Pawnee Montane Skipper Post-fire Habitat Assessment Survey - September 2006

Natural Heritage Program COLORADO

Colorado State University Knowledge to Go Places

Cover photo: a view of Sheep Rock from within the Hayman Fire area (*photo credit John Sovell*)

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Prepared For

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South Platte Ranger District
Morrison, Colorado

U.S. Fish and Wildlife Service
Lakewood, Colorado

And

Denver Water
Denver, Colorado

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INTRODUCTION

The Hayman and Schoonover forest fires burned across a large fraction of the historical habitat of the Pawnee montane skipper butterfly (*Hesperia leonardus montana*) during the summer of 2002 in Jefferson and Douglas counties, Colorado. These fires burned approximately 40% of the Pawnee montane skipper's 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 listed Threatened species to make an initial estimate of the post-fire habitat effects and to detect presence of skippers. The multi-agency team (USFS, USFWS, and Denver Water) conducted the sampling in mid-September 2002 (ENSR 2002). This sampling was developed into a longer-term monitoring effort in 2003 and was expanded to include the Buffalo Creek (1996) and Hi-Meadow (2000) fire areas. The purpose of this monitoring effort is to document Pawnee montane skipper habitat conditions in both burned and unburned skipper habitat, on the Hayman and Schoonover fire areas and to assess changes in skipper abundance in response 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 drainage.

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 and their habitats.

A subset of the transects surveyed in 2003 were sampled in 2004, 2005, and again in 2006 to continue assessing the rate of recovery of skipper populations and their habitat within the burn areas (Hayman and Schoonover). The Buffalo Creek and Hi-Meadow fire areas were not sampled in 2006.

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. This, along with the almost decade-long dry conditions of the area, provided an opportunity to study the influence that abnormally low precipitation levels have on Pawnee montane skipper habitat and populations. It is likely that the Pawnee montane skipper 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 Pawnee montane skipper population responds to the dual effects of both fire and drought.

METHODS

Project Area

For purposes of estimating fire-caused habitat reductions over the entire known range of the Pawnee montane skipper in the South Platte River drainage, skipper habitat burned by four recent past major fires (Buffalo Creek, Hi-Meadow, Hayman, and Schoonover) was estimated for the project area (**Figure 1**). The Schoonover fire burned a small portion of Pawnee montane skipper habitat in 2002, and monitoring plots were placed within its boundary, and within adjacent suitable habitat burned by the Hayman Fire.

The USFS prepared a burn severity map for the Hayman Fire, based on interpretation of aerial photography and satellite imagery (USFS 2002). This burn severity map, combined with the map of occupied skipper habitat (**Figure 1**), was used to establish the 2002 sampling study area. The geographical area of the 2002 study encompassed the entirety of the Hayman Fire within the estimated suitable Pawnee montane skipper habitat, the global extent of which occurs in the South Platte River drainage, Jefferson, Douglas, Park, and Teller counties, Colorado. Sampling plots were randomly located within each of three sampling units within the project area. The sampling plots 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 2**). Areas unburned by the Hayman fire within the South Platte drainage were sampled from Trumbull on the south, to Long Scraggy Peak on the north (**Figure 2**).

In 2003, new transects were added to this post fire study to assess the level of recovery of skipper habitat and skipper populations in the Buffalo Creek Fire area and the Hi-Meadow Fire area (**Figure 3**) that burned in 1996 and 2000, respectively. Each of these two areas experienced low severity burns and are similar in forest structure to the Hayman low severity burn areas of 2002. Comparisons among low severity burn sites differing in the length of time since burning (Buffalo Creek 1996, Hi-Meadow 2000, and Hayman 2002) were possible with the addition of transects in these two areas.

Figure 1. Skipper Habitat burned by major fire since 1996. Wildfire areas (1996-2002) and skipper habitat.

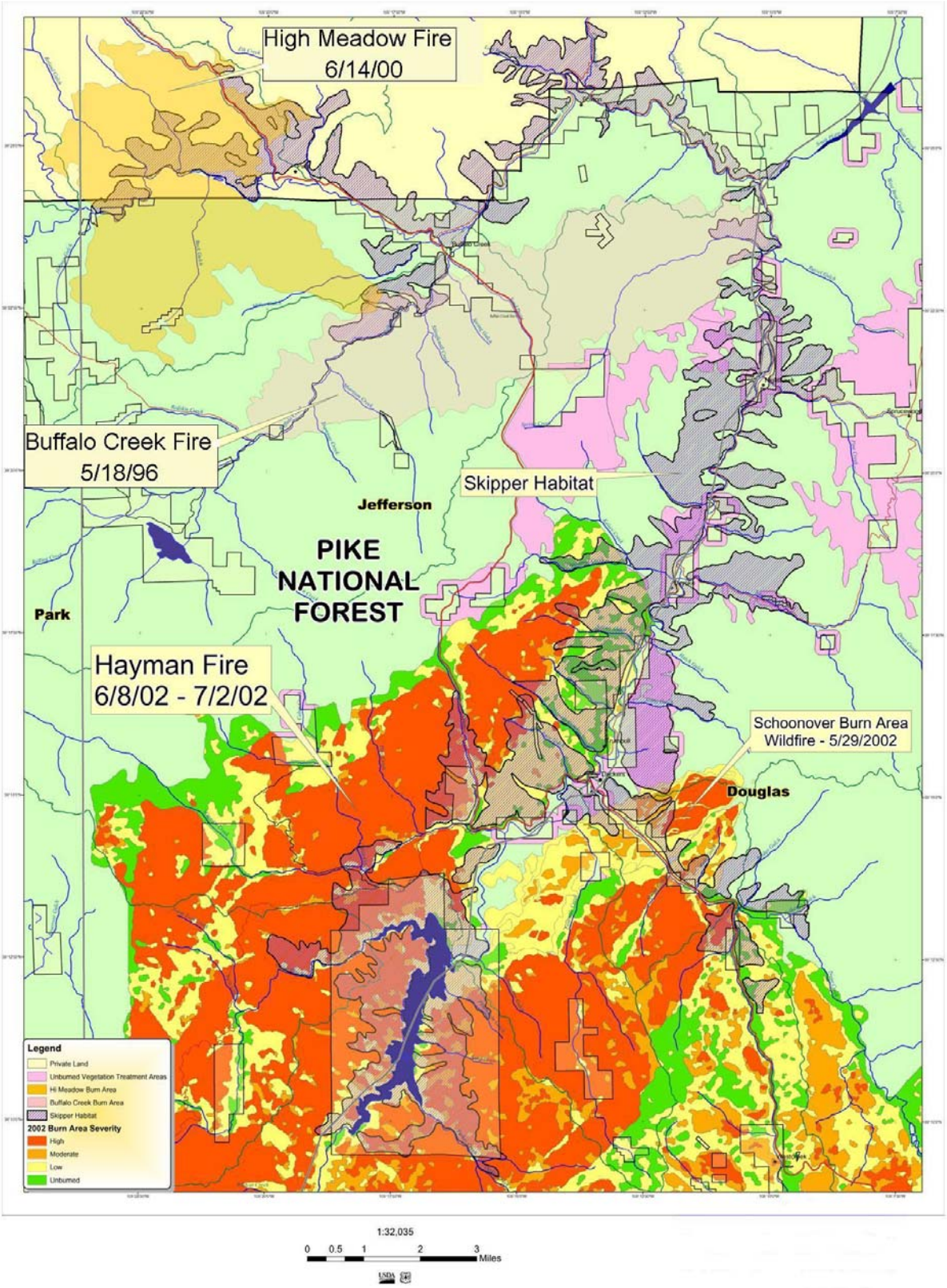


Figure 2. The location of the Pawnee montane skipper post-fire monitoring sampling blocks in the Hayman and Schoonover fire areas.

