	39.46	39.46	12	105	53.12	0	0.00	0	0.00	0	0.00	0	0.00
2	16	2006	0	0.00	38	19.22	19.22	6	216	109.27	0	0.00	0	0.00	0	0.00	0	0.00
2	17	2006	0	0.00	70	35.41	35.41	1	111	56.15	0	0.00	0	0.00	0	0.00	0	0.00
2	18	2006	0	0.00	44	22.26	22.26	24	128	64.75	0	0.00	0	0.00	0	0.00	0	0.00
2	20	2006	0	0.00	100	50.59	50.59	4	162	81.95	0	0.00	0	0.00	0	0.00	0	0.00
2	23	2006	0	0.00	112	56.66	56.66	12	88	44.52	0	0.00	0	0.00	1	0.51	1	0.51
2	27	2006	0	0.00	66	33.39	33.39	7	22	11.13	0	0.00	0	0.00	0	0.00	0	0.00
2	31	2006	0	0.00	71	35.92	35.92	30	40	20.23	0	0.00	0	0.00	0	0.00	0	0.00
2	38	2006	0	0.00	112	56.66	56.66	5	1	0.51	0	0.00	0	0.00	0	0.00	0	0.00
2	520	2006	0	0.00	104	52.61	52.61	14	106	53.62	0	0.00	1	0.51	0	0.00	1	0.51
2	522	2006	0	0.00	157	79.42	79.42	26	106	53.62	2	1.01	0	0.00	5	2.53	7	3.54
2	523	2006	0	0.00	83	41.99	41.99	8	65	32.88	1	0.51	2	1.01	1	0.51	4	2.02
0	320	2007	218	110.28	2	1.01	111.29	10	51	25.80	10	5.06	2	1.01	2	1.01	14	7.08
0	330	2007	169	85.49	0	0.00	85.49	26	0	0.00	1	0.51	1	0.51	2	1.01	4	2.02
0	343	2007	174	88.02	8	4.05	92.07	16	31	15.68	1	0.51	0	0.00	1	0.51	2	1.01
0	347	2007	191	96.62	18	9.11	105.72	9	4	2.02	1	0.51	1	0.51	0	0.00	2	1.01
1	2	2007	18	9.11	61	30.86	39.96	5	11	5.56	2	1.01	0	0.00	1	0.51	3	1.52
1	5	2007	45	22.76	9	4.55	27.32	17	103	52.10	0	0.00	0	0.00	1	0.51	1	0.51
1	8	2007	50	25.29	27	13.66	38.95	3	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	15	2007	133	67.28	63	31.87	99.15	9	31	15.68	3	1.52	0	0.00	0	0.00	3	1.52
1	518	2007	123	62.22	75	37.94	100.16	10	185	93.58	0	0.00	0	0.00	1	0.51	1	0.51
1	521	2007	83	41.99	52	26.30	68.29	21	145	73.35	1	0.51	0	0.00	1	0.51	2	1.01
1	525	2007	112	56.66	19	9.61	66.27	12	79	39.96	2	1.01	0	0.00	0	0.00	2	1.01
1	528	2007	54	27.32	111	56.15	83.47	8	247	124.95	1	0.51	1	0.51	0	0.00	2	1.01
1	530	2007	217	109.77	40	20.23	130.01	7	123	62.22	3	1.52	2	1.01	5	2.53	10	5.06
1	534	2007	118	59.69	39	19.73	79.42	8	66	33.39	2	1.01	0	0.00	1	0.51	3	1.52
1	538	2007	238	120.39	11	5.56	125.96	10	36	18.21	5	2.53	1	0.51	2	1.01	8	4.05
1	540	2007	79	39.96	133	67.28	107.24	13	72	36.42	1	0.51	0	0.00	0	0.00	1	0.51
1	547	2007	134	67.79	72	36.42	104.21	7	317	160.36	2	1.01	0	0.00	0	0.00	2	1.01
1	548	2007	71	35.92	35	17.71	53.62	7	25	12.65	1	0.51	1	0.51	0	0.00	2	1.01
2	3	2007	0	0.00	209	105.7	105.72	14	34	17.20	0	0.00	1	0.51	1	0.51	2	1.01
2	11	2007	0	0.00	86	43.50	43.50	18	21	10.62	0	0.00	0	0.00	1	0.51	1	0.51
2	16	2007	0	0.00	33	16.69	16.69	12	45	22.76	0	0.00	0	0.00	0	0.00	0	0.00
2	17	2007	0	0.00	82	41.48	41.48	3	57	28.83	1	0.51	0	0.00	2	1.01	3	1.52
2	18	2007	0	0.00	43	21.75	21.75	11	16	8.09	0	0.00	0	0.00	0	0.00	0	0.00
2	20	2007	0	0.00	55	27.82	27.82	0	75	37.94	0	0.00	0	0.00	0	0.00	0	0.00
2	23	2007	0	0.00	98	49.57	49.57	12	19	9.61	0	0.00	0	0.00	0	0.00	0	0.00
2	27	2007	0	0.00	38	19.22	19.22	8	102	51.60	4	2.02	0	0.00	2	1.01	6	3.04
2	31	2007	0	0.00	121	61.21	61.21	16	80	40.47	0	0.00	0	0.00	1	0.51	1	0.51
2	38	2007	0	0.00	213	107.7	107.75	1	29	14.67	0	0.00	0	0.00	0	0.00	0	0.00
2	520	2007	20	10.12	152	76.89	87.01	14	124	62.73	0	0.00	0	0.00	0	0.00	0	0.00
2	522	2007	0	0.00	81	40.97	40.97	27	119	60.20	12	6.07	0	0.00	1	0.51	13	6.58
2	523	2007	0	0.00	146	73.86	73.86	5	33	16.69	0	0.00	0	0.00	1	0.51	1	0.51
2	549	2007	0	0.00	170	86.00	86.00	3	269	136.08	0	0.00	0	0.00	0	0.00	0	0.00
0	330	2008	89	45.02	2	1.01	46.03	23	26	13.15	3	1.52	0	0.00	1	0.51	4	2.02
0	343	2008	152	76.89	16	8.09	84.98	20	315	159.35	5	2.53	0	0.00	1	0.51	6	3.04
0	320	2008	354	179.07	2	1.01	180.09	13	11	5.56	1	0.51	0	0.00	1	0.51	2	1.01
0	347	2008	110	55.64	0	0.00	55.64	6	113	57.16	4	2.02	1	0.51	2	1.01	7	3.54
1	518	2008	129	65.26	25	12.65	77.90	9	168	84.98	4	2.02	0	0.00	4	2.02	8	4.05
1	525	2008	65	32.88	16	8.09	40.97	11	190	96.11	2	1.01	0	0.00	0	0.00	2	1.01

