Pawnee Montane Skipper Post-fire Habitat Assessment Survey - September 2004

Prepared For

U.S. Fish and Wildlife Service
Lakewood, Colorado

U.S.
Forest Service
South Platte Ranger District
Morrison, Colorado

And

Denver Water
Denver, Colorado

Prepared By
Colorado Natural Heritage Program
Colorado State University
January 2005

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

The Hayman and Schoonover forest fires burned across a large fraction of the historical Pawnee montane skipper butterfly (*Hesperia leonardus montana*) habitat during the summer of 2002 in Jefferson and Douglas counties, Colorado. The fires burned approximately 40% of the Pawnee montane skippers historical 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 skippers. The multi-agency team (USFS, USFWS, and Denver Water) conducted the sampling in mid-September 2002 (ENSR 2002).

In early September 2003, these same transects were again sampled by the multi-agency team to gauge the rate of recovery of skipper populations and their habitats. To increase the temporal scope of these post-fire habitat surveys, new transects were established in 2003 in areas of skipper habitat burned by two earlier fires - the Buffalo Creek Fire of May 1996 and the High Meadow Fire of June 2000 (ENSR 2003).

In early September 2004, a subset of those transects surveyed in 2003 were again sampled by the multi-agency team to continue gauging the rate of recovery of skipper populations and their habitat.

In 2002, the South Platte River drainage received very little precipitation in fall, winter, and spring. 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 leading to extinction. The current monitoring effort offers an opportunity to examine how capable, given its current population size, is the Pawnee montane skipper of withstanding the dual effects of both fire and drought.

2.0 PROJECT OBJECTIVES

This project was established to implement a monitoring program to document Pawnee montane skipper habitat condition and population trends, in both burned and unburned skipper habitat, on the Hayman Fire area in 2002 and subsequent years. Understanding trends in population abundance, and the recolonization dynamics of burned areas, are important to understanding conservation status of the butterfly in the entire extent of its known distribution within the South Platte River drainage, and is the purpose of this monitoring effort.

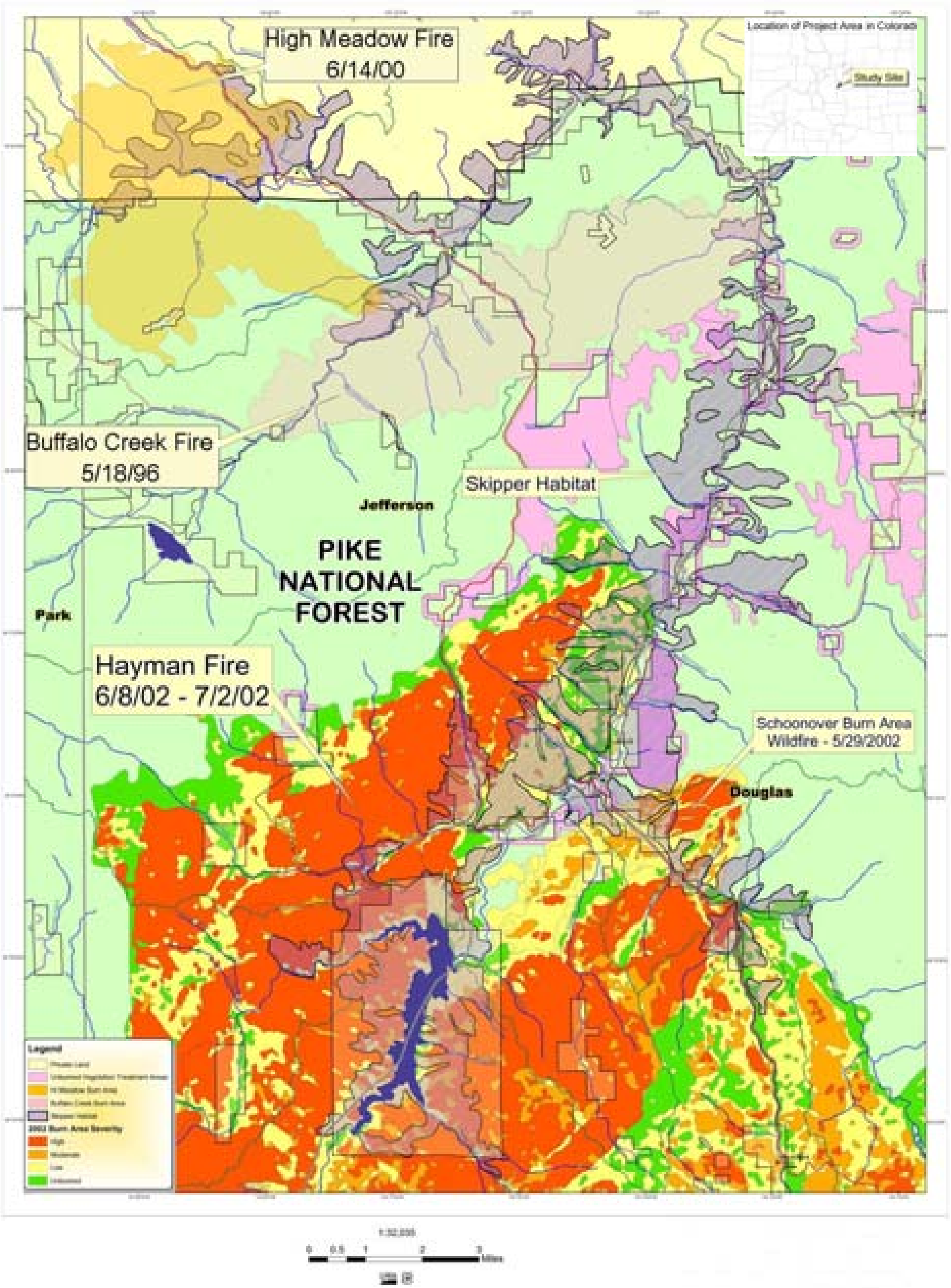
3.0 PROJECT AREA

For purposes of estimating fire-caused habitat reductions over the entire known range of the Pawnee montane skipper in the South Platte River drainage, the amount of skipper habitat burned by four recent past major fires (Buffalo Creek, High Meadow, Hayman, and Schoonover) were included in the project area (**Figure 3-1**). The Schoonover fire burned a small portion of Pawnee montane skipper habitat in 2002, and although no monitoring plots were placed within its boundary, adjacent suitable habitat burned by the Hayman Fire was sampled.

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 3-1**), was used to establish the 2002 sampling study area. The original geographical area of this study in 2002 encompassed the entirety of the Hayman Fire within the mapped 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 two sampling units within the project area. The north unit of sampling plots follows the South Platte drainage between the confluence of Wigwam Creek and the northern boundary of the Hayman Fire in the vicinity of Oxyoke (**Figure 3-2a**), and the south unit includes plots placed on both sides of Cheesman Reservoir and in the Horse Creek drainage southeast of Deckers (**Figure 3-2b**). 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 3-2a**).

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 (**Figure 3-3**) and the High Meadow Fire area (**Figure 3-4**) that burned in 1996 and 2000, respectively. Each of these two areas experienced low severity burns and are similar in forest architecture to the Hayman low severity burn areas of 2002. Comparisons between low severity burn sites differing in the length of time since burning (Buffalo Creek 1996, High Meadow 2000, and Hayman 2002) were possible with the addition of transects in these two areas.

Figure 3-1. Skipper Habitat burned by major fire since 1996. Wildfire areas (1996-2002) and skipper habitat



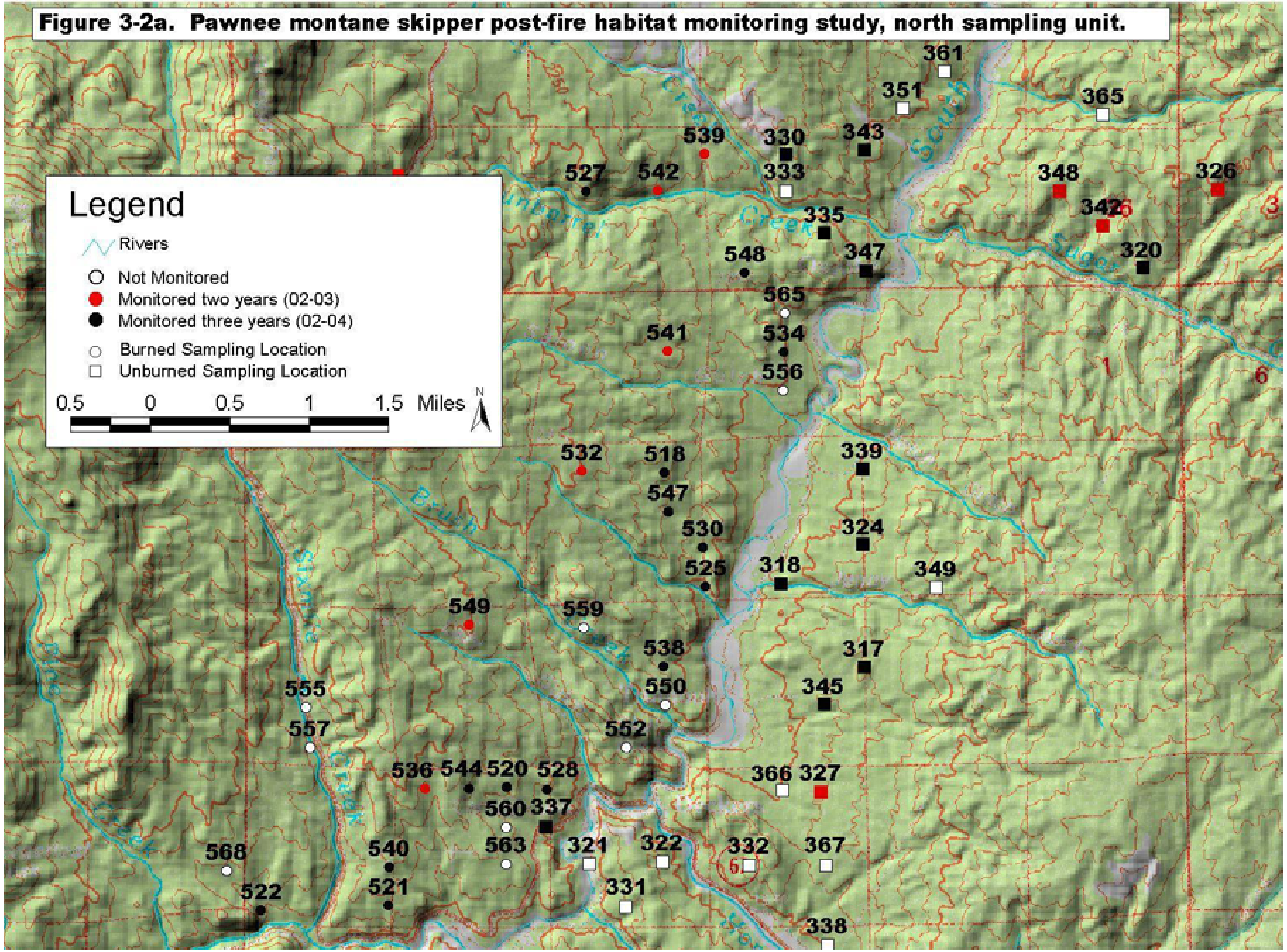
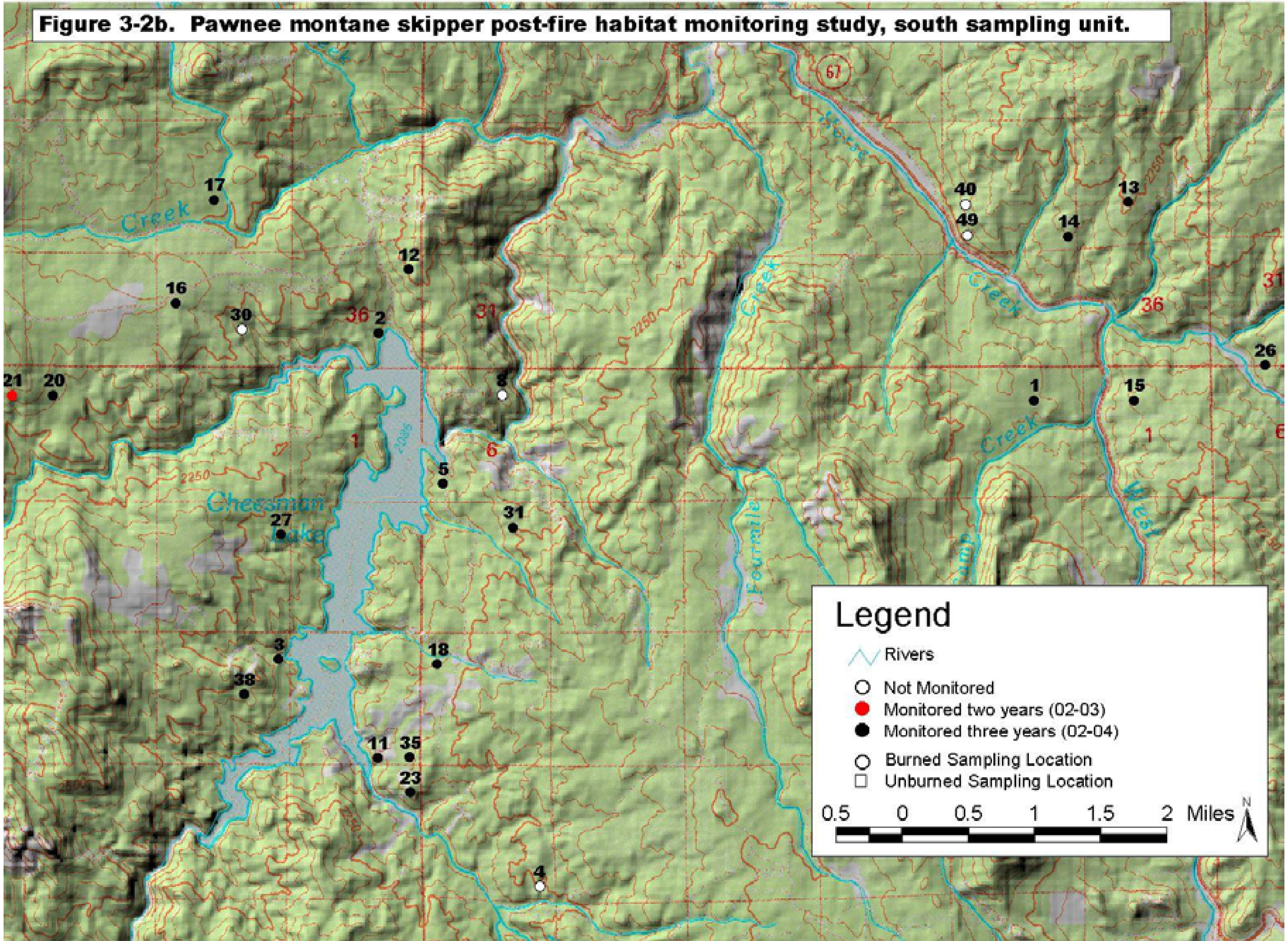