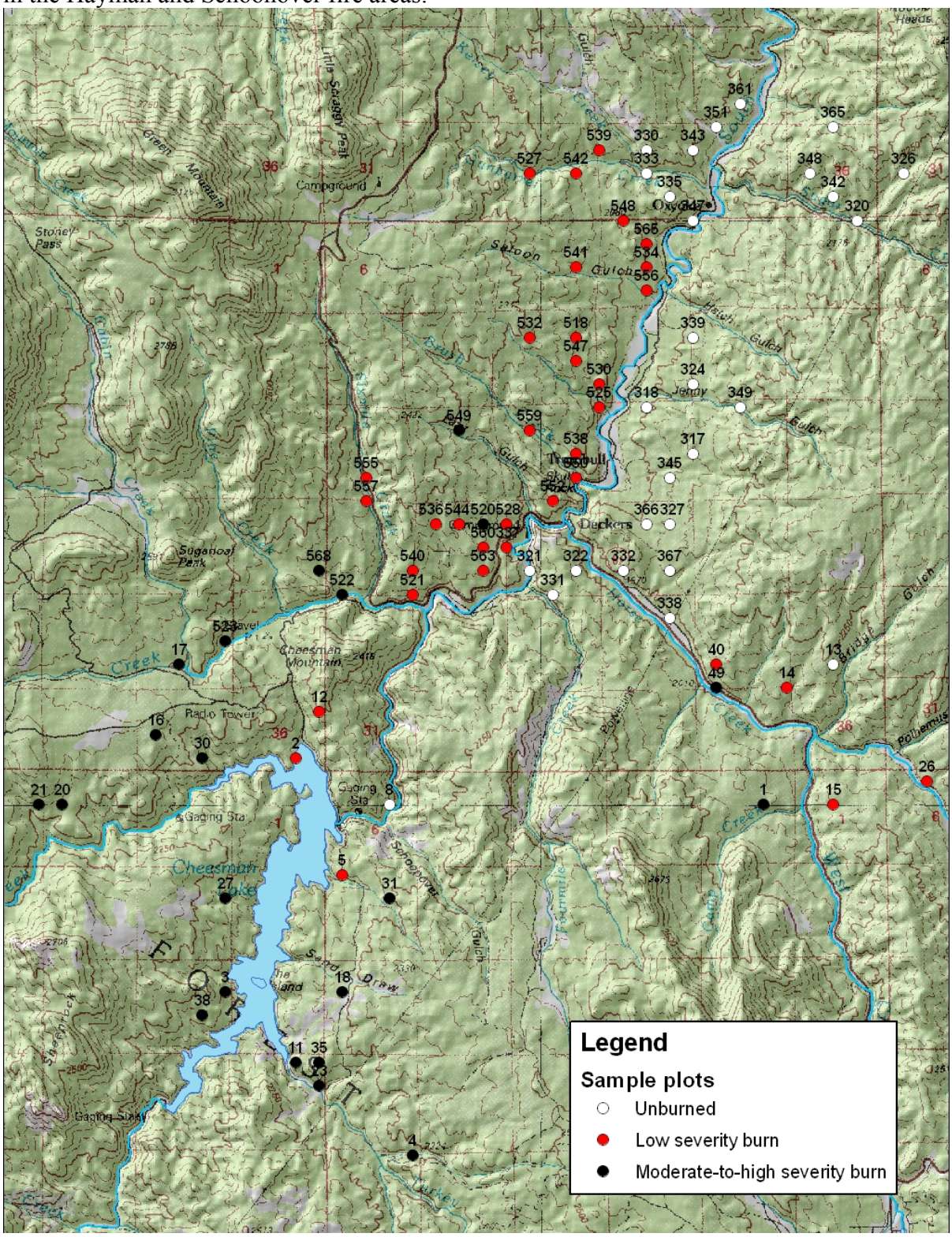
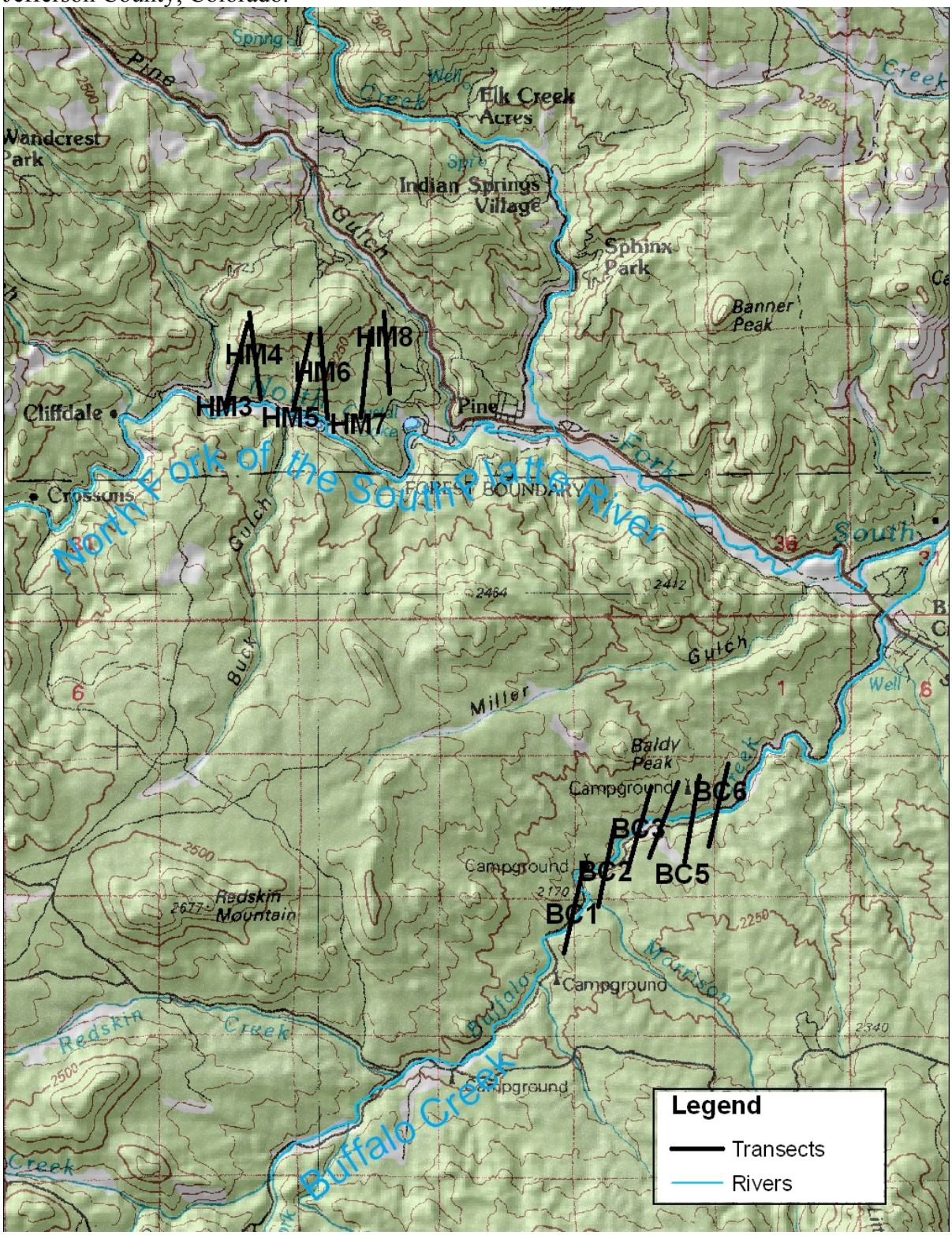