Burn intensity[1]	Plot #	Year	Live trees	Live Trees/ac[2]	Dead Trees	Dead Trees/ ac	All Trees/ac	Bogr freq	Lipu[4]	Lipu /ac	Hlm[5]	Hlm /ac	Hco[6]	Hco /ac	Unk[7]	Unk /ac	Total skippers	Total skippers\ac
1	528	2008	50	25.29	82	41.48	66.77	9	167	84.48	2	1.01	0	0.00	0	0.00	2	1.01
1	530	2008	147	74.36	20	10.12	84.48	6	68	34.40	2	1.01	1	0.51	2	1.01	5	2.53
1	547	2008	102	51.60	56	28.33	79.93	6	76	38.45	2	1.01	0	0.00	0	0.00	2	1.01
1	2	2008	0	0.00	45	22.76	22.76	16	197	99.65	1	0.51	0	0.00	0	0.00	1	0.51
1	5	2008	42	21.25	7	3.54	24.79	17	74	37.43	0	0.00	1	0.51	0	0.00	1	0.51
1	8	2008	57	28.83	36	18.21	47.04	6	6	3.04	7	3.54	1	0.51	6	3.04	14	7.08
1	521	2008	47	23.78	52	26.30	50.08	23	159	80.43	2	1.01	0	0.00	2	1.01	4	2.02
1	534	2008	135	68.29	46	23.27	91.56	11	605	306.04	1	0.51	0	0.00	0	0.00	1	0.51
1	540	2008	56	28.33	54	27.32	55.64	14	59	29.85	1	0.51	0	0.00	0	0.00	1	0.51
1	548	2008	41	20.74	32	16.19	36.93	3	94	47.55	0	0.00	1	0.51	2	1.01	3	1.52
1	538	2008	330	166.93	29	14.67	181.60	42	0	0.00	0	0.00	1	0.51	4	2.02	5	2.53
1	15	2008	92	46.54	58	29.34	75.88	10	71	35.92	0	0.00	1	0.51	1	0.51	2	1.01
2	520	2008	0	0.00	96	48.56	48.56	0	246	124.44	3	1.52	8	4.05	9	4.55	20	10.12
2	20	2008	0	0.00	66	33.39	33.39	10	800	404.69	3	1.52	1	0.51	1	0.51	5	2.53
2	523	2008	0	0.00	69	34.90	34.90	8	115	58.17	4	2.02	0	0.00	4	2.02	8	4.05
2	3	2008	0	0.00	116	58.68	58.68	21	135	68.29	0	0.00	0	0.00	0	0.00	0	0.00
2	18	2008	0	0.00	35	17.71	17.71	21	132	66.77	1	0.51	0	0.00	0	0.00	1	0.51
2	11	2008	0	0.00	71	35.92	35.92	15	27	13.66	0	0.00	0	0.00	1	0.51	1	0.51
2	23	2008	0	0.00	66	33.39	33.39	25	108	54.63	2	1.01	0	0.00	0	0.00	2	1.01
2	27	2008	0	0.00	30	15.18	15.18	11	205	103.70	10	5.06	0	0.00	7	3.54	17	8.60
2	31	2008	0	0.00	64	32.37	32.37	23	70	35.41	0	0.00	0	0.00	0	0.00	0	0.00
2	38	2008	0	0.00	120	60.70	60.70	5	11	5.56	0	0.00	0	0.00	0	0.00	0	0.00
2	16	2008	0	0.00	37	18.72	18.72	16	100	50.59	1	0.51	0	0.00	1	0.51	2	1.01
2	17	2008	0	0.00	73	36.93	36.93	3	111	56.15	0	0.00	0	0.00	0	0.00	0	0.00
2	522	2008	0	0.00	58	29.34	29.34	26	52	26.30	1	0.51	0	0.00	7	3.54	8	4.05
2	549	2008	5	2.53	66	33.39	35.92	11	80	40.47	0	0.00	1	0.51	0	0.00	1	0.51
0	320	2009	108	54.63	0	0.00	54.63	11	183	92.57	4	2.02	1	0.51	4	2.02	9	4.55