Figure 3-2a. Pawnee montane skipper post-fire habitat monitoring study, north sampling unit.
Legend
Rivers
Not Monitored
Monitored two years (02-03)
Monitored three years (02-04)
Burned Sampling Location
Unburned Sampling Location
0.5 0 0.5 1 1.5 Miles
N
361
351
365
539
330
343
527
542
333
348
326
342
335
320
548
347
565
541
534
556
532
518
339
547
530
324
318
525
349
549
559
538
317
550
345
555
557
552
536
544
520
528
366
327
560
337
568
540
563
321
322
332
367
522
521
331
338

Figure 3-2b. Pawnee montane skipper post-fire habitat monitoring study, south sampling unit.



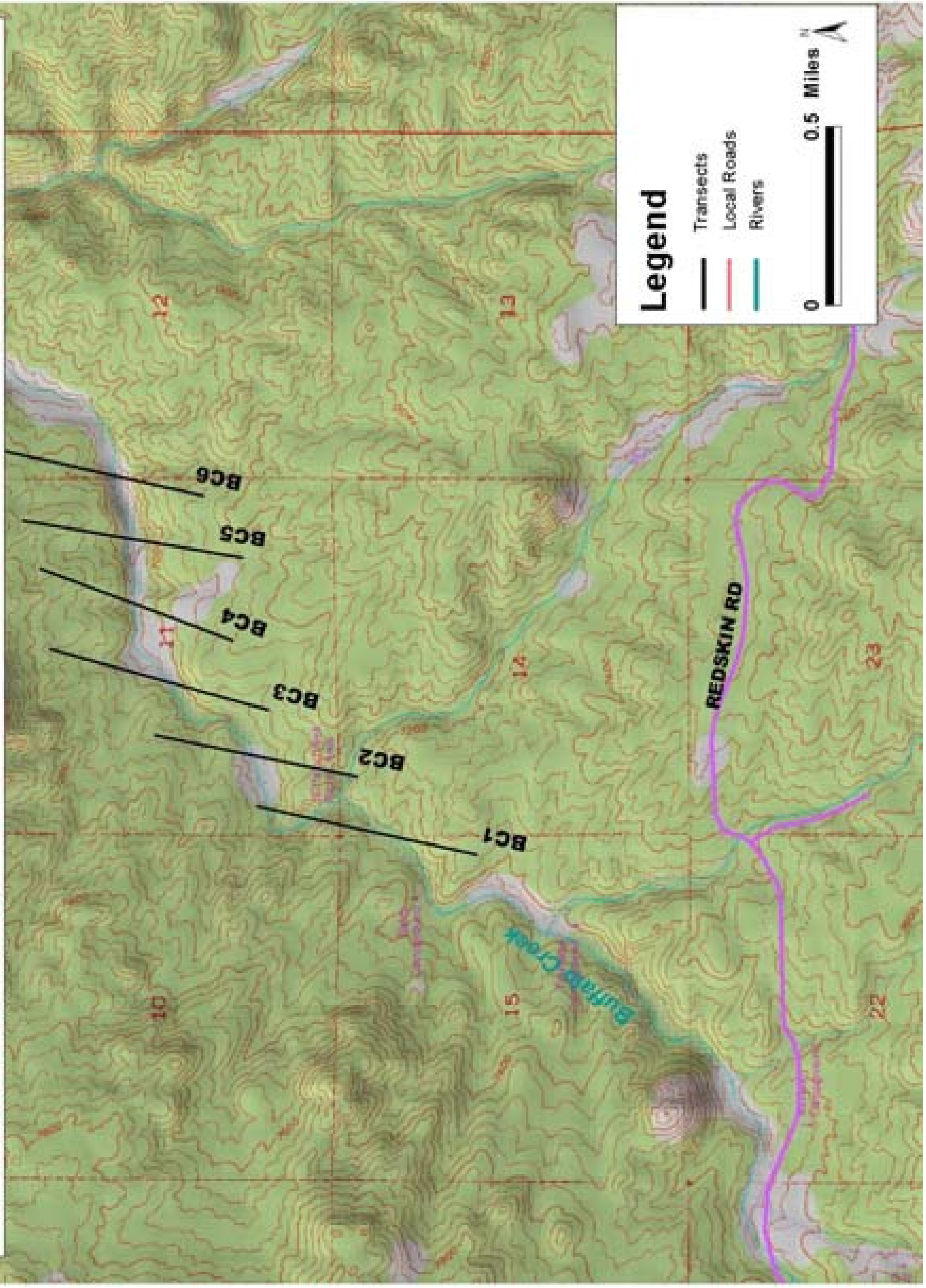


Figure 3-3. Buffalo Creek, 2004 skipper sampling transects located one mile southwest of the Buffalo Creek Forest Service work station, Jefferson County, Colorado.

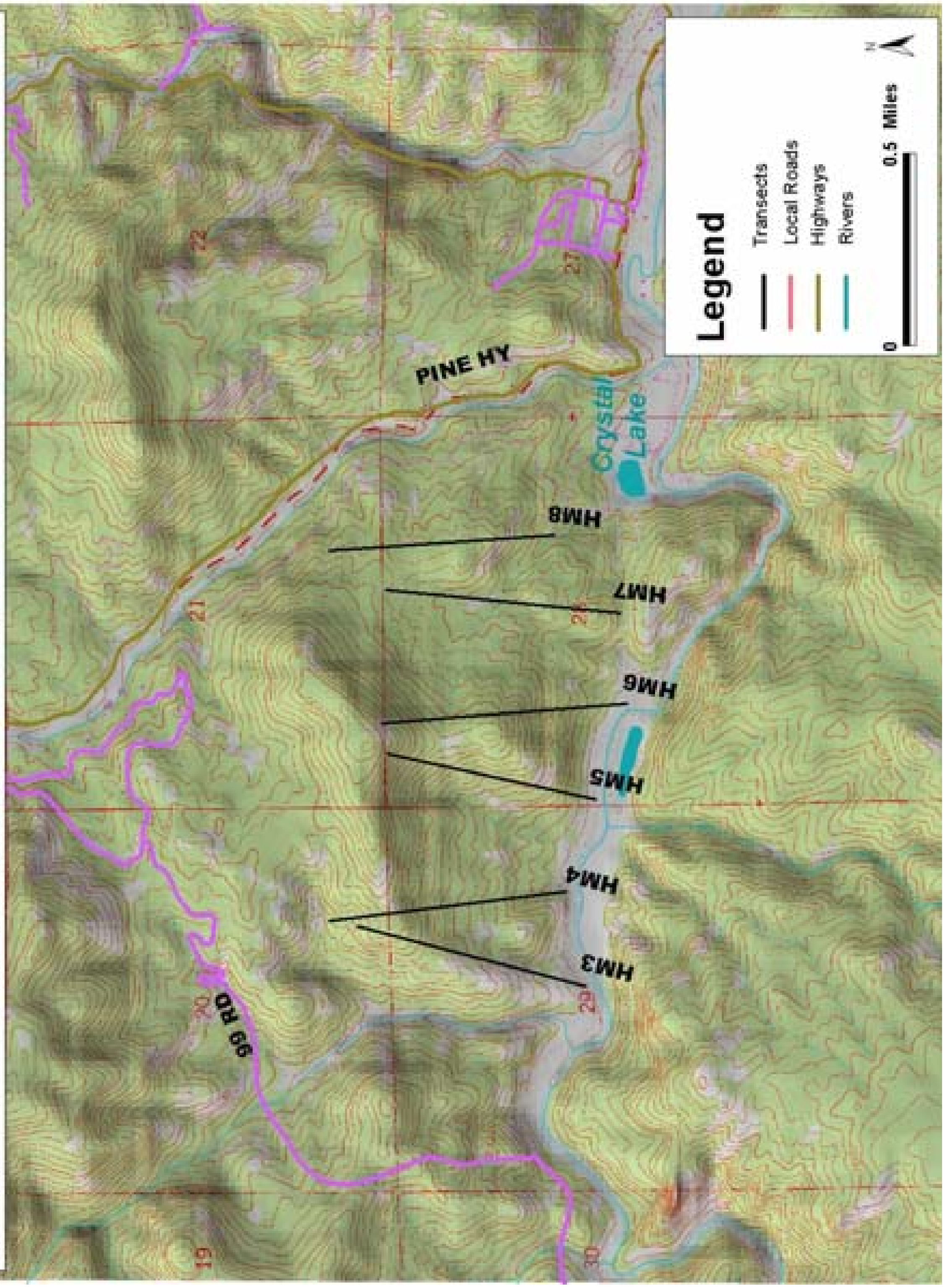


Figure 3-4. High Meadow Fire, 2004 skipper sampling transects located at Pine Valley Ranch Park, Jefferson County, Colorado.

4 .0 FIELD DATA COLLECTED AND PROJECT OUTPUTS

1. Measured in the monitoring effort were a) an estimate of skipper numbers based on belt transect counts; b) an estimate of the number of blooming *Liatris* stems (primary adult skipper nectar source); c) the frequency of blue grama grass clumps (skipper larval foodplant); d) living and dead trees in larger size classes within burned and unburned areas; and e) records of BAER treatments (surface stabilization activities like scarification) observed on transects. Collection of these parameters was not consistent across years (**Table 4-1**).

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

3. A recalculation of currently suitable skipper habitat in the upper South Platte drainage, based on these field studies and interpretation of post-fire satellite imagery.