Figure 3. Hi-Meadow and Buffalo Creek sampling transects located at Pine Valley Ranch and one mile southwest of the buffalo Creek Forest Service Work Station, respectively, in Jefferson County, Colorado.



Field Data Collected and Project Outputs

1. Measured along belt transects in the monitoring effort were a) numbers of skippers present; b) number of blooming *Liatris* stems (primary adult skipper nectar source); c) the relative frequency of blue grama grass clumps (skipper 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. Measurement of these parameters was not consistent across years (**Table 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 mapped skipper habitat in areas that experienced different burn intensities.

Table 1. Parameters measured during the post-fire monitoring project (2002 to 2005).

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

[1]New to the 2003 sampling effort and continued through 2005 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.

Project Design and Sampling Methods

The field sampling methods used from 2002 to 2006 are similar to those used for rapid assessment sampling of skipper habitat and occurrence 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 skipper 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 intensity map (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 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-one plots were sampled between September 5 and September 14, 2005 (**Figure 4**). Transects sampled in 2002, 2003, 2004, and/or 2005 that were not re-sampled in 2006 were transects 317, 318, 324, 326, 327, 333, 335, 345, and 348 (all unburned plots); transects 5, 12, 13, 14, 26, 337, 527, 532, 536, 539, 541, 542 and 544 (all low severity burn plots); and transects 1, 21, 35, 49, 549, and 568 (all moderate-to-high severity burn plots). Sampling was scaled back in 2006 because of funding constraints and survey work was not conducted on the Buffalo Creek and Hi-Meadow transects during 2006. Attempts were made to sample the same plots in every year of the study, but constraints of weather, field crew size, and funding made this impractical.

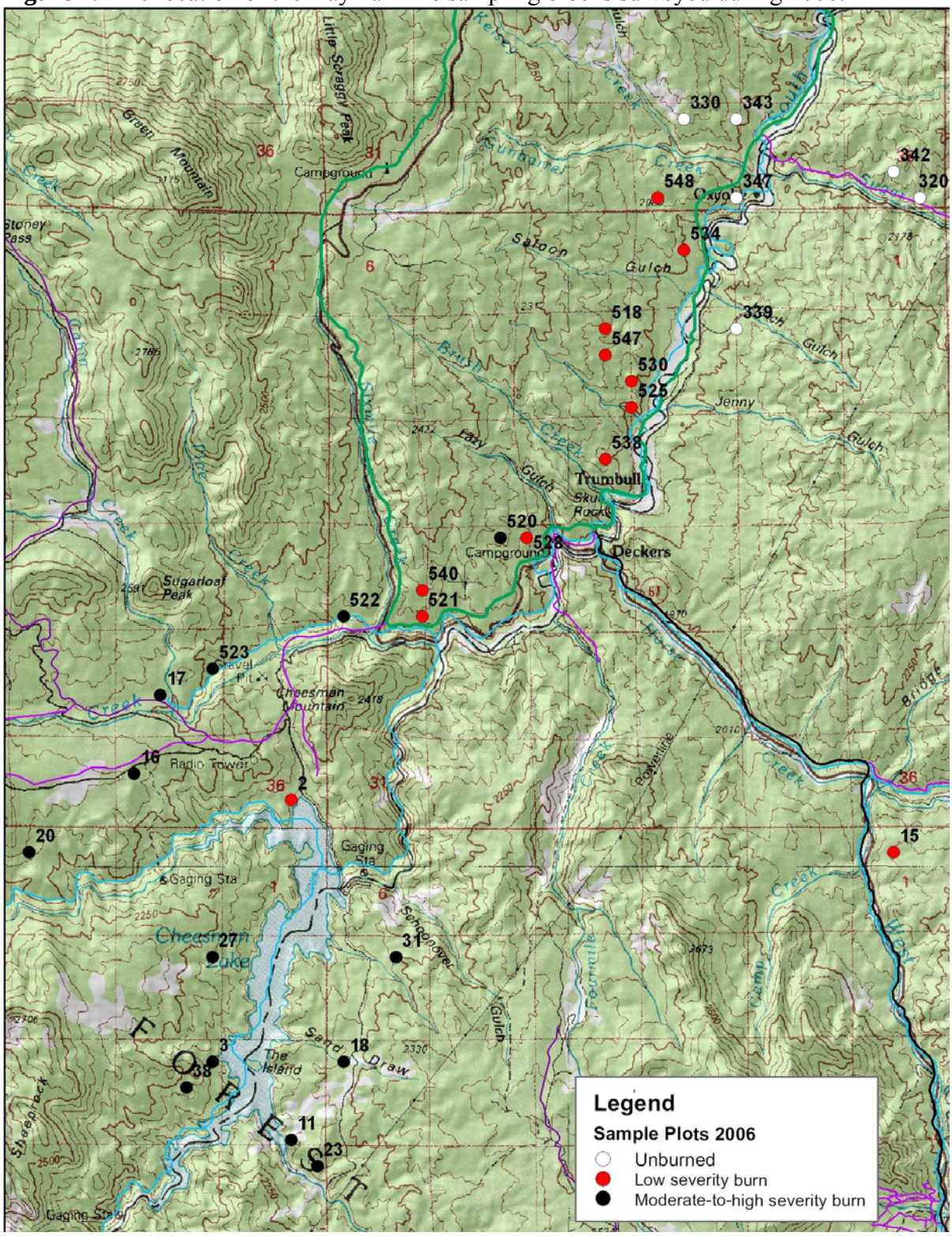
The distance of each low severity and moderate-to-high severity burn plot to unburned mapped skipper habitat was estimated in ArcGIS 9.0 using the USFS burn severity map, the estimated habitat suitability map for the Pawnee montane skipper, and the coordinates of the Universal Transverse Mercator center point of each sample block.