0	330	2009	79	39.96	3	1.52	41.48	15	77	38.95	2	1.01	1	0.51	0	0.00	3	1.52
0	343	2009	87	44.01	8	4.05	48.06	16	196	99.15	3	1.52	0	0.00	2	1.01	5	2.53
0	347	2009	147	74.36	17	8.60	82.96	12	184	93.08	3	1.52	0	0.00	0	0.00	3	1.52
1	2	2009	20	10.12	18	9.11	19.22	12	302	152.77	5	2.53	1	0.51	0	0.00	6	3.04
1	5	2009	46	23.27	11	5.56	28.83	19	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1	8	2009	206	104.21	39	19.73	123.94	6	21	10.62	2	1.01	0	0.00	0	0.00	2	1.01
1	15	2009	115	58.17	83	41.99	100.16	8	83	41.99	0	0.00	1	0.51	0	0.00	1	0.51
1	518	2009	214	108.25	36	18.21	126.46	11	536	271.14	2	1.01	0	0.00	12	6.07	14	7.08
1	521	2009	70	35.41	38	19.22	54.63	19	612	309.59	3	1.52	0	0.00	3	1.52	6	3.04
1	525	2009	92	46.54	9	4.55	51.09	7	219	110.78	7	3.54	0	0.00	0	0.00	7	3.54
1	528	2009	80	40.47	90	45.53	86.00	12	747	377.88	2	1.01	0	0.00	0	0.00	2	1.01
1	530	2009	176	89.03	18	9.11	98.14	9	160	80.94	1	0.51	1	0.51	0	0.00	2	1.01
1	534	2009	121	61.21	22	11.13	72.34	5	980	495.74	4	2.02	3	1.52	2	1.01	9	4.55
1	538	2009	184	93.08	22	11.13	104.21	11	123	62.22	0	0.00	0	0.00	1	0.51	1	0.51
1	540	2009	55	27.82	0	0.00	27.82	23	364	184.13	0	0.00	1	0.51	2	1.01	3	1.52
1	547	2009	125	63.23	57	28.83	92.07	12	271	137.09	1	0.51	0	0.00	6	3.04	7	3.54
1	548	2009	73	36.93	46	23.27	60.20	10	285	144.17	3	1.52	1	0.51	5	2.53	9	4.55
2	3	2009	0	0.00	119	60.20	60.20	15	118	59.69	3	1.52	1	0.51	2	1.01	6	3.04
2	11	2009	0	0.00	35	17.71	17.71	18	142	71.83	0	0.00	0	0.00	2	1.01	2	1.01
2	16	2009	0	0.00	29	14.67	14.67	5	140	70.82	0	0.00	0	0.00	0	0.00	0	0.00
2	17	2009	0	0.00	71	35.92	35.92	4	85	43.00	0	0.00	0	0.00	0	0.00	0	0.00
2	18	2009	0	0.00	27	13.66	13.66	23	488	246.86	0	0.00	0	0.00	0	0.00	0	0.00
2	20	2009	0	0.00	40	20.23	20.23	1	599	303.01	0	0.00	0	0.00	0	0.00	0	0.00
2	23	2009	0	0.00	62	31.36	31.36	17	23	11.63	2	1.01	0	0.00	0	0.00	2	1.01
2	27	2009	0	0.00	14	7.08	7.08	10	405	204.87	4	2.02	1	0.51	0	0.00	5	2.53
2	31	2009	0	0.00	63	31.87	31.87	48	188	95.10	0	0.00	0	0.00	1	0.51	1	0.51
2	38	2009	0	0.00	113	57.16	57.16	5	36	18.21	1	0.51	0	0.00	0	0.00	1	0.51
2	520	2009	55	27.82	101	51.09	78.91	10	624	315.66	0	0.00	0	0.00	0	0.00	0	0.00
2	522	2009	0	0.00	69	34.90	34.90	24	203	102.69	2	1.01	0	0.00	2	1.01	4	2.02
2	523	2009	0	0.00	130	65.76	65.76	11	256	129.50	1	0.51	0	0.00	1	0.51	2	1.01