4. Assessments of habitat recovery and factors influencing skipper reoccupation of burned habitat in areas that have experienced different burn intensities and fire intervals.

Table 4-1. Parameters measured during the post-fire monitoring project (2002, 2003, 2004).

	Year of collection		
Parameter	**2002**	**2003**	**2004**
Estimate of skipper numbers	Yes	Yes	Yes
Estimate of blooming *Liatris* stems	Yes	Yes	Yes
Frequency of blue grama grass clumps	Yes	Yes	Yes
Living trees	Yes	Yes	Yes
Standing dead trees[1]	--	Yes	Yes
BAER treatments[2]	Yes	Yes	--

[1]New to the 2003 sampling effort and continued in 2004 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]Dropped from the 2004 field study were recording of BAER treatments observed on transects.

5.0 PROJECT DESIGN AND SAMPLING METHODS

5.1 Sampling Area Dimensions and Selection

The field sampling methods used from 2002 to 2004 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 mapped 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 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 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 mapped habitat was less than 75 percent of the block further reduced potential sampling areas.

A sub-sample was taken of each 40-acre block selected for sampling 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). Forty-six transects were sampled between August 31, and September 8, 2004 (**Figure 3-2a** and **3-2b**). Of this number, 11 were located in unburned areas, 20 were located in low severity burn areas, and 15 were located in moderate to high severity burned areas (see Appendix B for dates of sampling). Ten transects sampled in 2003 were not re-sampled in 2004, including transects 326, 327 and 348 (all unburned); 532, 536, 538, 539, and 541 (all low severity burn plots); and 21 and 549 (both moderate-to-high severity burn plots). In addition, plots 13 and 26 were part of the October 2001 Polhemus prescribed burn, a low intensity fire. Since inception of the monitoring program in 2002, both plots have been analyzed as low intensity burn plots.

The transects at the Buffalo Creek Fire (1996) are located on either side of South Buffalo Creek and Forest Road 543 about 1.2 miles southwest of the USFS Buffalo Creek Work Station on Highway 126. The High Meadow Fire transects are on south-facing slopes just north of the North Fork of the South Platte River in Pine Valley Ranch Park (Jefferson County Open Space). The Buffalo Creek and High Meadow fires were moderate-to-high severity burns, but the full range of burn intensities was unavailable for these two fires in known skipper habitat, so monitored transects were placed in known low severity burn areas. The Buffalo Creek and High Meadow plots are compared to Hayman low severity burn plots in the analyses that follow (see Section 7.2). These transects were established in 2003 and data were collected in 2003 and 2004 from the transects. In each study area, six 1,000-m linear transects were established in parallel (**Figures 3-3** and **3-4**). The protocols for habitat assessment and skipper counts on these 12 new transects were the same as those used on the Hayman Fire transects, except that the transects were linear instead of diamond-shaped, and the total area surveyed was 2.5 acres (1,000 x 10 m) instead of 2 acres (800 x 10 m). These linear transects were divided into four legs of 250 m each, which in turn were subdivided into 10 segments of 25 m each for recording purposes. The data obtained were expressed as frequency data (for blue grama), and density per acre (for trees, gayfeather, and skippers), so that the results were directly comparable to results from the Hayman surveys.

5.2 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 then the parameters measured along each transect.

5.2.1 Sampling Site locations

The UTM coordinates for the center point of each 40-acre sampling site were included on the sampling order lists located behind the Sampling Order table in the protocol. Each team used a GPS instrument to find this center point, and then made a determination as to how to best 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.

5.2.2 Data Collection

The following section describes the information that was collected and compiled on the data sheet (**Figure 5-1**). All data were taken within the area of the belt transect (800 x 10 m) with the exception of other observations that were useful in analyzing habitat conditions. These other observations 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 day 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.

Figure 5-1. 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		
[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
[illegible]	#	#	#	#	#	#	#	#	#	#	#	#	#

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		
[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
[illegible]	#	#	#	#	#	#	#	#	#	#	#	#	#

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		
[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
[illegible]	#	#	#	#	#	#	#	#	#	#	#	#	#

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		
[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0-20													
20-40													
40-60													
60-80													
80-100													
100-120													
120-140													
140-160													
160-180													
180-200													
[illegible]	#	#	#	#	#	#	#	#	#	#	#	#	#

- 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.

- 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 recorded in 2003 or 2004.

  - 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 in 2003 and 2004, 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 (Lipu) stem counts. Stems of blooming Prairie gayfeather (*Liatris punctata*) 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 comma 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.

6 .0 DATA MANAGEMENT AND ANALYSIS

6.1 Data Management

Data sheets were copied and distributed to the sponsoring agencies. Transect GPS locations were entered into the USFS 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.

6.2 Transect Grouping for Analysis

USFS burn intensity classes were based on the appearance of the burned and unburned trees on satellite and aerial photo imagery. After completing the skipper habitat sampling, and reviewing the collected data in 2002, the USFS map was found to be 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 there was no skipper survivorship in these areas, and overstory recovery will require many years. The low intensity 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 may have survived in these low severity burn areas, and some overstory trees remain, it is likely that skipper reoccupation may occur over a shorter time frame. Consequently, transects located within low burn severity areas mapped by the USFS were analyzed as a single group.

6.3 Statistical Analysis

As indicated above, the burn severity classification appears to be biologically useful in evaluating skipper habitat condition and potential for recovery. 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 in 2002, each skipper habitat variable was examined in relation to burn intensity (which has been mapped, and can be remapped over time). 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 high and moderate severity). For the Hayman Fire area, data were analyzed using a two factorial design with three levels of year (2002, 2003, and 2004), and three levels of burn severity (unburned, low severity, and moderate-to-high severity). For the Buffalo Creek, High Meadow, and Hayman fire areas, data were analyzed using a two factorial design with two levels of year (2003, and 2004) and one level of burn severity (low severity burn). 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 $P=0.05$. To correct for non-normality in the dataset, either log (for frequency data) or square-root transformations were performed prior to analysis. All analyses were conducted using SAS 9.1 (SAS 2004).

Setting a level of significance in statistics determines the likelihood of committing a Type I Error, or in our study the probability a difference between sample means will be declared significant, when no difference exits. Such errors can occur, because some samples will show a relationship just by chance. When performing many testes 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). Type II Error rates are most influenced by sample size, 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. Estimates of power for most of the analyses performed here were greater than .85, and in most cases exceeded 0.90 (significant differences between compared means would be detected 85% to >90% of the time). The only exception was in the comparison of means for gayfeather, where estimates of power were consistently below 0.50, regardless of whether a significance level of 0.05 or 0.1 was used. This low power of detection for differences in gayfeather, probably relates to its spotty distribution and low abundance within the project area.

7.0 RESULTS AND DISCUSSION

7.1 Post-fire Skipper Habitat Conditions and Abundance on the Hayman Burn Area

7.1.1 Current Versus Historic Habitat Use

The total suitable habitat for the Pawnee montane skipper (*Hesperia leonardus montana*) in the South Platte River drainage is approximately 24,831 acres (ENSR 2003). Between 1996 and 2002, approximately 48.3 percent (12,026 acres) of the habitat was burned in four separate fires: the Buffalo Creek, High Meadow, Schoonover and Hayman fires. See ENSR (2003), for an indepth discussion of changes to historic skipper habitat resulting from these four fires. Understanding trends in population abundance and the recolonization dynamics of burned areas, is important to understanding the conservation status of the butterfly in the entire extent of its known distribution within the South Platte River drainage.

7.1.2 Post-fire Changes in Forest Structure

Monitoring data from previous years (2002 and 2003) have shown, that among years, the number of live trees in unburned and low severity burn areas were significantly greater in number, than in the moderate-to-high severity burn area (ENSR 2003). This is also true for 2004 (**Table 7-1**). A comparison of live tree stem counts in 2003 and 2004, indicates an increase of live trees in all treatment groups (**Table 7-1**). The difference is likely the result of sampling area, rather than a true increase in the number of live tree stems. The transect centerlines established in 2004 did not exactly match the centerlines in 2002 or 2003 because transect start and end points were not permanently marked. Also, the determination of what constituted a live tree differed between 2002 and the subsequent two years of monitoring (see 5.2.2 Data Collection, tree counts), which could account for the observed differences. This calls into question the decrease in live tree stems counted in 2003 compared to the 2002 sampling period (ENSR 2003). It is possible that live tree stem counts did decline from 2002 to 2003 in the Hayman fire area, but the sampling design of the present study is insufficient to determine the amount of decline attributable to sampling error versus a true loss of trees.

Data from two years of monitoring (2003 and 2004), indicate numbers of dead tree stems increased significantly from less to more severely burned areas, as one would suspect (**Table 7-2**). As mentioned previously, the purpose of this study is to determine the temporal distribution and trends in abundance of Pawnee montane skippers in areas of varying burn intensities. Understanding the timeline and degree of recolonization in the moderate-to-high severity burn areas will help define conservation status of the Pawnee montane skipper.

Table 7-1. Live tree stems (>6 inches dbh) per acre among sample years (2002, 2003, and 2004) and habitat condition (unburned, low, and moderate to high) for Hayman fire transects.

Year	Burn Intensity	Sample Size (# of Transects)	Mean (stems per acre)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2004	unburned	11	84.07	56.94	AB
	low	20	67.43	50.01	B
	moderate to high	15	2.13	5.03	C
2003	unburned	14	79.53	58.02	AB
	low	25	47.73	40.83	B
	moderate to high	17	0.30	0.76	C
2002	unburned	13	127.84	58.61	A
	low	25	80.69	63.40	AB
	moderate to high	17	0.92	2.44	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 7-2. Standing dead tree stems (>6 inches dbh) per acre among sample years (2002, 2003, and 2004) and habitat condition (unburned, low, and moderate to high) for Hayman fire transects.

Year	Burn Intensity	Sample Size (# of Transects)	Mean (stems per acre)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2004	unburned	11	5.38	8.53	A
	low	20	35.54	26.01	B
	moderate to high	15	58.48	32.93	BC
2003	unburned	14	2.64	2.96	A
	low	25	27.40	24.08	B
	moderate to high	17	62.16	29.19	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.

7.1.3 Blue grama (*Bouteloua gracilis*) Occurrence

Blue grama shows a statistically insignificant recovery across all conditions of burn severity in 2004 (**Table 7-3**). Drought in 2002, reduced frequency of blue grama below historical levels observed in 1986 (ENSR 2003), and the lingering effects of drought suppressed frequencies even further in 2003. In 2004, however, frequency of blue grama was statistically similar to 2002, suggesting some recovery of blue grama occurred in 2004, but not enough to statistically distinguish 2004 frequencies from those of 2003 (**Table 7-3**).

Table 7-3. Blue grama (*Bouteloua gracilis*) among sample years (2002, 2003, and 2004) and habitat condition (unburned, low, and moderate to high) for Hayman fire transects.

Year	Burn Intensity	Sample Size (# of Transects)	Mean (% frequency)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2004	unburned	11	11.82	7.61	AB
	low	20	11.20	8.64	AB
	moderate to high	15	16.00	24.48	AB
2003	unburned	14	8.29	6.68	B
	low	25	7.72	4.60	B
	moderate to high	17	5.76	3.29	B
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.

7.1.4 Gayfeather (*Liatris punctata*) Occurrence

In 2004, gayfeather continued a recovery initiated in 2003. Compared to 2002, number of stems per acre in 2004 were significantly greater under all habitat conditions, and stem counts in low severity burn areas were significantly greater in 2004, than for all conditions of burn severity in 2003 (**Table 7-4**), suggesting that gayfeather was responding to release from the drought conditions of 2002. As stated in previous reports, this perennial plant is well adapted for such a response, with its massive subterranean crown, and deep root system (ENSR 2003). Similar to data from the previous two years of monitoring, stem counts per acre among all conditions of burn severity were statistically similar in 2004, indicating that gayfeather has a distribution unaffected by fire severity (**Table 7-4**).

Table 7-4. Prairie gayfeather (*Liatris punctata*) among sample years (2002, 2003, and 2004) and habitat condition (unburned, low, and moderate to high) for Hayman fire transects.