Field Sampling Methods

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

Sampling Site locations: The UTM coordinates for the center point of each 40-acre sampling plot were included on the sampling list in the protocol supplied to each field crew. Each team used a GPS instrument to find this center point, and then made a determination on how best to sample the habitat variation within the 40-acre block (i.e., a starting point was established at or near the center point of the block so that a diamond-shaped transect [200 m on a side] could be 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 10 20-m sub-segments along each 200-m transect leg. At the end of each 200-m leg, a 90-degree turn was made, and a new compass heading established. 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 chalk or white board included in the foreground of each photograph.

Figure 4. The location of the Hayman Fire sampling blocks surveyed during 2006.



Data Collection: The following section describes the information that was collected and compiled on the data sheet (**Figure 5**). Observations within the area of the belt transect (800 x 10 m) were recorded on the data sheets. Additional observations (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: sample block # from the sampling order table and the UTM coordinate of the starting point; observers; date and time of sampling; weather conditions (percent cloud cover), measured or estimated temperature, and 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). 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 2005, 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.

Figure 5. Distribution of *Bouteloua gracilis* (**Bogr**), *Liatris punctata* (**Lipu**), *Hesperia comma* (**Hco**), *Hesperia leonardus montana* (**Hlm**)

Observers: _____ Sample Block # _____ Date: _____

Weather: % Cloud Cover (0-100%): _____ Temperature: _____ Wind (√): Low ___ Medium ___ High ___ **GPS: NAD27 CONUS**

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

GPS Coordinates at start (UTM): _____

Sample Segment	Trees >6" DBH		plants		skippers								
	# live	# dead	Bogr	Lipu	Hlm			Hco			UNK		
www					.'	?	?	.'	?	?	.'	?	?
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
count:	#	#	√	#	#	#	#	#	#	#	#	#	#

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

GPS Coordinates at start (UTM): _____

Sample Segment	Trees >6" DBH		plants		skippers								
	# live	# dead	Bogr	Lipu	Hlm			Hco			UNK		
www					.'	?	?	.'	?	?	.'	?	?
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
count:	#	#	√	#	#	#	#	#	#	#	#	#	#

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

GPS Coordinates at start (UTM): _____

Sample Segment	Trees >6" DBH		plants		skippers								
	# live	# dead	Bogr	Lipu	Hlm			Hco			UNK		
www					.'	?	?	.'	?	?	.'	?	?
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
count:	#	#	√	#	#	#	#	#	#	#	#	#	#

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

GPS Coordinates at start (UTM): _____

Sample Segment	Trees >6" DBH		plants		skippers								
	# live	# dead	Bogr	Lipu	Hlm			Hco			UNK		
www					.'	?	?	.'	?	?	.'	?	?
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
count:	#	#	√	#	#	#	#	#	#	#	#	#	#

- Adult skipper butterfly counts (Hlm and Hco). Individual skipper butterflies of either the common branded skipper (*Hesperia comma*) or the Pawnee montane skipper (*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 notes on data sheets.

RESULTS

A total of 31 sample plots were surveyed within the Hayman Fire area with 13 of the samples from moderate-to-high severity burns, 12 from low severity burn plots, and 6 from unburned plots. In 2006, 80 *Hesperia* skippers (*H. comma* and *H. leonardus Montana*) were recorded from all of the Hayman sample plots. There were 29 skippers recorded from 5 of 6 (83%) unburned plots, 38 skippers recorded from 11 0f 12 (92%) low severity burn plots, and 13 from 4 of 13 (31%) moderate-to-high severity burn plots. This represents a significant per plot decline in the number of *Hesperia* skippers observed per acre from 4.20 in 2005 to 2.05 in 2006 (**Table 2**). The number of *Hesperia* skippers counted on sample plots in 2006 was similar to the numbers counted in 2002 and 2003 (**Table 2**).

Table 2. The mean per acre number of *Hesperia* skippers (*H. comma* and *H. leonardus montana*) recorded per plot among sample years (2002, 2003, 2004, 2005, and 2006) for all transects.

Year	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (P=0.05) [1]
2006	31	2.05	3.31	**A**
2005	65	4.20	4.77	**B**
2004	58	1.58	3.20	**C**
2003	68	0.17	0.41	**A**
2002	55	0.02	0.14	**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.

In 2006, 31 Pawnee montane skippers were recorded from all of the Hayman sample plots. There were 12 skippers recorded from 4 of 6 (67%) unburned plots, 16 skippers recorded from 7 of 12 (58%) low severity burn plots, and 3 skippers recorded from 2 of 13 (15%) moderate-to-high severity burn plots. This represents a per plot decline in the number of Pawnee montane skippers observed per acre compared to 2005, but was still more than observed from 2002 to 2004 (**Figure 6**). This trend in the mean number per acre of Pawnee montane skippers per plot was the same for the unidentified *Hesperia* skippers (*Hesperia* spp.) observed during all five years of monitoring (**Figure 7**).

Figure 6. The mean per acre number of Pawnee montane skipper (*Hesperia leonardus montana*) recorded per plot (±SE) from unburned, low severity burn, and moderate-to-high severity burn plots for each of five years monitored, 2002 to 2006.