Burn intensity[1]	Plot #	Year	Live trees	Live Trees/ac[2]	Dead Trees	Dead Trees/ ac	All Trees/ac	Bogr freq	Lipu[4]	Lipu /ac	Hlm[5]	Hlm /ac	Hco[6]	Hco /ac	Unk[7]	Unk /ac	Total skippers	Total skippers\ac
2	549	2009	0	0.00	69	34.90	34.90	46	636	321.73	1	0.51	0	0.00	0	0.00	1	0.51

[1] 0 = unburned; 1 = low intensity burn; 2 = moderate-to-high intensity burn.
[2] ac = acre.
[3] Bogr Freq = Frequency of *Bouteloua gricilis*.
[4] Lipu = the adult nectar plant *Liatris punctata*.
[5] Hlm = *Hesperia leonardus montana*.
[6] Hco = *Hesperia comma*.
[7] UNK = an unidentified skipper of either species, *Hesperia leonardus montana* or *Hesperia comma*

APPENDIX C

PAWNEE MONTANE SKIPPER COUNTS FROM 2002 THROUGH 2009 FOR BURNED TRANSECTS WITH THE DISTANCE THAT EACH IS TO UNBURNED SUITABLE SKIPPER HABITAT.

Plot	Year	Burn intensity[1]	Hlm count	Distance category	Distance (m) to unburned habitat
2	2002	1	0	193	0-200
15	2002	1	0	34	0-200
26	2002	1	0	34	0-200
337	2002	1	0	10	0-200
518	2002	1	0	10	0-200
525	2002	1	0	10	0-200
527	2002	1	0	10	0-200
530	2002	1	0	96	0-200
532	2002	1	0	10	0-200
534	2002	1	0	77	0-200
538	2002	1	0	10	0-200
539	2002	1	0	39	0-200
541	2002	1	0	110	0-200
542	2002	1	0	45	0-200
547	2002	1	0	10	0-200
548	2002	1	0	105	0-200
5	2002	1	0	385	200-500
521	2002	1	0	242	200-500
528	2002	1	0	238	200-500
540	2002	1	0	355	200-500
544	2002	1	0	483	200-500
12	2002	1	0	913	500+
13	2002	1	0	832	500+
14	2002	1	0	974	500+
536	2002	1	0	840	500+
520	2002	2	0	285	200-500
522	2002	2	0	376	200-500
523	2002	2	0	233	200-500
549	2002	2	0	283	200-500
1	2002	2	0	570	500+
3	2002	2	0	787	500+
11	2002	2	0	792	500+
16	2002	2	0	1747	500+
17	2002	2	0	2675	500+
18	2002	2	0	1007	500+
20	2002	2	0	1422	500+
21	2002	2	0	4,006	500+
23	2002	2	0	1158	500+