Year	Burn Intensity	Sample Size (# of Transects)	Mean (stems per acre)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2004	unburned	11	71.65	83.42	AB
	low	20	79.85	63.63	A
	moderate to high	15	79.69	135.64	AB
2003	unburned	14	27.97	25.68	BC
	low	25	12.89	14.17	CD
	moderate to high	17	20.50	17.68	BC
2002	unburned	13	4.63	7.40	CD
	low	25	0.18	0.44	D
	moderate to high	17	1.43	4.57	D

[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.

7.1.5 Skipper (*Hesperia leonardus montana*) Occurrence

In 2004, 44 Pawnee montane skippers (*H. l. montana*) were observed on the Hayman study area, including 18 from 11 unburned plots and 26 from 20 low severity plots sampled. This corresponds to a mean of 0.47 Pawnee montane skippers per acre for 46 sampled transects, roughly 5 times the 0.10 skippers per acre recorded from 56 transects in 2003, and 23 times the 0.02 skippers per acre recorded from 55 transects in 2002. On 11 Hayman unburned plots, 0.83 Pawnee montane skippers per acre were recorded in 2004 (**Table 7-5**); less than the 2.60 Pawnee montane skippers per acre recorded from 47 unburned plots in 1986. Although the recovery in 2004 was dramatic, counts are still lower than densities recorded in the 1980's, when 2.1 to 3.6 Pawnee montane skippers per acre were counted on unburned plots (ERT 1986, 1988, 1989). If unburned and low severity plots are considered jointly, 0.75 Pawnee montane skipper were recorded per acre in 2004. In 2004, many skippers we observed were not identified to species, and if these skippers are included in the analysis, there were 1.84 skippers per acre recorded from 31 unburned and low severity plots. It is unlikely that all unidentified skippers were Pawnee montane skippers, but some most certainly were. Of particular interest, is that no Pawnee montane skippers were observed on any moderate-to-high severity burn plots in 2004. Recolonization of these moderate-to high severity burn areas is important to the conservation status of this species in the South Platte River drainage.

In 2002 and 2003, numbers of Pawnee montane skippers were statistically similar on all monitored areas (**Table 7-5**), suggesting that drought in 2002 reduced skipper numbers on unburned areas, and both drought and fire reduced skippers on burned areas. No skippers were observed on moderate-to-high severity burn plots in 2002, and only four were observed in 2003.

In 2004, significantly more skippers were counted on unburned and low severity burn plots, than on moderate-to-high severity burn plots, indicting that skipper occupancy of intensely burned areas is low, even two years after a fire. Distribution and condition of low severity burn plots occupied by skippers in 2004 were near mapped suitable habitat left unburned by the fires, they were located towards the fires edge, where burn intensity might have been less severe, and gayfeather, live trees and blue grama were numerous on all occupied plots (**Figure 7-1**) (**Table 7.6**). Two plots do not fit the above description; low severity burn plots 544 and 14 were both occupied, but were towards the interior of the fire far from unburned mapped suitable habitat. Patterns of plot occupancy by skippers suggest skippers survived the fire in some plots (e.g. 544, 14), and in others recolonization from unburned mapped suitable habitat may be occurring.

Among years, mean number of skippers was lowest on burned plots, supplying further evidence that fire influenced skipper numbers. Forest attributes, including components of tree density, canopy cover, ground cover, species diversity, patterns of light and dark, and spatial heterogeneity may play important roles in habitat selection by Pawnee montane skippers. Through reductions in number of live trees, fire probably altered some of these attributes in moderate-to high severity burn areas, potentially making the habitat unsuitable to skippers. Alternatively, the intense crown fire experienced on these plots may have caused mortality of all skipper life stages (eggs, larvae, and adults) and lack of recolonization may reflect this mortality. It may require a few years of dispersal from unburned or low severity burn areas, to moderate-to-high severity burn areas, before skippers successfully recolonize areas where crown fires occurred. Movement patterns of Pawnee montane skippers are unknown (Opler 1998), but if occurrences are all small (under 10 hectares) and widely scattered, and there is some actual evidence of persistent patch vacancy, which is characteristic of the current population after the recent fire events, maximum movements of approximately one kilometer are not unlikely (NatureServe 2005). It will be important to continue monitoring the Hayman fire area to determine if, and when, the skippers do recolonize the moderate-to-high severity burn area.

Table 7-5. Pawnee montane skipper (*Hesperia leonardus montana*) per acre among sample years (2002, 2003, and 2004) and burn intensity (unburned, low, and moderate to high) for all Hayman transects sampled in 2002, 2003, and 2004.

Year	Burn Intensity	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (p=0.05)[1]
2004	unburned	11	0.83	0.88	A
	low	20	0.66	1.42	A
	moderate to high	15	0	0	B
2003	unburned	14	0.18	0.38	AB
	low	35	0.08	0.24	B
	moderate to high	17	0.03	0.12	B
2002	unburned	13	0.08	0.28	AB
	low	25	0	0	B
	moderate to high	17	0	0	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.

Table 7-6. Skipper habitat condition at low severity burn areas occupied by Pawnee montane skipper (*H. l. montana*) in 2004.

Transect #	Gayfeather counts	Live tree counts	Dead tree counts	Blue grama frequency	Pawnee montane skipper
Occupied by Pawnee montane skipper					
14	357	32	97	8	1
530	300	158	5	19	11
26	166	161	4	9	1
547	121	103	84	13	7
544	112	67	92	15	1
518	99	114	47	43	1
548	58	145	103	3	1
538	28	205	12	10	3

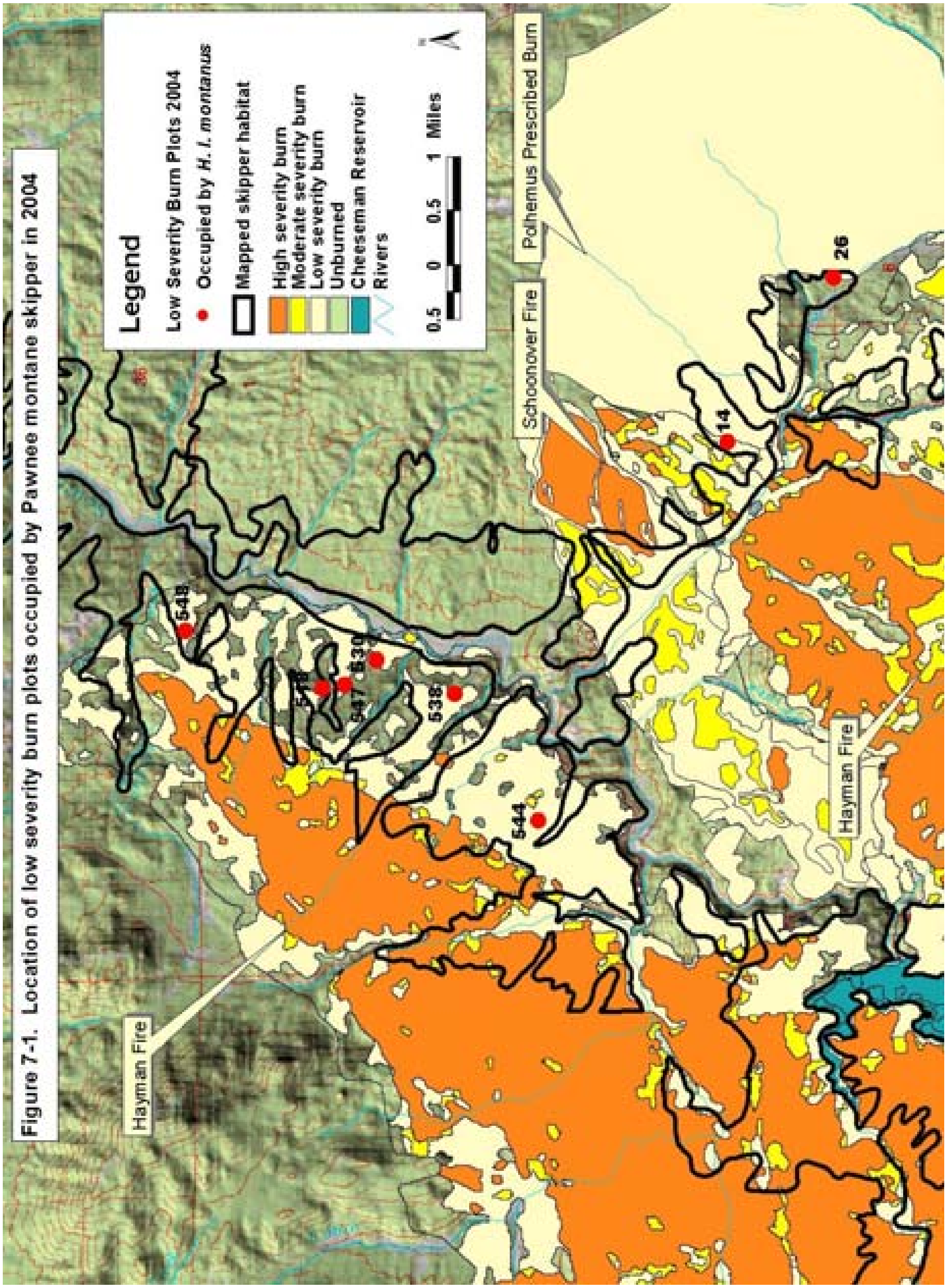


Figure 7-1. Location of low severity burn plots occupied by Pawnee montane skipper in 2004

7.2 Skipper Dispersal into Burned Areas: Comparison of the Hayman Fire (2002) with the Buffalo Creek (1996) and High Meadow Fires (2000).

Four separate fires, occurring in three different years, have burned approximately 50% of the suitable Pawnee Montane Skipper habitat since 1996. Low severity burns in three of these fire areas have been monitored, in varying degrees, since 2002 (**Table 7-7**). Analysis of the data from these fire areas offers information on host plant recovery and re-colonization by skipper butterflies, at varying times post-fire. The areas monitored were the Buffalo Creek, High Meadow, and Hayman fire areas. The Hayman Fire created a mosaic of low, moderate, to high severity burns across the landscape, and for the following analyses only Hayman low severity burn plots are included. As stated previously, the Buffalo Creek and High Meadow fires were moderate-to-high severity burns, but we placed transects in known low severity burn areas within these fires. Analysis shows that numbers of live trees on transects between these two areas (Buffalo Creek and High Meadow), were statistically similar to the Hayman low severity plots, indicating our placement of plots at Buffalo Creek and High Meadow successfully captured low severity burns.

7.2.1 Blue grama (*Bouteloua gracilis*) Occurrence

Within each year (2003 and 2004) that all three low severity burn areas were monitored, blue grama frequencies were statistically similar among all three areas (Buffalo Creek, Hayman, High Meadow) (**Table 7-8**). Because each plot burned in different years, this suggests that blue grama recovers rapidly after fire. In 2003, one year after burning, the frequency of blue grama on the Hayman plots was statistically indistinguishable from the Buffalo Creek plots, which burned in 1996.

Between the two years in which all three areas were monitored, High Meadow 2004 is the only significantly different sample. The frequency of blue grama increased in all three burn sites from 2003 to 2004, probably in response to relief from drought. As just stated, only in the High Meadow area was this increase significant.

Table 7-7. Transects monitored in low severity burned sites (1996, 2000, 2002) sampled in 2002 (Hayman) and 2003 and 2004 (Buffalo Creek, High Meadow, and Hayman).

Fire	Year of Burn	Transects Monitored 2002	Transects Monitored 2003	Transects Monitored 2004
Buffalo Creek	1996	0	6	6
High Meadow	2000	0	6	6
Hayman	2002	25	25	20

Table 7-8. Blue grama (*Bouteloua gracilis*) frequencies on low severity burned sites (1996, 2000, 2002) sampled in 2002 (Hayman) and 2003 and 2004 (Buffalo Creek, High Meadow, and Hayman).

Year	Site	Year of Burn	Sample Size (# of Transects)	Mean (% frequency)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2004	Buffalo Creek	1996	6	9.83	4.26	AB
	High Meadow	2000	6	29.5	35.45	A
	Hayman	2002	20	11.20	8.64	AB
2003	Buffalo Creek	1996	6	6.00	2.37	B
	High Meadow	2000	6	9.50	4.46	AB
	Hayman	2002	25	7.72	4.60	B
2002	Hayman	2002	25	23.48	9.83	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.