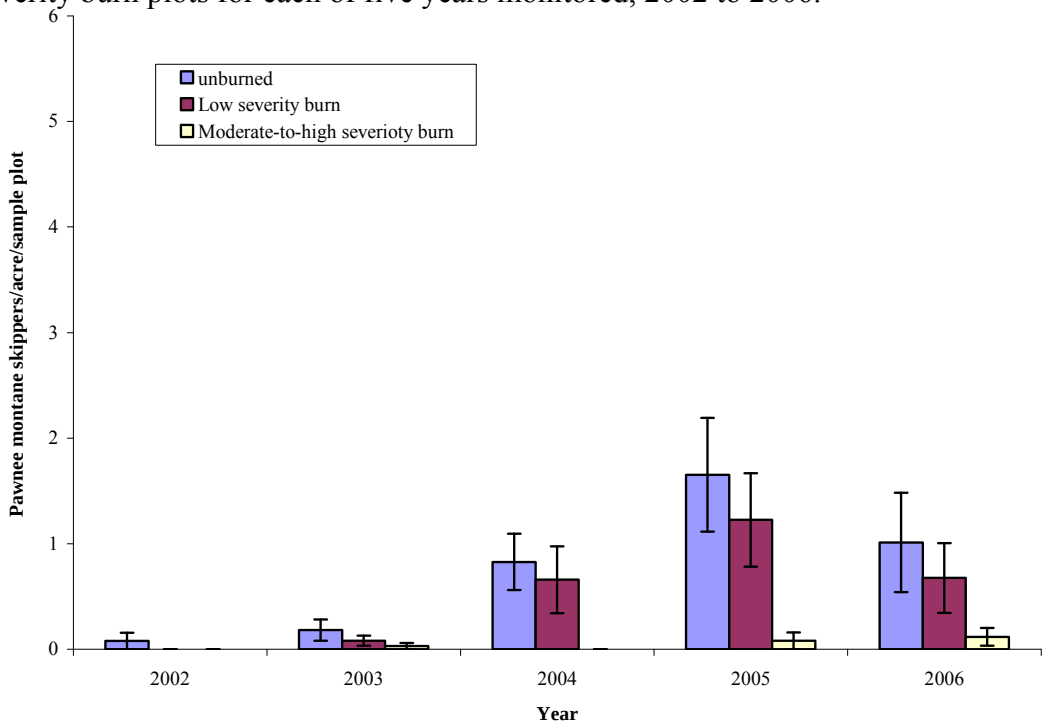
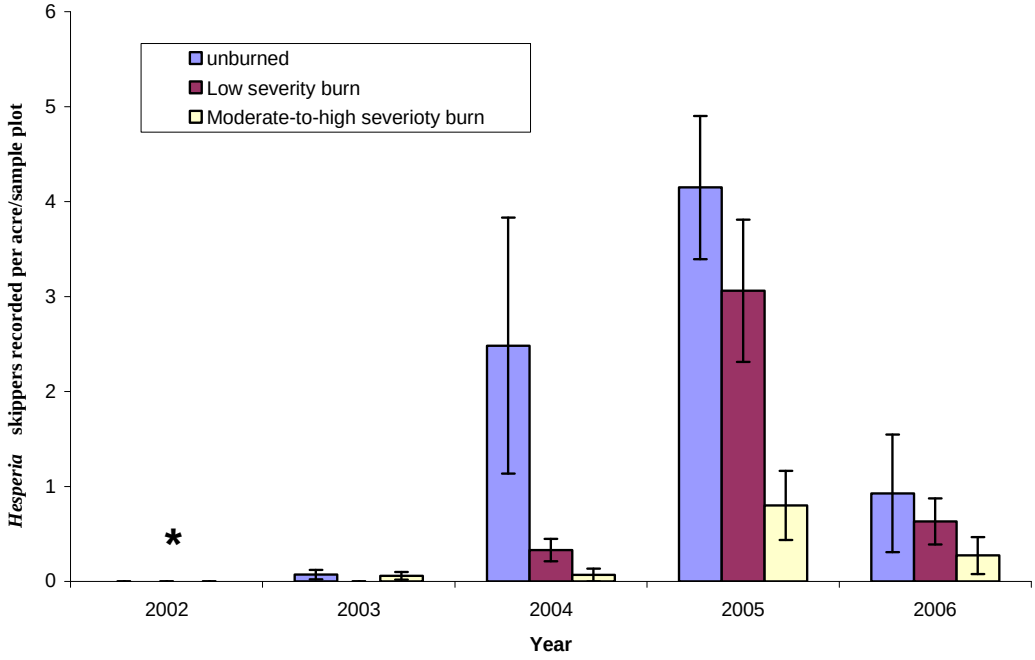


Figure 7. The mean per acre number of unidentified *Hesperia* skippers recorded per plot (±SE) from unburned, low severity, and moderate-to-high severity burn plots for each of five years monitored, 2002 to 2006 (* - data for unidentified skippers was missing for 2002).



The increase in Pawnee montane skippers between 2002 and 2005 was largely confined to the unburned and low intensity burn areas (**Table 3**). Rates of recovery in these two areas have been similar, with unburned areas showing slightly greater densities. Slowest to recover has been the moderate-to-high burned areas, in which no Pawnee montane skippers were seen in 2002 and 2004, and only 4 in 2003, 3 in 2005, and 3 again in 2006. During 2006 the mean number per acre of Pawnee montane skippers per plot actually increased slightly in the moderate-to-high severity burn plots from 0.08/acre in 2005 to 0.12/acre in 2006; although, this increase was not significant (**Table 3**).

Table 3. Pawnee montane skipper (*Hesperia leonardus montana*) densities on Hayman burn transects. Pawnee montane skippers per acre among sample years (2002, 2003, 2004, 2005, and 2006) within habitat condition types (unburned, low, and moderate-to-high severity burns) for all Hayman transects.

Year	Burn Intensity							
	Unburned			Low			Moderate-to-high	
	Means	Homogenous Groups (P=0.05)[1]		Means	Homogenous Groups (P=0.05)		Means	Homogenous Groups (P=0.05)
2006	1.02	**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**
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

In all five years of monitoring, the abundance of Pawnee montane skippers has been highest in the unburned areas and lowest in the moderate-to-high burn areas (**Table 4**). During the first three years (2002, 2003, and 2004) and again in 2006 these differences were not significantly different. In 2005 skipper density in unburned transects (1.65 skippers per acre) was significantly greater than that in the moderate-to-high burn areas (0.08). The number of Pawnee montane skipper increased at the unburned and low severity burn plots every year from 2002 to 2005, before declining in 2006. This seems to suggest that skipper habitat quality had improved in the unburned and low severity burn areas through 2005, but then became worse in 2006, while habitat quality changed little in the moderate-to-high burn areas during this period.

Table 4. Pawnee montane skipper (*Hesperia leonardus montana*) densities on the Hayman sample plots. Pawnee montane skippers per acre among habitat condition types (unburned, low, and moderate-to-high severity burns) within sample years (2002, 2003, 2004, and 2005) for all Hayman transects.

Year	Burn Intensity	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (p=0.05)[1]
2006	unburned	6	1.02	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**
	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.

The mean number per acre of Pawnee montane skipper observed per plot is correlated to the previous years annual total spring to summer (March to August) precipitation (**Figure 8**). There was a one year time-lag in the response of Pawnee montane skippers to precipitation, with precipitation in the studying area peaking in 2004, while Pawnee montane skipper abundance peaked in 2005. There were significant correlations between previous year's spring to summer precipitation and the mean number per acre of Pawnee montane skipper for unburned plots and low severity burn plots, but not for moderate-to-high severity burn plots (**Table 5**). This would suggest that given the decline in total spring to summer precipitation from 2005 to 2006 there should also be a correlated decline in the number of recorded Pawnee montane skippers in 2007 within the study area. During five years of monitoring mean annual spring to summer precipitation was below the 57 year mean in four years (2002, 2003, 2005, and 2006) and was above that mean only in 2004. The trend in the correlation between precipitation and the mean number per acre of Pawnee montane skippers was the same for the unidentified *Hesperia* skippers that were observed during the five years of monitoring except that the correlation was weaker (**Table 5, Figure 9**).