Plot	Year	Burn intensity[1]	Hlm count	Distance category	Distance (m) to unburned habitat
27	2002	2	0	1192	500+
31	2002	2	0	918	500+
35	2002	2	0	1185	500+
38	2002	2	0	1290	500+
2	2003	1	0	193	0-200
15	2003	1	0	34	0-200
26	2003	1	0	34	0-200
337	2003	1	0	10	0-200
518	2003	1	0	10	0-200
525	2003	1	0	10	0-200
527	2003	1	0	10	0-200
530	2003	1	0	96	0-200
532	2003	1	0	10	0-200
534	2003	1	0	77	0-200
538	2003	1	0	10	0-200
539	2003	1	1	39	0-200
541	2003	1	0	110	0-200
542	2003	1	0	45	0-200
547	2003	1	2	10	0-200
548	2003	1	1	105	0-200
5	2003	1	0	385	200-500
521	2003	1	0	242	200-500
528	2003	1	0	238	200-500
540	2003	1	0	355	200-500
544	2003	1	0	483	200-500
12	2003	1	0	913	500+
13	2003	1	0	832	500+
14	2003	1	0	974	500+
536	2003	1	0	840	500+
520	2003	2	0	285	200-500
522	2003	2	0	376	200-500
523	2003	2	1	233	200-500
549	2003	2	0	283	200-500
1	2003	2	0	570	500+
3	2003	2	0	787	500+
11	2003	2	0	792	500+
16	2003	2	0	1747	500+
17	2003	2	0	2675	500+

Plot	Year	Burn intensity[1]	Hlm count	Distance category	Distance (m) to unburned habitat
18	2003	2	0	1007	500+
20	2003	2	0	1422	500+
21	2003	2	0	4,006	500+
23	2003	2	0	1158	500+
27	2003	2	0	1192	500+
31	2003	2	0	918	500+
35	2003	2	0	1185	500+
38	2003	2	0	1290	500+
2	2004	1	0	193	0-200
15	2004	1	0	34	0-200
26	2004	1	1	34	0-200
337	2004	1	0	10	0-200
518	2004	1	1	10	0-200
525	2004	1	0	10	0-200
527	2004	1	0	10	0-200
530	2004	1	11	96	0-200
534	2004	1	0	77	0-200
538	2004	1	3	10	0-200
547	2004	1	7	10	0-200
548	2004	1	1	105	0-200
5	2004	1	0	385	200-500
521	2004	1	0	242	200-500
528	2004	1	0	238	200-500
540	2004	1	0	355	200-500
544	2004	1	1	483	200-500
12	2004	1	0	913	500+
13	2004	1	0	832	500+
14	2004	1	1	974	500+
520	2004	2	0	285	200-500
522	2004	2	0	376	200-500
523	2004	2	0	233	200-500
1	2004	2	0	570	500+
3	2004	2	0	787	500+
11	2004	2	0	792	500+
16	2004	2	0	1747	500+
17	2004	2	0	2675	500+
18	2004	2	0	1007	500+
20	2004	2	0	1422	500+
23	2004	2	0	1158	500+
27	2004	2	0	1192	500+
31	2004	2	0	918	500+
35	2004	2	0	1185	500+
38	2004	2	0	1290	500+
2	2005	1	0	193	0-200

Plot	Year	Burn intensity[1]	Hlm count	Distance category	Distance (m) to unburned habitat
15	2005	1	0	34	0-200
518	2005	1	7	10	0-200
525	2005	1	2	10	0-200
527	2005	1	0	10	0-200
530	2005	1	4	96	0-200
532	2005	1	0	10	0-200
534	2005	1	4	77	0-200
538	2005	1	0	10	0-200
539	2005	1	1	39	0-200
541	2005	1	3	110	0-200
542	2005	1	2	45	0-200
547	2005	1	16	10	0-200
548	2005	1	2	105	0-200
5	2005	1	0	385	200-500
521	2005	1	3	242	200-500
528	2005	1	0	238	200-500
540	2005	1	0	355	200-500
544	2005	1	2	483	200-500
49	2005	2	0	176	0-200
520	2005	2	0	285	200-500
522	2005	2	0	376	200-500
523	2005	2	0	233	200-500
549	2005	2	3	283	200-500
1	2005	2	0	570	500+
3	2005	2	0	787	500+
11	2005	2	0	792	500+
16	2005	2	0	1747	500+
17	2005	2	0	2675	500+
18	2005	2	0	1007	500+
20	2005	2	0	1422	500+
21	2005	2	0	4,006	500+
23	2005	2	0	1158	500+
27	2005	2	0	1192	500+
31	2005	2	0	918	500+
35	2005	2	0	1185	500+
38	2005	2	0	1158	500+
568	2005	2	0	954	500+
2	2006	1	0	193	0-200
15	2006	1	1	34	0-200
518	2006	1	3	10	0-200
525	2006	1	1	10	0-200
530	2006	1	8	96	0-200
534	2006	1	0	77	0-200
538	2006	1	1	10	0-200