7.2.2 Prairie Gayfeather (*Liatris punctata*) Occurrence

Within each year (2003 and 2004) that all three areas were monitored gayfeather stems per acre were statistically similar among all three low severity areas (Buffalo Creek, Hayman, High Meadow) (**Table 7-9**). Similar to blue grama, this suggests that gayfeather recovers rapidly after fire, because in 2003, one year post-fire, counts on Hayman plots are similar to Buffalo Creek and High Meadow, which burned in 1996 and 2000, respectively.

Between the two years in which all three areas were monitored, the only significantly different sample is Hayman 2004, which had counts of gayfeather greater than all three areas in 2003. Stem counts on all three areas increased in 2004, and were significantly greater than counts recorded from the Hayman plots for the drought year of 2002, indicating that this perennial flower with its rhizomatous root system, and vegetative regeneration responded rapidly to release from drought. In 2003, only on the Hayman plots were stem counts statistically greater than counts recorded in 2002, indicating that on all three areas it took gayfeather two years to show significant recovery from the 2002 drought.

Table 7-9. Prairie gayfeather (*Liatris punctata*) stems per acre on low severity burned sites (1996, 2000, 2002) sampled in 2002 (Hayman) and 2003 and 2004 (Buffalo Creek, High Meadow, and Hayman).

Year	Site	Year of Burn	Sample Size (# of Transects)	Mean (stems per acre)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2004	Buffalo Creek	1996	6	56.59	57.76	AB
	High Meadow	2000	6	45.66	51.11	AB
	Hayman	2002	20	79.85	63.63	A
2003	Buffalo Creek	1996	6	17.81	18.53	BC
	High Meadow	2000	6	6.14	5.51	BC
	Hayman	2002	25	12.89	14.17	B
2002	Hayman	2002	25	0.18	0.44	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.

7.2.3 Forest Structure and Skipper (*Hesperia*) Occurrence

By decreasing forest canopy cover through removal of live trees, low severity fire might benefit *Hesperia* butterflies, which prefer open dry forests with an understory of native grasses (NatureServe. 2004). The effect that landscape scale stand-replacing fire, like the Hayman Fire, had on *Hesperia* butterflies is less clear. Numbers of live, dead, and all standing tree stems were statistically similar among all of the low severity burn areas in all years sampled (**Table 7-10**). This was expected, indicating that the Forest Service's classification of the burn areas was very accurate. There was a large decrease from 2002 to 2003, in live trees on the Hayman burn area, but then an increase in 2004 that did not correspond with changes observed in dead trees, which also increased in 2004. As previously mentioned, these differences probably reflect differences in sampling area and/or sampling methodology, and not changes in forest structure. As discussed previously, significantly more dead trees were recorded on low severity burn plots of the Haymen fire, than on unburned plots (**Table 7-2**), suggesting that in low severity burn areas fire did influence forest canopy cover.

Table 7-10. Live, dead, and all tree stems (>6m dbh) per acre on low severity burned sites (1996, 2000, 2002) sampled in 2002 (Hayman, live trees only) and 2003 and 2004 (Buffalo Creek, High Meadow, and Hayman).

Year	Site	Year of Burn	Sample Size (# of Transects)	Mean (stems per acre)	Standard Deviation	Homogenous Groups (P=0.05)[1]
Live Standing Tree Stems						
2004	Buffalo Creek	1996	6	41.28	24.06	A
	High Meadow	2000	6	33.25	16.40	A
	Hayman	2002	20	67.43	50.01	A
2003	Buffalo Creek	1996	6	41.41	8.48	A
	High Meadow	2000	6	39.59	22.99	A
	Hayman	2002	25	47.73	40.83	A
2002	Hayman	2002	25	80.69	63.40	A
Dead Standing Tree Stems						
2004	Buffalo Creek	1996	6	24.75	14.06	A
	High Meadow	2000	6	50.86	28.53	A
	Hayman	2002	20	35.54	26.01	A
2003	Buffalo Creek	1996	6	26.64	15.92	A
	High Meadow	2000	6	57.40	28.47	A
	Hayman	2002	25	27.40	24.08	A
All Standing Tree Stems						
2004	Buffalo Creek	1996	6	68.06	12.33	A
	High Meadow	2000	6	84.11	33.67	A
	Hayman	2002	20	102.97	52.61	A
2003	Buffalo Creek	1996	6	66.03	13.52	A
	High Meadow	2000	6	96.99	39.70	A
	Hayman	2002	25	75.13	47.00	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.

On low severity burn plots skipper counts were significantly different only for the Hayman 2004 sample, which had greater counts than in 2003 and 2002 (**Table 7-11**). This suggests similarity in skipper populations on all low severity burn areas. There are, however, differences in the timing of fire events on each area, with the Haymen fire occurring in 2002, High Meadow in 2000, and Buffalo Creek in 1996. This may suggest that low intensity fires influence skipper numbers little, that recovery from them is quick, or that the 2002 drought reduced skipper numbers on older burn areas to levels observed on the Hayman area during the year of burn. Significant increases in skipper numbers on the Hayman plots in 2004, suggests that populations there are recovering, possibly as a result of improving habitat conditions, evidenced by increased frequency of blue grama and significantly more gayfeather on these plots. Whether this recovery is from drought, or from response of skippers to changing habitat conditions after fire, is indeterminable. Although not significant, the other areas also exhibited increased skipper numbers in 2004 compared to 2003, suggesting that all increases were in response to relief from drought conditions. Without recent pre-fire data on skipper numbers, it is impossible to statistically test if opening of the forest canopy on Hayman low severity burns is increasing skipper abundance. Although, skipper counts from the 1986 unburned plot surveys (ERT 1986) would allow for less rigorous comparison of post and pre-fire skipper abundance. However, ongoing monitoring of forest thinning in the Trumbull area supplies evidence correlating increases in the skippers' adult food plant (*Liatris*) resulting from controlled thinning, with increases in skipper numbers (Natural Perspectives 2004).

Evidence that forest thinning, whether through low severity burn or otherwise, has positive influence on *Hesperia* skipper populations is supplied by data collected in 2004 on Hayman unburned plots. Four unburned Hayman plots (317, 324, 339, 345) sampled in 2004, received mechanical thinning treatments in either 2002 (317, 345) or 2004 (339, 324), and these plots had high skipper counts in 2004. Of the 160 total skippers observed on 47 plots in 2004, 39% (63) were observed on these four mechanically thinned plots. These increases are consistent with results from monitoring of current vegetation thinning activities and *Hesperia* skipper populations in the Trumbull area of the South Platte River drainage (Natural Perspectives 2004).

Table 7-11. *Hesperia* skipper (*H. comma* and *H. leonardus montana*) per acre on low severity burn sites (1996, 2000, 2002) sampled in 2002 (Hayman) and 2003 and 2004 (Buffalo Creek, High Meadow, and Hayman).

Year	Site	Year of Burn	Sample Size (# of Transects)	Mean (skippers per Acre)	Standard Deviation	Homogenous Groups (P=0.05)[1]
2004	Buffalo Creek	1996	6	1.15	2.62	AB
	High Meadow	2000	6	0.67	1.30	AB
	Hayman	2002	20	1.37	2.08	A
2003	Buffalo Creek	1996	6	0.00	0.00	AB
	High Meadow	2000	6	0.27	0.66	AB
	Hayman	2002	25	0.10	0.25	B
2002	Hayman	2002	25	0.00	0.00	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.

7.3 Post-fire Skipper Habitat Conditions and Trends in Skipper Population Abundance on the entire Project Area

7.3.1 Skipper (*Hesperia*) Occurrence

During three years of monitoring, populations of *Hesperia* skippers were continuously increasing throughout the project area (**Table 7-12**). This was true for all sample areas and burn severity conditions (**Table 7-13**). The mean number of all *Hesperia* skippers (*H. l. montana* and *H. comma*) observed on all study plots (including Buffalo Creek and High Meadow), in 2002, 2003, and 2004 was 0.02, 0.17 and 1.58 per acre, respectively. Overall, among years the only significant increase in skipper numbers occurred in 2004 (**Table 7-12**), and resulted from increases in skippers on unburned plots, where 4.78 skippers per acre were recorded (**Table 7-13**). On all other plots, skipper numbers were also increasing among years, but these increases were neither large nor significant; this is particularly true of the high-severity-burn area (**Table 7-13**). If the four unburned plots that received thinning, and which may function because of their changed structure like low severity burn plots, are analyzed with low severity plots, skipper abundance drops to 3.22/acre on unburned plots and increases to 2.5/acre on low severity plots. These increases in skipper abundance (**Table 7-14**) are correlated with increases in blue grama and gayfeather densities in 2004, to the historic levels observed in 1986 (ERT).

Table 7-12. *Hesperia* skipper (*H. comma* and *H. leonardus montana*) per acre among sample years (2002, 2003, and 2004) for all transects.

Year	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (p=0.05) [1]
2004	58	1.58	3.20	A
2003	68	0.17	0.41	B
2002	55	0.02	0.14	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.

Table 7-13. *Hesperia* skipper (*H. comma* and *H. leonardus montana*) per acre among sample years (2002, 2003, and 2004) and burn intensity (unburned, low, and moderate-to-high) for all transects sampled in 2002, 2003, and 2004.

Year	Burn Intensity	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (p=0.05)[1]
2004	unburned	11	4.78	5.52	A
	low	32	1.20	2.02	BC
	moderate to high	15	0.07[2]	0.26	C
2003	unburned	14	0.40	0.57	BC
	low	37	0.11	0.33	C
	moderate to high	17	0.12	0.38	C
2002	unburned	13	0.08	0.28	C
	low	25	0	0	C
	moderate to high	17	0	0	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.
[2]Two skippers of unknown identity were recorded from plot 1 in 2004. No Pawnee montane skippers were identified from moderate-to-high severity burn plots in 2004.

Table 7-14. *Hesperia* skipper (*H. comma* and *H. leonardus montana*) per acre among transects of differing burn intensity (unburned, low, and moderate-to-high) for all transects sampled in 2002, 2003, and 2004.

Burn Intensity	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (p=0.05) [1]
unburned	38	1.56	3.57	A
low	94	0.45	1.30	B
moderate to high	49	0.06	0.27	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.

Influences of fire on skipper populations might result from decline of plants important to skipper life history stages. For *Hesperia*, in the South Platte River drainage this would include the host and nectar plants, blue grama and gayfeather, respectively. For blue grama, there was significant differences among years, burn intensity, and by interaction among year and burn intensity on study plots. These differences, however, were inconsistent and indicate a decline associated with drought, and equivalent recovery in 2004, after drought relief. This was true for all study areas (**Table 7-15**). In fact, in 2004 blue grama frequencies on unburned plots was lower, though not significantly, than blue grama on low and moderate-to-high severity burn plots; yet skippers are still significantly more numerous on unburned transects.

Table 7-15. Frequency of blue grama (*Bouteloua gracilis*) among sample years (2002, 2003, and 2004) and burn intensity (unburned, low, and moderate-to-high) for all transects sampled in 2002, 2003, and 2004.

Year	Burn Intensity	Sample Size (# of Transects)	Mean (% frequency)	Standard Deviation	Homogenous Groups (p=0.05)[1]
Among Years (df=2, F=11.09, P<0.0001)					
2004		58	14.31	18.05	A
2003		68	7.35	4.71	B
2002		55	19.07	12.14	A
Among Burn Intensity (df=2, F=9.95, P<0.0001)					
	unburned	38	14.45	11.08	A
	low	94	14.18	13.19	A
	moderate to-high	49	10.14	18.05	B
Interaction Among Year and Burn Intensity (df=4, F=3.72, P<0.01**)**					
2004	unburned	11	11.82	7.61	ABC
	low	32	14.38	17.50	ABC
	moderate to high	15	16.00	24.48	ABC
2003	unburned	14	8.29	6.68	AB
	low	37	7.73	4.32	AB
	moderate to high	17	5.76	3.29	AB
2002	unburned	13	23.31	12.10	A C
	low	25	23.48	9.83	A C
	moderate to high	17	9.35	9.87	AB

[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.