Figure 8. Mean (±SE) number per acre of Pawnee montane skipper (*Hesperia leonardus montana*) observed per plot on unburned, low severity burn, and high-to-moderate severity burn areas from 2002 to 2006. The mean (±SE) annual spring to summer (March-August) precipitation for the years 2002 to 2006 and the mean (±SE) annual spring to summer precipitation from 1949 to 2006 recorded at Cheesman Reservoir are also shown.

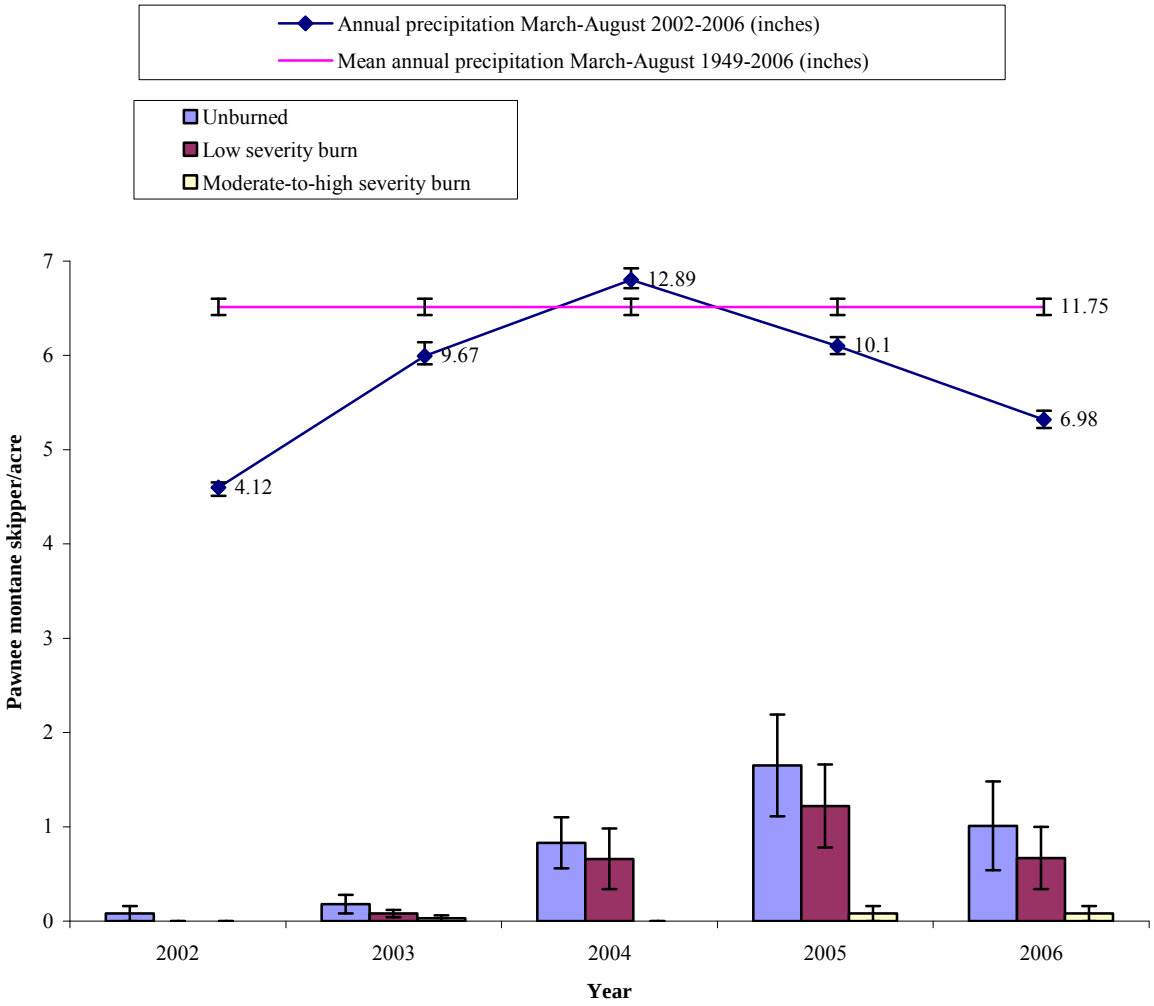
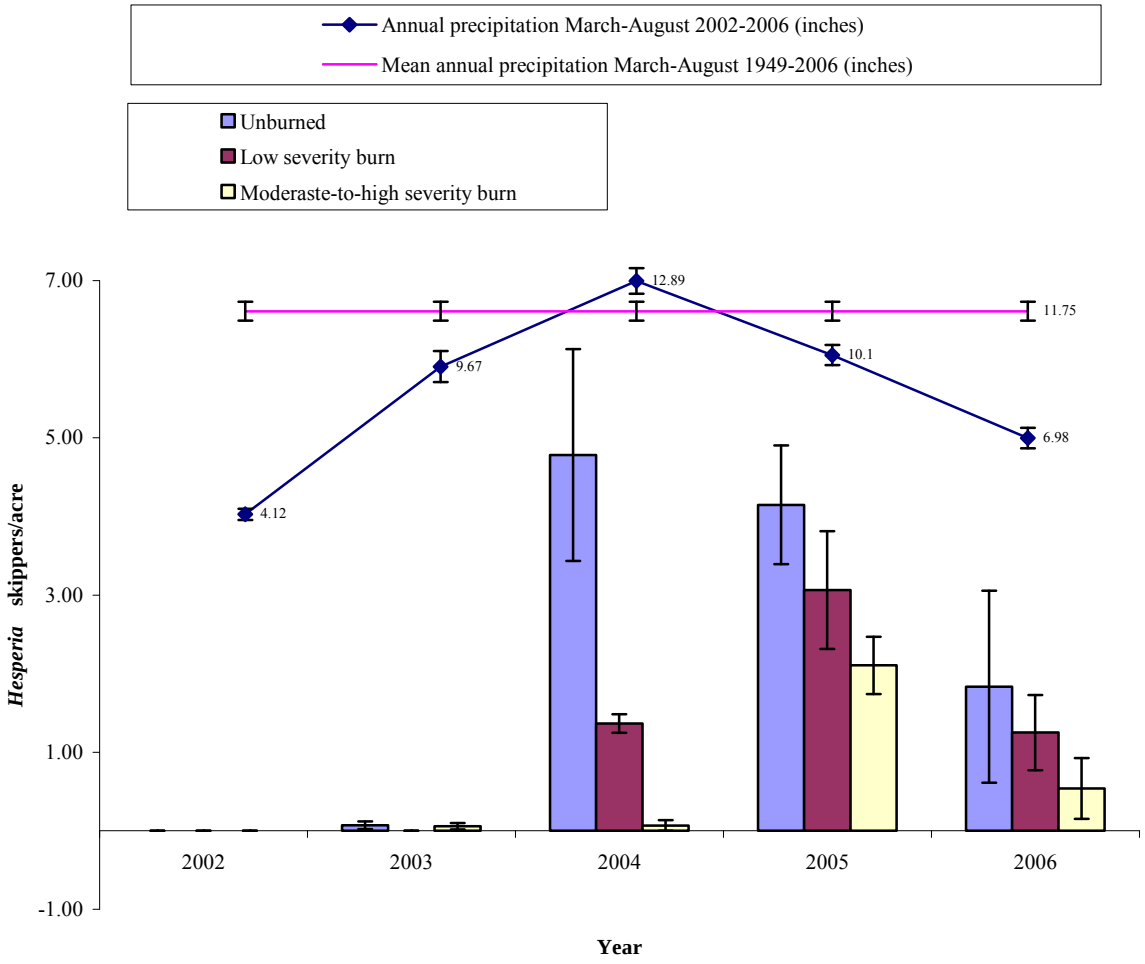


Table 5. Correlation coefficient between total annual spring to summer (March to August) precipitation and the mean number per acre of Pawnee montane skipper (*Hesperia leonardus montana*).