Plot	Year	Burn intensity[1]	Hlm count	Distance category	Distance (m) to unburned habitat
547	2006	1	0	10	0-200
548	2006	1	0	105	0-200
521	2006	1	1	242	200-500
528	2006	1	1	238	200-500
540	2006	1	0	355	200-500
520	2006	2	0	285	200-500
522	2006	2	2	376	200-500
523	2006	2	1	233	200-500
3	2006	2	0	787	500+
11	2006	2	0	792	500+
16	2006	2	0	1747	500+
17	2006	2	0	2675	500+
18	2006	2	0	1007	500+
20	2006	2	0	1422	500+
23	2006	2	0	1158	500+
27	2006	2	0	1192	500+
31	2006	2	0	918	500+
38	2006	2	0	1158	500+
2	2007	1	2	193	0-200
8	2007	1	0	20	0-200
15	2007	1	3	34	0-200
518	2007	1	0	10	0-200
525	2007	1	2	10	0-200
530	2007	1	3	96	0-200
534	2007	1	2	77	0-200
538	2007	1	5	10	0-200
547	2007	1	2	10	0-200
548	2007	1	1	105	0-200
5	2007	1	0	385	200-500
521	2007	1	1	242	200-500
528	2007	1	1	238	200-500
540	2007	1	1	355	200-500
520	2007	2	0	285	200-500
522	2007	2	12	376	200-500
523	2007	2	0	233	200-500
549	2007	2	0	283	200-500
3	2007	2	0	787	500+
11	2007	2	0	792	500+
16	2007	2	0	1747	500+
17	2007	2	1	2675	500+
18	2007	2	0	1007	500+
20	2007	2	0	1422	500+
23	2007	2	0	1158	500+
27	2007	2	4	1192	500+

Plot	Year	Burn intensity[1]	Hlm count	Distance category	Distance (m) to unburned habitat
31	2007	2	0	918	500+
38	2007	2	0	1158	500+
2	2008	1	4	193	0-200
8	2008	1	2	20	0-200
15	2008	1	2	34	0-200
518	2008	1	2	10	0-200
525	2008	1	0	10	0-200
530	2008	1	2	96	0-200
534	2008	1	1	77	0-200
538	2008	1	1	10	0-200
547	2008	1	0	10	0-200
548	2008	1	0	105	0-200
5	2008	1	2	385	200-500
521	2008	1	1	242	200-500
528	2008	1	7	238	200-500
540	2008	1	0	355	200-500
520	2008	2	1	285	200-500
522	2008	2	0	376	200-500
523	2008	2	1	233	200-500
549	2008	2	0	283	200-500
3	2008	2	3	787	500+
11	2008	2	3	792	500+
16	2008	2	4	1747	500+
17	2008	2	0	2675	500+
18	2008	2	1	1007	500+
20	2008	2	0	1422	500+
23	2008	2	2	1158	500+
27	2008	2	10	1192	500+
31	2008	2	0	918	500+
38	2008	2	0	1158	500+
2	2009	1	5	193	0-200
8	2009	1	2	20	0-200
15	2009	1	0	34	0-200
518	2009	1	2	10	0-200
525	2009	1	7	10	0-200
530	2009	1	1	96	0-200
534	2009	1	4	77	0-200
538	2009	1	0	10	0-200
547	2009	1	1	10	0-200
548	2009	1	3	105	0-200
5	2009	1	0	385	200-500
521	2009	1	3	242	200-500
528	2009	1	2	238	200-500
540	2009	1	0	355	200-500