Gayfeather shows a strong response to drought relief, with significant increases in counts of stems per acre in both 2003 and 2004 (**Table 7-16**). This response, however, was not predicated on burn condition, as gayfeather counts were equivalent among all burn severities, and without an interaction among year and burn condition (**Table 7-16**). This suggests that significantly fewer skippers on burned plots results not from loss of host and nectar plants without subsequent recovery, but from either high intensity fire creating habitat less suitable for skippers or from a lack of recolonization of these areas by skippers.

Table 7-16. Stems per acre of gayfeather (*Liatris punctata*) among sample years (2002, 2003, and 2004) and burn intensity (unburned, low, and moderate-to-high) for all transects sampled in 2002, 2003, and 2004.

Year	Burn Intensity	Sample Size (# of Transects)	Mean (stems per acre	Standard Deviation	Homogenous Groups (p=0.05)[1]
Among Year (df=2, F=72.81, P<0.0001)					
2004		58	72.31	88.01	A
2003		68	17.73	18.62	B
2002		55	1.62	4.65	C
Among Burn Intensity (df=2, F=1.75, P>0.1)					
	unburned	38	32.63	53.54	A
	low	94	28.52	46.65	A
	moderate-to-high	49	32.00	81.03	A
Interaction Among Year and Burn Intensity (df=4, F=0.53, P>0.1)					
2004	unburned	11	71.65	83.42	AB D
	low	32	69.08	60.43	A D
	moderate to high	15	79.69	135.64	AB D
2003	unburned	14	27.97	25.68	ABCDE
	low	37	12.59	14.04	ABC E
	moderate to high	17	20.50	17.68	ABCDEF
2002	unburned	13	4.63	7.40	ABC EF
	low	25	0.18	0.44	C F
	moderate to high	17	1.43	4.57	C EF

[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.

7.3.2 Skipper (*Hesperia leonardus montana*) Occurrence

There were significant increases of Pawnee montane skippers in the study area in 2004 (df=2, F=72.81, P<0.0001), with all of these skippers observed on unburned and low severity burn areas (**Table 7-17**). Over three years of monitoring, there were significantly fewer Pawnee montane skippers observed in moderate-to-high severity burn areas, than in unburned areas (df=2, F=1.75, P<0.01) (**Table 7-17**). It appears, Pawnee montane skippers are recovering in unburned and low severity burn areas, particularly in 2004 (**Table 7-17**). Changes in availability of host and nectar plants after the Hayman Fire, do not explain the significantly fewer Pawnee montane skippers counted on moderate-to-high severity burn plots (see 7.3.1 Skipper (*Hesperia*) Occurrence). It appears, reduction in abundance of live trees in moderate-to-severely burned areas may create habitat less suitable for Pawnee montane skipper. Alternatively, recovery of Pawnee montane skipper populations in the moderate-to-high severity burn area may depend on dispersal and recolonization by skippers from unburned and low severity burn areas, and the process may happen on a time scale greater than the length of our monitoring. Monitoring of the Hayman fire area should continue to identify if, and when, occupation of intensely burned areas occurs, which is important to the conservation status of the Pawnee montane skipper.

Table 7-17. Pawnee montane skippers per acre (*Hesperia leonardus montana*) among sample years (2002, 2003, and 2004) and burn intensity (unburned, low, and moderate-to-high) for all transects sampled in 2002, 2003, and 2004.

Year	Burn Intensity	Sample Size (# of Transects)	Mean (skippers per acre)	Standard Deviation	Homogenous Groups (p=0.05)[1]
Among Year (df=2, F=72.81, P<0.0001)					
2004		58	0.51	1.15	A
2003		68	0.09	0.26	B
2002		55	0.02	0.13	B
Among Burn Intensity (df=2, F=1.75, P<0.01)					
	unburned	38	0.33	0.63	A
	low	94	0.25	0.88	AB
	moderate-to-high	49	0.01	0.07	B
Interaction Among Year and Burn Intensity (df=4, F=0.53, P<0.05)					
2004	unburned	11	0.82	0.88	A
	low	32	0.65	1.42	AB
	moderate to high	15	0	0	BC
2003	unburned	14	0.18	0.38	BC
	low	37	0.08	0.25	BC
	moderate to high	17	0.03	0.12	BC
2002	unburned	13	0.08	0.28	BC
	low	25	0	0	BC
	moderate to high	17	0	0	BC

[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.

7.3.3 Current versus Historic Habitat Condition

Total Pawnee montane skipper habitat within the South Platte River drainage was estimated at 24,831 acres, based upon extensive sampling and analysis of aerial photography completed within the drainage in the 1980s (ENSR 2003). Since 1996, large forest fires have burned approximately 12,486 acres or approximately 48% of the mapped suitable habitat (ENSR 2003) (**Table 7-18**). Monitoring indicates that Pawnee montane skipper populations were recovering on low severity burns, with statistically equivalent estimates of abundance on low severity and unburned areas in 2004 (**Table 7-17**). Pawnee montane skippers were also recorded on transects of the Buffalo Creek and High Meadow fires in 2004, where 0.51 skippers per acre were observed. However, on moderate-to-high severity burns in the Hayman Fire area evidence of recovery was absent (**Table 7-5**). Considering low severity burn areas and moderate severity burns of the Buffalo Creek and High Meadow fires, as suitable for Pawnee montane skippers, but all other moderate-to-high severity burns as unsuitable, leaves 5,168 acres of burned unsuitable habitat, or 20.8% of the total mapped suitable habitat. If all moderate severity burns, including Buffalo Creek and High Meadow, are considered unsuitable, total unsuitable burned acres increases to 7,480, or 30.1 % of the total mapped suitable habitat.

Table 7-18. Acres of Pawnee montane skipper habitat burned since 1996[1]

Fire	Date	Acres	Percent of Total Habitat
Buffalo Creek – Moderate To High[2]	May 1996	724	2.9
High Meadow – Moderate Severity	June 2000	984	3.9
High Meadow – High Severity June	June 2000	604	2.4
Schoonover – Low Severity May	May 2002	365	1.5
Schoonover – Moderate And High Severities	May 2002	124	0.5
Hayman – Low Severity	June 2002	4,191	16.8
Hayman – Moderate Severity	June 2002	1,011	4.1
Hayman – High Severity	June 2002	4,033	16.2
Total		**12,026**	**48.3**

[1]Total estimated Pawnee montane skipper habitat: 24,831 acres.
[2]Assumed; no severity classification available.

8.0 SUMMARY

Understanding trends in population abundance and habitat associations, and the recolonization dynamics of burned areas, are important to planning for conservation of the Pawnee montane skippers population within the South Platte River drainage. During three years of monitoring, combined populations of *Hesperia* skippers (*H. comma* and *H. l. montana*) continuously increased throughout the project area. This was true for all unburned and low severity burn sample areas. The mean number of *Hesperia* skippers observed on all study plots (including Buffalo Creek and High Meadow) in 2002, 2003, and 2004 was 0.02, 0.17 and 1.58 per acre, respectively. Recovery of *Hesperia* sjippers on unburned plots was even more dramatic, where 4.78 *Hesperia* skippers per acre were recorded in 2004 (2.99/acre when low severity plots are included). This may suggest that *Hesperia* skipper populations within the project area are at all time highs compared to the 2.1 to 3.6 Pawnee montane skippers (*H. l. montana*) per acre recorded in the 1980's (ERT 1986, 1988, 1989), but this is impossible to state without knowing the density of all *Hesperia* skippers (*H. l. montana* and *H. comma*) in the 1980's. Overall, among years, the only significant increase in skippers occurred in 2004, when *Hesperia* skipper abundance increased dramatically on unburned areas (4.78/acre). On all other plots, *Hesperia* skippers also increased among years, and on low severity burn plots, where *Hesperia* skippers increased from 0 in 2002, to 0.11/acre in 2003, and to 1.20/acre in 2004, the increases were large, but non-significant. Numbers of *Hesperia* skippers on moderate-to-high severity plots increased little, with no skippers recorded in 2000, 0.12/acre in 2003, and 0.07/acre in 2004.

When comparing burn conditions, over the three years of monitoring the highest density of skippers was observed on unburned areas (0.33/acre), followed closely by low severity burn areas (0.25/acrea), and with virtually no skippers occurring on high severity burn areas (0.01/acre).

Considering only the low severity burn areas (Hayman, Buffalo Creek, and High Meadow), skipper counts for all years of monitoring were statistically similar except for the Hayman 2004 sample. Significant increases in skipper numbers on the Hayman plots in 2004 (compared to 2002 and 2003), indicates that populations there are recovering, possibly as a result of improved habitat condition, as evidenced by increasing densities of blue grama and gayfeather. After fire, gayfeather significantly increased on low severity plots of the Hayman Fire area, and were almost double the densities observed on Buffalo Creek and High Meadow in 2004. Monitoring of forest thinning in the Trumbull area, correlates increases in the skippers' adult food plant (gayfeather) resulting from controlled thinning with increases in skipper numbers (Natural Perspectives 2004). With increases in density of gayfeather and concurrent survival of some trees, low severity burn areas are probably benefiting *Hesperia* skippers, but to some extent effects of the drought may compromise this benefit.

Patterns of skipper occupancy on the Hayman low severity burn area, suggests that on some plots populations survived the fire, and on others, recolonization from unburned habitat may be occurring.

Considering only the Hayman Fire area, in 2004 0.47 Pawnee montane skippers per acre were observed, a vast increase over the 0.16 per acre recorded in 2003. The 2004 count included 44

Pawnee montane skipper observations, with 18 occurring on seven unburned transects, 26 on eight low severity burn transects and none on the high-to-moderate severity burn area.

Referring to **Table 7-5** for the Hayman Fire plots, in 2002 and 2003 numbers of Pawnee montane skippers were statistically similar for all habitat conditions (unburned, low, and moderate to high). Because the Hayman Fire had just occurred, it suggests that drought in 2002 had more wide ranging influence on skipper numbers than did the Hayman Fire, which burned 30% of suitable skipper habitat at high intensity. However, fire had a clear affect at the local scale with few skippers recorded in the Hayman moderate-to-high severity burn plots in any year of monitoring.

It appears that skippers are not reoccupying moderate-to-high severity burn areas. In 2004, significantly more skippers were counted on unburned and low severity burn plots, than on moderate-to-high severity burn plots, suggesting that intensely burned areas are less able to support skippers, even two years after a fire event. Fire may influence skipper populations by influencing plants important to skipper life history stages. In the case of *Hesperia*, in the South Platte River drainage this would include the host and nectar plants, blue grama and gayfeather, respectively. However, densities of both blue grama and gayfeather on moderate-to high severity burns in 2004 were high and similar to historic levels observed in 1986 (ERT), when skippers were abundant. This suggests that significantly fewer skippers on intensely burned plots, results not from loss of host and nectar plants without subsequent recovery, but from other factors like a loss of live trees, or a lack of recolonization.

9.0 CONCLUSIONS

Understanding the population dynamics of the Pawnee montane skipper butterfly, and recolonization of the Hayman Fire area are important to understanding the conservation status of the butterfly. It appears that in three years of monitoring, unburned plots support significantly more Pawnee skippers and populations on low severity burn areas are recovering. Forest thinning in the Trumbull area has resulted in increased numbers of both *Hesperia* skippers and gayfeather (Natural Perspectives 2004), which corresponds to observed increases in both *Hesperia* skippers and gayfeather on low severity burns of the Hayman Fire. Lack of response by *Hesperia* skippers on intensely burned areas appears not to result from loss of host and nectar plant populations, as those populations recovered significantly over all burn conditions in 2004. It is more likely that reducing live tree counts to near zero on moderate-to-high severity burn areas creates habitat unsuitable for *Hesperia* skippers, or that all life stages of *Hesperia* skippers were extirpated from these areas, and recolonization by short-distance dispersing *Hesperia* skippers has yet to occur.

Forest structure was changed by fire, with significantly more dead trees existing on burn areas and with their numbers increasing with burn severity. Our research cannot exclude that Pawnee skippers are selectively avoiding intensely burned areas because of this change in forest structure. Whether fire has created unsuitable habitat, or reoccupation by skippers occurs at a temporal scale longer than the current monitoring effort could be determined through further monitoring.