***Hesperia leonardus montana*/acre**	**r^2**	**P-value**
Unburned plots	0.92	<0.01
Low severity burn plots	0.96	<0.01
Moderate-to-high severity burn plots	0.19	>0.05
Unidentified *Hesperia* skippers/acre		
Unburned plots	0.74	>0.05
Low severity burn plots	0.61	>0.05
Moderate-to-high severity burn plots	0.59	>0.05

Figure 9. Mean (±SE) number of unidentified *Hesperia* skippers per acre observed on unburned, low severity burn, and high-to-moderate severity burn areas from 2002 to 2006. The mean (±SE) annual spring and summer precipitation for the years 2002 to 2006 and the mean (±SE) annual precipitation from 1949 to 2006 recorded at Cheesman Reservoir are also shown.



During all five years of monitoring, most of the Pawnee montane skippers recorded at both the low and moderate-to-high severity burn plots were located in close proximity to unburned mapped skipper habitat. Significantly more of the Pawnee montane skippers observed within the low severity and moderate-to-high severity burn areas were recorded from sample plots within 200 meters of unburned mapped skipper habitat (Chi-square=208, df=14, P<0.0001) (**Figure 10**). No Pawnee montane skippers were recorded from any moderate-to-high severity burn plots that were greater than 500 meters from unburned mapped skipper habitat even though a disproportionate number of the samples taken from this burn severity category came from this distance class. This trend in the distribution of Pawnee montane skippers recorded being near unburned mapped skipper habitat was the same for the unidentified *Hesperia* skippers recorded during the five years of monitoring (Chi-square=242, df=32, P<0.0001), except that there were some unidentified *Hesperia* skippers recorded from moderate-to-high severity burn plots at distances greater than 500 meters from the nearest unburned mapped skipper habitat (**Figure 11**)

Figure 10. The percent number of samples, Pawnee montane skippers (*Hesperia leonardus montana*), and samples recording Pawnee montane skippers at 0-200 meters, 200-500 meters, and at greater than 500 meters from unburned mapped skipper habitat at both low severity and high-to-moderate severity burn areas from 2002-2006 (unburned plots are shown for purposes of comparison; total number of Pawnee montane skippers observed within each interval are shown above the bars).

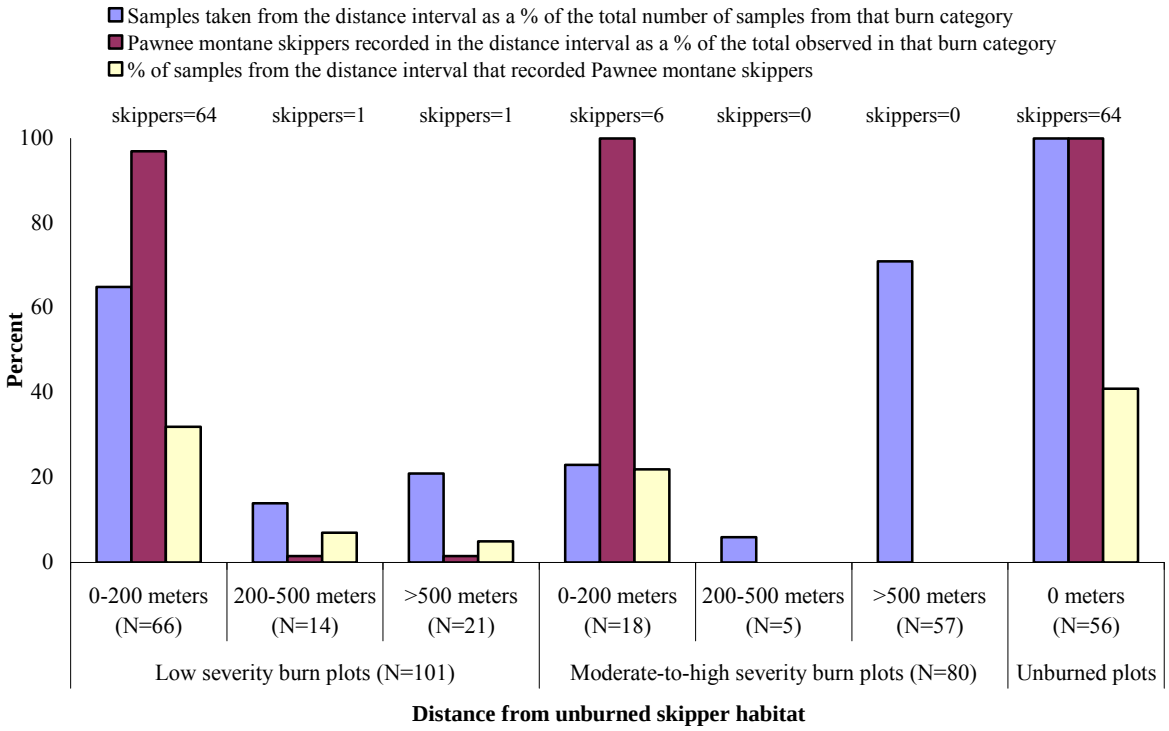
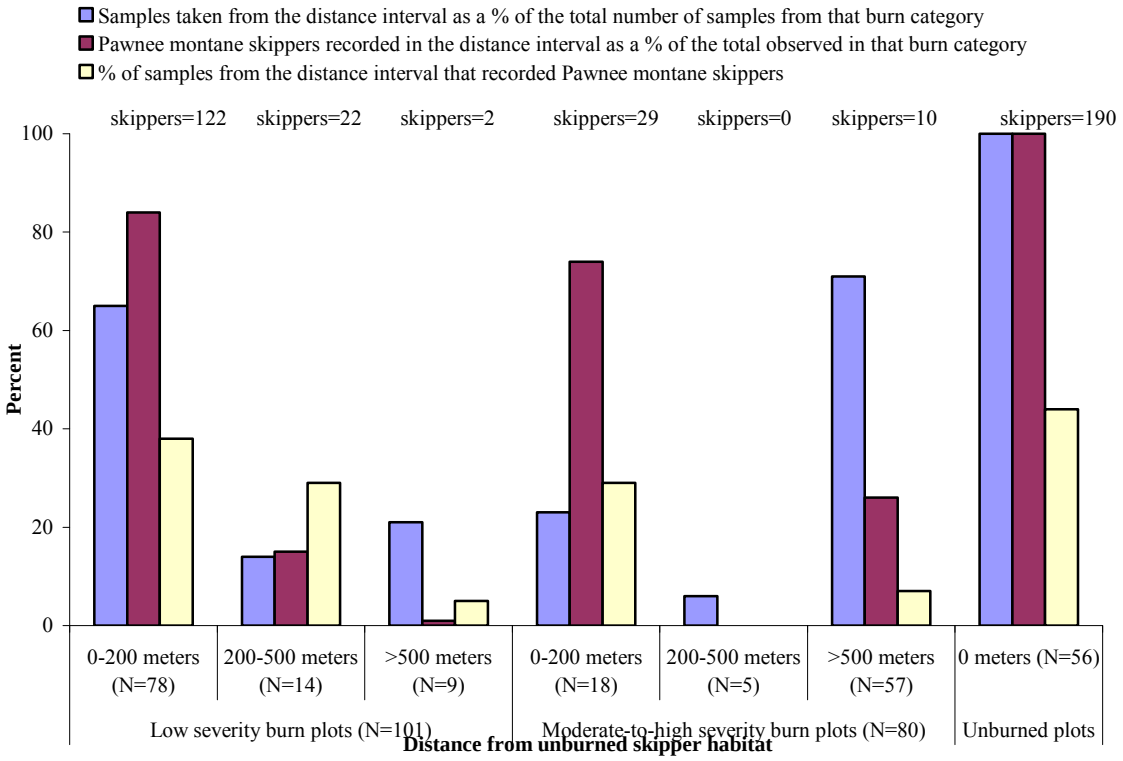