Plot	Year	Burn intensity[1]	Hlm count	Distance category	Distance (m) to unburned habitat
520	2009	2	0	285	200-500
522	2009	2	2	376	200-500
523	2009	2	1	233	200-500
549	2009	2	1	283	200-500
3	2009	2	3	787	500+
11	2009	2	0	792	500+
16	2009	2	0	1747	500+
17	2009	2	0	2675	500+

Plot	Year	Burn intensity[1]	Hlm count	Distance category	Distance (m) to unburned habitat
18	2009	2	0	1007	500+
20	2009	2	0	1422	500+
23	2009	2	2	1158	500+
27	2009	2	4	1192	500+
31	2009	2	0	918	500+
38	2009	2	1	1158	500+

[1] 1 = low intensity burn; 2 = moderate-to-high intensity burn.

APPENDIX D

HABITAT CONDITION AT MODERATE-TO-HIGH SEVERITY BURN TRANSECTS BOTH OCCUPIED AND UNOCCUPIED BY PAWNEE MONTANE SKIPPERS AND THEIR DISTANCE TO UNBURNED SUITABLE SKIPPER HABITAT FOR THE PERIOD 2002 TO 2009.

Year	Transect #	# of Hlm	# of flowering gayfeather stems	Blue grama frequency	# of live trees	# of dead trees	Distance category	Distance (m) to unburned habitat	Distance (m) to low severity burn habitat
2002	1	0	3	3	13	0	500+	570	55
2002	3	0	0	10	0	0	500+	787	10
2002	11	0	0	15	0	0	500+	792	10
2002	16	0	37	25	1	0	500+	1747	136
2002	17	0	8	3	0	0	500+	2675	104
2002	18	0	0	13	0	0	500+	1007	604
2002	20	0	0	3	0	0	500+	1422	416
2002	21	0	0	0	0	0	500+	4,006	644
2002	23	0	0	3	0	0	500+	1158	13
2002	27	0	0	28	0	0	500+	1192	125
2002	31	0	0	0	0	0	500+	918	297
2002	35	0	0	0	0	0	500+	1185	196
2002	38	0	0	0	0	0	500+	1290	103
2002	520	0	0	23	1	0	200-500	285	32
2002	522	0	0	5	0	0	200-500	376	37
2002	523	0	0	23	16	0	200-500	233	28
2002	549	0	0	5	0	0	200-500	283	54
2003	1	0	119	5	1	87	500+	570	55
2003	3	0	45	14	2	180	500+	787	10
2003	11	0	36	7	0	74	500+	792	10
2003	16	0	38	2	0	62	500+	1747	136
2003	17	0	7	2	0	147	500+	2675	104
2003	18	0	44	11	0	53	500+	1007	604
2003	20	0	78	7	0	116	500+	1422	416
2003	21	0	0	5	0	96	500+	4,006	644
2003	23	0	23	9	0	115	500+	1158	13
2003	27	0	94	6	0	66	500+	1192	125
2003	31	0	24	6	0	117	500+	918	297
2003	35	0	8	5	0	27	500+	1185	196
2003	38	0	4	6	6	200	500+	1290	103
2003	520	0	24	5	1	163	200-500	285	32
2003	522	0	89	1	0	181	200-500	376	37
2003	549	0	14	3	0	214	200-500	283	54
2003	523	1	42	4	0	191	200-500	233	28
2004	1	0	1062	8	0	138	500+	570	55
2004	3	0	13	12	0	185	500+	787	10
2004	11	0	115	12	0	45	500+	792	10