10.0 RECOMMENDATIONS

The Pawnee montane skipper occupation map should be updated with a new map based on the 1986 map. All low to moderate severity burn areas should be included, with occupation of these areas verified through a field survey (see below), while all high severity burn areas should highlighted separately and identified as uncertainty in their occupancy by Pawnee montane skippers. Adding all Pawnee montane skipper occurrence data collected since 2000, should offer confirmation of the resulting map, showing the extent of skippers in both the recently burned areas, and the entire South Platte River drainage.

A habitat occupation survey, based on either the Two Forks quarter section survey method or long transects devoted to finding Pawnee montane skipper, should be implemented. Survey work should be focused on low severity and moderate-to-high severity burn areas, to document occupation of these areas by Pawnee montane skippers. This occupation survey should continue over several years, to determine distribution of skippers in burned areas, and for reference need include only a reduced number of unburned areas, where the current monitoring effort has confirmed populations are abundant and increasing.

11.0 REFERENCES CITED

ENSR International 2002. Pawnee montane skipper 2002 post-fire habitat assessment survey. 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 09075-006-200.

_____. 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.

Natural Perspectives. 2004. Pawnee montane skipper monitoring study for the upper South Platte watershed protection and restoration project: August/September 2004.

NatureServe. 2004. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: December 17, 2004).

NatureServe. 2005. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.2. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: February 7, 2005).

Phillips, S.J., M. Dudik, and R.E. Schapire. 2004. A maximum entropy approach to species distribution modeling. Proceedings of the Twenty-first Century International Conference on Machine Learning.

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.

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

APPENDIX A

2004 Field Protocol for Pawnee Montane Skipper Post-fire Habitat Assessment Survey

Adult Skipper and Skipper Habitat Monitoring in the Burn Areas of the Hayman, Schoonover, Buffalo Creek, and High Meadow 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 2004, the third 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. The sampling methods to be used in 2004 are based on modifications of those used in 2002 and 2003, modified in light of the analyses of the monitoring results obtained in these two years.

The primary output of this 2004 program will be a qualitative estimate of skipper numbers based on belt transect counts, an estimate of the number of blooming *Liatris* stems (primary adult skipper nectar source), the frequency of Blue Grama grass clumps (skipper larval foodplant), and both living and standing dead trees within the study area outlined above. Another output of this work will be a revised map of suitable skipper habitat in the upper South Platte drainage, based on these field studies and interpretation of post-fire satellite imagery.

[+] See 2004 Addendum for the Buffalo Creek and High Meadow fires on page six.

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 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. Potential sampling areas were further reduced by eliminating blocks that were predominantly on private lands, and blocks where mapped habitat was less than 75 percent of the block. The following maps are included in this protocol (TAB C):

- 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.

To collect data comparable to those obtained during the first two monitoring efforts, this year's monitoring effort will be within the same 55 sampling units visited in 2002 and 2003. However, instead of the sampling all 55 units, budget constraints have reduced the number of sampling units to between 25 and 35, depending on suitable weather during the sampling periods of September 2-3 and 7-10. Consistent with the goals for this program developed collaboratively in 2002 and 2003 with FS and USFWS, the 2004 monitoring effort will assess habitat conditions as well measure skipper activity as an estimate of population density.

Field teams will consist of a minimum of 2 persons each, although the number of field teams to participate during the study are not yet known with certainty, pending finalization of funding for independent contractors and establishment of availability of agency personnel.

Consultation with Denver Water has led to the selection of September 8 or 9 (Wednesday or Thursday) as the day that teams will work in the Cheesman Reservoir area. One or two crews will need boat support; the other crews will work north of the dam and will not require additional 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 make determination as how to best sample the habitat variation within the 40-acre block (*i.e.,* a starting point must be established so that a diamond-shaped transect can be located within the designated 40-acre block).

Sampling Transect. The attached protocol **GPS Procedures for recording position of waypoints in the diamond-shaped transects for habitat monitoring of the Pawnee Montane Skipper (TAB B)** 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 2004 Hayman Burn Area**." The width of the belt transect is 10 meters (5 meters 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 write the UTM coordinate of the starting 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**).
- 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 (45^0, 90^0, 180^0, or 270^0)
- 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 the leg (i.e., the 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 only those stems that have open flowers.
- **Skipper butterflies (Hlm and Hco)**: Individual skipper butterflies of either the comma 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 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 between transects should be recorded with GPS coordinates on the back of a data sheet. See color illustrations of these two species (attached).

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 progress and to resolve problems (***except*** for September 8 or 9, when the teams will meet at the Deckers' Store parking lot before driving together to Cheesman Reservoir). The field teams will meet back at the start location at the end of each day to insure that all teams are safely out of the field, and that all data sheets are turned over to the field coordinator (Boyce Drummond: 970-690-7455). Steve Culver (303-275-5614) of USFS will have the overall responsibility for insuring team compliance with fire-related access restrictions and worker safety requirements. Ms. Jenny McCurdy (303-628-6542) will be the Denver Water representative for access needed to Denver Water Cheesman Reservoir property, and other DW property along the river.

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 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). A compass is the primary backup for transect location if there are GPS failures.
- Digital Camera (film camera is ok, but digital prints on CD must be ordered at the time of processing.)
- Clipboard and data sheets
- Two hand counters for counting trees and *Liatris* stems
- 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.
- USFS radio for inter-team communication

2003 Addendum: Buffalo Creek and High Meadow Fire Transects

To better interpret the response of Pawnee Montane Skipper populations to forest fires, monitoring transects were established in 2003 in the areas affected by the Buffalo Creek (1996) and High Meadow (2000) fires. These 1000-meter linear transects were established on roughly parallel N-S axes, located approximately 400 meters apart. There are 6 transects in each of two areas (see maps in TAB E). The Buffalo Creek transects are centered on the Buffalo Creek drainage as it parallels Douglas County Road 543 about 2 miles southwest of the Buffalo Creek USFS Work Station (USFS lock access required). The High Meadow transects will run north from State Road 126 about a mile west of Pine, and are accessed.

These 12 transects were sampled in 2003 using the methods described above for the Hayman Fire blocks, except that they **are linear instead of diamond-shaped and are 1000m in length instead of 800 meters**. In 2004, three teams of two researchers will sample these 12 transects again, on two days during the period of August 30 through September 3.

A Survey Data Sheet has been designed for Buffalo Creek that closely follows the Survey Data Sheet for the Hayman Post-Fire Surveys, *viz.* **"PAWNEE MONTANE SKIPPER SURVEY DATA SHEET 2004 Buffalo Creek (BC) and High Meadow (HM) Burn Areas."**

Appendix B
Hayman Transect Data

2004

Burn/Unburn	Burn intensity	Transect #	Date sampled	live trees	live trees/A	dead trees	dead trees/A	all trees/A	Bogr % F	Lipu	Lipu/A	Hlm	Hco	UNK	OFFSITE	total skip	skip/acre
0	0	317	90204	33	17	3	2	320	10	494	250	0	0	0	0	0	0.00
0	0	318	90704	122	62	0	0	318	5	38	19	1	0	0	0	1	0.51
0	0	320	90204	255	129	8	4	328	18	101	51	4	6	2	0	12	6.07
0	0	324	83104	93	47	4	2	328	26	32	16	0	0	3	0	3	1.52
0	0	330	90104	66	33	1	1	331	23	28	14	3	1	0	2	4	2.02
0	0	335	90704	377	191	58	29	393	1	7	4	0	4	2	0	6	3.04
0	0	339	83104	98	50	1	1	340	8	172	87	5	13	10	0	28	14.16
0	0	342	90204	265	134	8	4	350	8	153	77	0	1	2	0	3	1.52
0	0	343	90104	136	69	13	7	356	13	85	43	2	1	0	3	3	1.52
0	0	345	90204	85	43	1	1	346	8	417	211	1	1	30	0	32	16.19
0	0	347	90704	298	151	20	10	367	10	31	16	2	5	5	0	12	6.07
1	1	2	90804	0	0	111	56	113	8	257	130	0	0	0	0	0	0.00
1	1	5	90804	17	9	25	13	30	3	5	3	0	0	0	0	0	0.00
1	1	12	90804	0	0	205	104	217	5	36	18	0	0	0	2	0	0.00
1	1	13	90704	72	36	74	37	87	8	68	34	0	0	2	2	2	1.01
1	1	14	90704	32	16	97	49	111	8	357	181	1	0	0	4	1	0.51
1	1	15	90104	183	93	92	47	107	9	173	88	0	1	0	1	1	0.51
1	1	26	90104	161	81	4	2	30	9	166	84	1	2	1	0	4	2.02
1	1	337	90704	185	94	13	7	350	9	38	19	0	0	2	0	2	1.01
1	1	518	90204	114	58	47	24	565	43	99	50	1	2	3	1	6	3.04
1	1	521	90304	176	89	55	28	576	15	285	144	0	1	1	0	2	1.01
1	1	525	90104	172	87	85	43	610	4	298	151	0	0	0	0	0	0.00
1	1	527	90704	379	192	154	78	681	15	14	7	0	2	1	0	3	1.52
1	1	528	90704	242	122	63	32	591	10	91	46	0	0	0	0	0	0.00
1	1	530	90304	158	80	5	3	535	19	300	152	11	0	0	0	11	5.56
1	1	534	90204	249	126	27	14	561	6	228	115	0	0	0	0	0	0.00
1	1	538	90304	205	104	12	6	550	10	28	14	3	0	0	1	3	1.52
1	1	540	90304	6	3	57	29	597	12	423	214	0	0	0	0	0	0.00
1	1	544	90204	67	34	92	47	636	15	112	57	1	1	0	1	2	1.01
1	1	547	90304	103	52	84	42	631	13	121	61	7	6	3	0	16	8.09
1	1	548	90204	145	73	103	52	651	3	58	29	1	0	0	0	1	0.51
1	2	1	90104	0	0	138	70	139	8	1062	537	0	0	2	0	2	1.01
1	2	3	90804	0	0	185	94	188	12	13	7	0	0	0	0	0	0.00
1	2	11	90804	0	0	45	23	56	12	115	58	0	0	0	0	0	0.00
1	2	16	90204	10	5	20	10	36	94	152	77	0	0	0	0	0	0.00
1	2	17	90104	0	0	130	66	147	0	285	144	0	0	0	0	0	0.00
1	2	18	90804	0	0	90	46	108	14	49	25	0	0	0	0	0	0.00
1	2	20	90204	0	0	196	99	216	1	2	1	0	0	0	0	0	0.00
1	2	23	90804	0	0	84	42	107	6	61	31	0	0	0	0	0	0.00
1	2	27	90804	18	9	56	28	83	48	321	162	0	0	0	0	0	0.00
1	2	31	90804	0	0	30	15	61	11	11	6	0	0	0	0	0	0.00
1	2	35	90804	0	0	71	36	106	3	15	8	0	0	0	0	0	0.00
1	2	38	90804	0	0	106	54	144	8	52	26	0	0	0	1	0	0.00
1	2	520	90204	35	18	192	97	712	2	62	31	0	0	0	0	0	0.00
1	2	522	90704	0	0	195	99	717	17	37	19	0	0	0	0	0	0.00
1	2	523	90104	0	0	196	99	719	4	126	64	0	0	0	0	0	0.00
			Totals/Means	4557/99	2305/50	3256/71	1647/36	15545/338	594/13	7078/154	3580/78	44/1	47/1	69/2	NA/18	160/3	80.94/1.76