Figure 11. The percent number of samples, *Hesperia* skippers, and samples recording unidentified *Hesperia* skippers at 0-200 meters, 200-500 meters, and at greater than 500 meters from unburned mapped skipper habitat at both low severity and high-to-moderate severity burn areas from 2002-2006 (unburned plots are shown for purposes of comparison; total number of unidentified *Hesperia* skippers observed within each interval are shown above the bars).



DISCUSSION

The trend in the mean per acre number of Pawnee montane skipper recoded per plot has remained the same among burn severity categories throughout all five years of monitoring. Pawnee montane skippers are most numerous on unburned plots, with low severity burn plots supporting slightly fewer Pawnee montane skippers than unburned plots, while the moderate-to-high severity burn plots support considerably fewer Pawnee montane skipper. This trend would still hold true even if all the unidentified *Hesperia* skippers that were recorded were actually Pawnee montane skippers. If this were true, the number of Pawnee montane skippers observed per year would increase, but the trends in distribution of those skippers among unburned, low severity, and moderate-to-high severity burn plots would remain the same.

Habitat quality and the number of Pawnee montane skippers continued to increase from 2002 to 2005 as the effects of drought became less pronounced in the region, but at the moderate-to-high severity burn areas there was very little increase in the number of *Hesperia* skippers recorded during this period. This discrepancy may result from the reduction in abundance of live trees in moderate-to-highly burned areas creating habitat less suitable for Pawnee montane skippers.

Pawnee montane skipper numbers were significantly correlated to precipitation within the study area. There was a one year time-lag in the response of Pawnee montane skippers to precipitation, with precipitation peaking in 2004, while Pawnee montane skipper abundance peaked in 2005. This was followed by a decline in Pawnee montane skipper abundance in 2006 after a year of below normal spring to summer precipitation in 2005. Below normal levels of spring to summer precipitation continued in 2006, which would predict for additional declines in Pawnee montane skippers in 2007.

Changes in availability of larval foodplants and adult nectar plants after the Hayman Fire do not explain the fewer Pawnee montane skippers counted on moderate-to-high severity burn plots. Instead, reduction in abundance of live trees in moderate-to-highly burned areas probably creates habitat less suitable for Pawnee montane skippers. In addition, it appears that the proximity of burned areas to unburned suitable skipper habitat influences the probability of recording skippers from a burned plot. This suggests that reoccupation of burned areas will occur on the fringes of the burned area first, with subsequent dispersal into the centers of the burned area. The 3 individual Pawnee montane skippers observed in 2005 were all in transect plot 549 and the 3 individuals from 2006 were either from plots 522 or 523, all of these plots are close to unburned mapped skipper habitat, suggesting that proximity to such a relatively intact area may be crucial to the rate of recolonization. This does not discount the possibility that skippers from unburned habitat along the fringes of burned areas are making incidental exploratory flights of short duration into highly burned areas without actually reoccupying them. As a result, the Pawnee montane skippers recorded from moderate-to-high severity burn plots may not represent actual reoccupation events. Skippers may not reoccupy these highly burned habitats until there is some recovery of the ponderosa pine overstory. That some unidentified *Hesperia* skippers were recorded at

burned plots greater than 500 meters from unburned mapped skipper habitat could indicate improvements in habitat quality in some burn areas with subsequent reoccupation by skippers, or it could indicate that some skippers exhibit extensive movements between patches of suitable habitat that takes them through the less suitable highly burned areas. Monitoring the recolonization of the moderate-to highly burned habitat is important to assessing the recovery of both the habitat and skippers within this burn classification. In addition, reoccupation of moderate-to-high severity burn areas by Pawnee montane skippers, or the lack thereof, will impact the conservation status of this species in the South Platte River drainage.

CONCLUSIONS

This is the first year of the five years of monitoring that the number of Pawnee montane skippers counted at unburned and low severity burn plots has declined. The mean per acre number of Pawnee montane skippers recorded per plot at moderate-to-high severity burn plots increased an insignificant amount from 0.08 in 2005, to 0.12 in 2006. This increase, even when coupled with the decline in 2006 of skippers counted on unburned and low severity burn plots, still leaves skipper numbers on the moderate-to-high severity burn plots at levels that are over five times less than on the unburned and low severity burn plots. Pawnee montane skippers have clearly still not begun to reoccupy the highly burned areas of the Hayman Fire. The reasons for this may relate to the need for a healthy forest overstory, which may be essential for butterfly survival and reproduction.

The major question that still remains is why have Pawnee montane skippers not yet re-occupied severely burned areas where adult nectar plants and the larval foodplant are abundant. Monitoring should continue to determine if, and when, Pawnee montane skippers reoccupy the moderate-to-high severity burn plots. 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. This occupation survey should continue over several years to determine the rate of recolonization and distribution of skippers in burned areas. In addition researchers recommend that some new linear transects be established that extend across the transitions among unburned, and low severity and moderate to high severity burn habitats so that skipper behavior can be more closely examined over this habitat transition.

LITERATURE CITED

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