Year	Transect #	# of Hlm	# of flowering gayfeather stems	Blue grama frequency	# of live trees	# of dead trees	Distance category	Distance (m) to unburned habitat	Distance (m) to low severity burn habitat
2004	16	0	152	94	10	20	500+	1747	136
2004	17	0	285	0	0	130	500+	2675	104
2004	18	0	49	14	0	90	500+	1007	604
2004	20	0	2	1	0	196	500+	1422	416
2004	23	0	61	6	0	84	500+	1158	13
2004	27	0	321	48	18	56	500+	1192	125
2004	31	0	11	11	0	30	500+	918	297
2004	35	0	15	3	0	71	500+	1185	196
2004	38	0	52	8	0	106	500+	1290	103
2004	520	0	62	2	35	192	200-500	285	32
2004	522	0	37	17	0	195	200-500	376	37
2004	523	0	126	4	0	196	200-500	233	28
2005	1	0	783	1	0	163	500+	570	55
2005	3	0	366	9	4	122	500+	787	10
2005	11	0	222	11	0	45	500+	792	10
2005	16	0	694	9	0	21	500+	1747	136
2005	17	0	221	5	18	116	500+	2675	104
2005	18	0	708	14	0	42	500+	1007	604
2005	20	0	1110	3	0	47	500+	1422	416
2005	21	0	0	0	0	101	500+	4,006	644
2005	23	0	67	13	0	127	500+	1158	13
2005	27	0	841	18	0	82	500+	1192	125
2005	31	0	373	18	0	85	500+	918	297
2005	35	0	101	4	0	43	500+	1185	196
2005	38	0	245	8	2	75	500+	1158	103
2005	49	0	858	2	0	136	0-200	176	30
2005	520	0	186	12	0	139	200-500	285	32
2005	522	0	369	16	0	114	200-500	376	37
2005	523	0	127	12	11	83	200-500	233	28
2005	568	0	220	16	13	442	500+	954	305
2005	549	3	502	11	2	137	200-500	283	54
2006	3	0	16	23	7	96	500+	787	10
2006	11	0	105	12	0	78	500+	792	10
2006	16	0	216	6	0	38	500+	1747	136
2006	17	0	111	1	0	70	500+	2675	104
2006	18	0	128	24	0	44	500+	1007	604
2006	20	0	162	4	0	100	500+	1422	416
2006	23	0	88	12	0	112	500+	1158	13
2006	27	0	22	7	0	66	500+	1192	125
2006	31	0	40	30	0	71	500+	918	297
2006	38	0	1	5	0	112	500+	1158	103
2006	520	0	106	14	0	104	200-500	285	32
2006	522	2	106	26	0	157	200-500	376	37

Year	Transect #	# of Hlm	# of flowering gayfeather stems	Blue grama frequency	# of live trees	# of dead trees	Distance category	Distance (m) to unburned habitat	Distance (m) to low severity burn habitat
2006	523	1	65	8	0	83	200-500	233	28
2007	3	0	34	14	0	209	500+	787	10
2007	11	0	21	18	0	86	500+	792	10
2007	16	0	45	12	0	33	500+	1747	136
2007	18	0	16	11	0	43	500+	1007	604
2007	20	0	75	0	0	55	500+	1422	416
2007	23	0	19	12	0	98	500+	1158	13
2007	31	0	80	16	0	121	500+	918	297
2007	38	0	29	1	0	213	500+	1158	103
2007	520	0	124	14	20	152	200-500	285	32
2007	523	0	33	5	0	146	200-500	233	28
2007	549	0	269	3	0	170	200-500	283	54
2007	17	1	57	3	0	82	500+	2675	104
2007	27	4	102	8	0	38	500+	1192	125
2007	522	12	119	27	0	81	200-500	376	37
2008	3	0	135	21	0	116	500+	787	10
2008	11	0	27	15	0	71	500+	792	10
2008	17	0	111	3	0	73	500+	2675	104
2008	31	0	70	23	0	64	500+	918	297
2008	38	0	11	5	0	120	500+	1158	103
2008	549	0	80	11	5	66	200-500	283	54
2008	16	1	100	16	0	37	500+	1747	136
2008	18	1	132	21	0	35	500+	1007	604
2008	20	3	800	10	0	66	500+	1422	416
2008	23	2	108	25	0	66	500+	1158	13
2008	27	10	205	11	0	30	500+	1192	125
2008	520	3	246	0	0	96	200-500	285	32
2008	522	1	52	26	0	58	200-500	376	37
2008	523	4	115	8	0	69	200-500	233	28
2009	11	0	142	18	0	35	500+	792	10
2009	16	0	140	5	0	29	500+	1747	136
2009	17	0	85	4	0	71	500+	2675	104
2009	18	0	488	23	0	27	500+	1007	604
2009	20	0	599	1	0	40	500+	1422	416
2009	520	0	624	10	55	101	200-500	285	32
2009	3	3	118	15	0	119	500+	787	10
2009	23	2	23	17	0	62	500+	1158	13
2009	27	4	405	10	0	14	500+	1192	125
2009	38	1	36	5	0	113	500+	1158	103
2009	522	2	203	24	0	69	200-500	376	37
2009	523	1	256	11	0	130	200-500	233	28
2009	549	1	636	46	0	69	200-500	283	54