2003

Burn/Unburn	Burn intensity	Transect #	Date sampled	live trees	live trees/A	dead trees	dead trees/A	all trees/A	Bogr % F	Lipu	Lipu/A	Hlm	Hco	UNK	OFFSITE	total skip	skip/acre
0	0	317	90204	33	17	3	2	320	10	494	250	0	0	0	0	0	0.00
0	0	318	90704	122	62	0	0	318	5	38	19	1	0	0	0	1	0.51
0	0	320	90204	255	129	8	4	328	18	101	51	4	6	2	0	12	6.07
0	0	324	83104	93	47	4	2	328	26	32	16	0	0	3	0	3	1.52
0	0	330	90104	66	33	1	1	331	23	28	14	3	1	0	2	4	2.02
0	0	335	90704	377	191	58	29	393	1	7	4	0	4	2	0	6	3.04
0	0	339	83104	98	50	1	1	340	8	172	87	5	13	10	0	28	14.16
0	0	342	90204	265	134	8	4	350	8	153	77	0	1	2	0	3	1.52
0	0	343	90104	136	69	13	7	356	13	85	43	2	1	0	3	3	1.52
0	0	345	90204	85	43	1	1	346	8	417	211	1	1	30	0	32	16.19
0	0	347	90704	298	151	20	10	367	10	31	16	2	5	5	0	12	6.07
1	1	2	90804	0	0	111	56	113	8	257	130	0	0	0	0	0	0.00
1	1	5	90804	17	9	25	13	30	3	5	3	0	0	0	0	0	0.00
1	1	12	90804	0	0	205	104	217	5	36	18	0	0	0	2	0	0.00
1	1	13	90704	72	36	74	37	87	8	68	34	0	0	2	2	2	1.01
1	1	14	90704	32	16	97	49	111	8	357	181	1	0	0	4	1	0.51
1	1	15	90104	183	93	92	47	107	9	173	88	0	1	0	1	1	0.51
1	1	26	90104	161	81	4	2	30	9	166	84	1	2	1	0	4	2.02
1	1	337	90704	185	94	13	7	350	9	38	19	0	0	2	0	2	1.01
1	1	518	90204	114	58	47	24	565	43	99	50	1	2	3	1	6	3.04
1	1	521	90304	176	89	55	28	576	15	285	144	0	1	1	0	2	1.01
1	1	525	90104	172	87	85	43	610	4	298	151	0	0	0	0	0	0.00
1	1	527	90704	379	192	154	78	681	15	14	7	0	2	1	0	3	1.52
1	1	528	90704	242	122	63	32	591	10	91	46	0	0	0	0	0	0.00
1	1	530	90304	158	80	5	3	535	19	300	152	11	0	0	0	11	5.56
1	1	534	90204	249	126	27	14	561	6	228	115	0	0	0	0	0	0.00
1	1	538	90304	205	104	12	6	550	10	28	14	3	0	0	1	3	1.52
1	1	540	90304	6	3	57	29	597	12	423	214	0	0	0	0	0	0.00
1	1	544	90204	67	34	92	47	636	15	112	57	1	1	0	1	2	1.01
1	1	547	90304	103	52	84	42	631	13	121	61	7	6	3	0	16	8.09
1	1	548	90204	145	73	103	52	651	3	58	29	1	0	0	0	1	0.51
1	2	1	90104	0	0	138	70	139	8	1062	537	0	0	2	0	2	1.01
1	2	3	90804	0	0	185	94	188	12	13	7	0	0	0	0	0	0.00
1	2	11	90804	0	0	45	23	56	12	115	58	0	0	0	0	0	0.00
1	2	16	90204	10	5	20	10	36	94	152	77	0	0	0	0	0	0.00
1	2	17	90104	0	0	130	66	147	0	285	144	0	0	0	0	0	0.00
1	2	18	90804	0	0	90	46	108	14	49	25	0	0	0	0	0	0.00
1	2	20	90204	0	0	196	99	216	1	2	1	0	0	0	0	0	0.00
1	2	23	90804	0	0	84	42	107	6	61	31	0	0	0	0	0	0.00
1	2	27	90804	18	9	56	28	83	48	321	162	0	0	0	0	0	0.00
1	2	31	90804	0	0	30	15	61	11	11	6	0	0	0	0	0	0.00
1	2	35	90804	0	0	71	36	106	3	15	8	0	0	0	0	0	0.00
1	2	38	90804	0	0	106	54	144	8	52	26	0	0	0	1	0	0.00
1	2	520	90204	35	18	192	97	712	2	62	31	0	0	0	0	0	0.00
1	2	522	90704	0	0	195	99	717	17	37	19	0	0	0	0	0	0.00
1	2	523	90104	0	0	196	99	719	4	126	64	0	0	0	0	0	0.00
			Totals/Means	4557/99	2305/50	3256/71	1647/36	15545/338	594/13	7078/154	3580/78	44/1	47/1	69/2	NA/18	160/3	80.94/1.76

2002

Burn/Unburn	Burn intensity	Transect #	Date sampled	live trees	live trees/A	Bagr %F	Lipu	Lipu/A	Hlm	Hca	UNK	OFFSITE	totalskip	skip/acre
0	0	317	90302	288	146	25	25	13	0	0			0	0.00
0	0	318	90302	201	102	23	2	1	0	0			0	0.00
0	0	324	90302	337	171	13	23	12	2	0			2	1.01
0	0	327	90302	469	237	8	1	1	0	0			0	0.00
0	0	330	90302	121	61	45	0	0	0	0			0	0.00
0	0	335	90302	292	148	18	2	1	0	0			0	0.00
0	0	339	90402	377	191	15	4	2	0	0			0	0.00
0	0	343	90402	120	61	30	49	25	0	0			0	0.00
0	0	345	91102	178	90	10	8	4	0	0			0	0.00
0	0	347	90402	246	124	35	2	1	0	0			0	0.00
0	0	348	91102	384	194	38	1	1	0	0			0	0.00
0	0	1757	91102	156	79	33	2	1	0	0			0	0.00
0	0	1857	91102	115	58	10	0	0	0	0			0	0.00
1	1	337	91102	260	132	43	1	1	0	0			0	0.00
1	1	2	90602	41	21	30	1	1	0	0			0	0.00
1	1	5	90602	303	153	25	0	0	0	0			0	0.00
1	1	12	90602	36	18	5	0	0	0	0			0	0.00
1	1	13	90502	45	23	25	1	1	0	0			0	0.00
1	1	14	90502	48	24	23	0	0	0	0			0	0.00
1	1	15	90902	99	50	0	0	0	0	0			0	0.00
1	1	26	91002	88	45	20	4	2	0	0			0	0.00
1	1	518	90402	155	78	28	0	0	0	0			0	0.00
1	1	521	90402	91	46	23	1	1	0	0			0	0.00
1	1	525	90402	81	41	10	0	0	0	0			0	0.00
1	1	527	90502	91	46	25	0	0	0	0			0	0.00
1	1	528	90402	58	29	15	0	0	0	0			0	0.00
1	1	530	90402	161	81	23	0	0	0	0			0	0.00
1	1	532	90402	260	132	30	0	0	0	0			0	0.00
1	1	534	91102	494	250	15	0	0	0	0			0	0.00
1	1	536	90502	75	38	28	0	0	0	0			0	0.00
1	1	538	90502	298	151	25	0	0	0	0			0	0.00
1	1	539	90502	175	89	20	0	0	0	0			0	0.00
1	1	540	90502	73	37	38	0	0	0	0			0	0.00
1	1	541	90902	318	161	28	0	0	0	0			0	0.00
1	1	542	91102	60	30	38	0	0	0	0			0	0.00
1	1	544	90902	88	45	30	1	1	0	0			0	0.00
1	1	547	90902	404	204	25	0	0	0	0			0	0.00
1	1	548	91102	184	93	15	0	0	0	0			0	0.00
1	2	1	91002	13	7	3	3	2	0	0			0	0.00
1	2	3	90602	0	0	10	0	0	0	0			0	0.00
1	2	11	90602	0	0	15	0	0	0	0			0	0.00
1	2	16	90902	1	1	25	37	19	0	0			0	0.00
1	2	17	90902	0	0	3	8	4	0	0			0	0.00
1	2	18	90602	0	0	13	0	0	0	0			0	0.00
1	2	20	90902	0	0	3	0	0	0	0			0	0.00
1	2	21	90902	0	0	0	0	0	0	0			0	0.00
1	2	27	90602	0	0	28	0	0	0	0			0	0.00
1	2	31	90602	0	0	0	0	0	0	0			0	0.00
1	2	35	90602	0	0	0	0	0	0	0			0	0.00
1	2	38	90602	0	0	0	0	0	0	0			0	0.00
1	2	23	90602	0	0	3	0	0	0	0			0	0.00
1	2	520	90402	1	1	23	0	0	0	0			0	0.00
1	2	522	90402	0	0	5	0	0	0	0			0	0.00
1	2	523	90502	16	8	23	0	0	0	0			0	0.00
1	2	549	91002	0	0	5	0	0	0	0			0	0.00
				7301/133	3695/67	1049/19	176/3	89/2	2/0.04	0/0			2/0.04	1/0.02

Appendix C
Buffalo Creek and High Meadow Transect Data

BC Transects 2003

Burn intensity	Transect #	Date sampled	live trees	live trees/A	dead trees	dead trees/A	all trees_A	Bogr_F	Lipu	Lipu_A	Hlm	Hco	UNK	total skip	skip/acre	OFFSITE
1	BC1	91003	76	31	106	43	13	5	3	1	0	0	0	0	0	1
1	BC2	91003	129	52	74	30	22	6	32	13	0	0	0	0	0	0
1	BC3	91003	112	45	38	15	19	10	8	3	0	0	0	0	0	0
1	BC4	91003	111	45	54	22	19	7	38	15	0	0	0	0	0	0
1	BC5	91003	78	32	112	45	13	3	129	52	0	0	0	0	0	0
1	BC6	91003	108	44	11	4	18	5	54	22	0	0	0	0	0	0
		Totals/Mean	614/102	248/41	395/66	160/27	103/17	36/6	264/44	107/18	0/0	0/0	0/0	0/0	0/0	1/0.17

HM Transects 2003

Burn intensity	Transect #	Date sampled	live trees	live trees/A	dead trees	dead trees/A	all trees_A	Bogr_F	Lipu	Lipu_A	Hlm	Hco	UNK	total skip	skip/acre	OFFSITE
1	HM3	91003	28	11	98	40	5	7	11	4	0	0	0	0	0.00	0
1	HM4	91003	73	30	200	81	12	7	0	0	0	0	0	0	0.00	0
1	HM5	91003	70	28	92	37	12	7	18	7	2	2	0	4	1.62	2
1	HM6	91003	132	53	51	21	22	11	22	9	0	0	0	0	0.00	0
1	HM7	91003	191	77	186	75	32	18	37	15	0	0	0	0	0.00	0
1	HM8	91003	93	38	224	91	16	7	3	1	0	0	0	0	0.00	0
		Totals/Mean	587/98	238/40	851/142	344/57	99/16	57/10	91/15	37/6	2/0.33	2/0.33	0/0	4/0.67	1.62/0.27	2/0.33

BC Transects 2004

Burn intensity	Transect #	Date sampled	live trees	live trees/A	dead trees	dead trees/A	all trees_A	Bogr_F	Lipu	Lipu_A	Hlm	Hco	UNK	total skip	skip/acre	OFFSITE
1	BC1	83004	43	17	112	45	7	10	28	11	0	0	0	0	0.00	0
1	BC2	83004	153	62	39	16	25	11	0	0	0	0	0	0	0.00	0
1	BC3	83004	168	68	35	14	28	3	232	94	0	0	0	0	0.00	0
1	BC4	83004	146	59	29	12	24	14	6	2	0	0	0	0	0.00	0
1	BC5	83004	44	18	96	39	8	7	273	110	0	0	1	1	0.40	0
1	BC6	83004	58	23	56	23	10	14	300	121	8	2	6	16	6.47	0
		Totals/Mean	612/102	248/41	367/61	149/25	103/17	59/10	839/140	340/57	8/1.33	2/0.33	7/1.17	17/2.83	7/1.15	0/0

HM Transects 2004

Burn intensity	Transect #	Date E1sampled	live trees	live trees/A	dead trees	dead trees/A	all trees_A	Bogr_F	Lipu	Lipu_A	Hlm	Hco	UNK	total skip	skip/acre	OFFSITE
1	HM3	83004	48	19	71	29	8	22	38	15	0	0	0	0	0.00	0
1	HM4	83004	86	35	258	104	14	101	3	1	0	0	0	0	0.00	0
1	HM5	83004	62	25	111	45	11	8	163	66	0	0	0	0	0.00	0
1	HM6	83004	67	27	73	30	11	10	113	46	0	0	0	0	0.00	0
1	HM7	83004	161	65	95	38	27	20	339	137	7	1	0	8	3.24	0
1	HM8	83004	69	28	146	59	12	16	21	8	0	2	0	2	0.81	0
		Totals/Mean	493/82	200/33	754/126	305/51	83/14	177/30	677/113	274/46	7/1.17	3/0.50	0/0	10/1.67	4/0.67	0/0