# Report to the U.S. Forest Service, Oregon Zoo, and U.S. Fish and Wildlife Service

## Mardon Skipper Coon Mountain Burn Site Occupancy Study and Surveys of Low Divide Road Sites

December 2010

Photograph by Scott Hoffman Black

**Scott Hoffman Black, Xerces Society Executive Director**
**Celeste Mazzacano, Xerces Society Staff Scientist**

## December 2010

**ABSTRACT**
Xerces Society staff monitored the Coon Mountain mardon skipper (*Polites mardon*) population in 2010 to determine the butterfly's response to a controlled burn conducted by the U.S. Forest Service in 2008. To study the effects of the burn, the site was divided into four monitoring zones. Each zone was further subdivided into burned and unburned areas, and a 150x30 foot transect was set up in each, resulting in a total of eight transects across the habitat area, four each in burned and unburned areas. Xerces staff counted mardon skippers in each transect and in each zone on two independent monitoring dates in May and June 2009. The sites were revisited on three dates in June 2010. Although mardon numbers have improved in the burned sites compared to 2009, substantially fewer mardon skipper were found in burned areas compared to unburned areas in each transect and zone.

Xerces staff also surveyed mardon meadows adjacent to Low Divide Road. We found two meadows that were occupied with mardon skipper but we found no mardon skippers in two nearby meadows that were previously reported as occupied. There may be the potential to provide a connection between meadows to encourage re-colonization at one site.

Development of long term management plans for all mardon sites is recommended.

**INTRODUCTION**
The mardon skipper (*Polites mardon)* is a rare and declining butterfly in the Pacific Northwest of the United States of America. It is a Washington State endangered species and a candidate species for federal listing under the U.S. Endangered Species Act. Mardon are grassland and open meadow obligates endemic to Washington, Oregon, and California. Historic mardon ranges are not known as documentation of this butterfly is scarce, and systematic population studies have only been done in recent decades (Black & Vaughan 2005). Mardon skippers were likely more widespread and abundant prior to the past 150 years of human development, which has negatively impacted their habitat via livestock grazing, fire suppression, and invasion of grassland habitat by native and non-native vegetation.

Mardon skipper is known from four geographic areas: (1) southern Puget Sound, (2) the Mt. Adams area (eastside of the Cascade Mountains) in southern Washington, (3) the Cascade mountains in southern Oregon, and (4) Del Norte County in north-coastal California and Curry County on the southern coast of Oregon.

Two accepted subspecies of mardon skipper have been described. Mattoon *et al*. (1998) proposed that the Oregon Cascades population be given subspecies status *Polites mardon klamathensis* while the Washington and Northern California populations comprise the subspecies *Polites mardon mardon*.

**History of Mardon Skipper in California**
Mardon skippers were first described by W. H. Edwards (1881) from specimens taken near Tenino, Thurston County, Washington by H. K. Morrison (Dornfeld 1980). No additional populations were known outside of Washington State until June 1979, when Sterling and Eileen Mattoon discovered a population on High Divide Ridge in Del Norte County, California.

Surveys in 2003 at the High Divide Ridge site (Note: these sites are now called the Low Divide Road Sites) identified four principal grasslands (totaling approximately 4.5 acres) in which mardon skipper were consistently observed (Haggard 2003). Three sites are in close proximity to each other (0.1 km), with the fourth being the most distant from these three (~0.3 km). Dozens of individual mardon have been detected during peak years in the 1-2 acre core area at this coastal California site (Haggard 2003). In 2004, lepidopterists found a new population in northwestern California, approximately 10 km from the closest known population (Gary Falxa, Biologist, USFWS, personal communication). At the Little Bald Hills portion of Redwood National Park, Arnold (2006) observed mardon skipper in nine meadows throughout an approximately 2,200 m length of trails on the flank and top of the hills on May 26, 2005. Arnold (2006) surveyed dozens of other sites in the region with suitable habitat but did not find any additional populations. Surveys conducted by the Xerces Society in 2007 on 21 sites in the Six River National Forest did not find additional populations. In 2008 Xerces Society staff re-surveyed several potential mardon sites on Rattlesnake Ridge and conducted new surveys of meadows at Coon Mountain (on the Six River NF). Mardon were discovered in the Coon mountain meadow complex on June 10, 2008. This is believed to be the largest population in California based on a one day count of 204 individuals on June 10, 2008 (Black *et al.* 2008) and follow up counts in 2009 and 2010.

**COON MOUNTAIN BURN STUDY 2009**

In September 2008, Scott Hoffman Black met with Brenda Devlin (USFS Biologist) and Gary Falxa (USFWS Biologist) to discuss modifications to the Coon Mountain burn plan that would ensure long term sustainability of mardon skipper at this site. Areas that should be left untouched were identified resulting in a burn in early winter 2008 that impacted approximately 30-40% of the core area occupied by the mardon. A study to determine the response of the butterfly to the burn was also designed.

Scott Hoffman Black and Logan Lauvray (Xerces) met with Brenda Devlin, Gary Falxa, and staff from the USFS fire crew on May 26, 2009. Burn staff helped delineate burned and unburned areas, which were also observable by the presence of burned shrubs. Xerces staff placed flagging at the sites to clearly demarcate burn boundaries for surveys.

To study the effects of the burn, the site was divided into four monitoring zones. Each zone was further subdivided into burned and unburned areas, and a 150x30 foot transect was set up in each, resulting in a total of eight transects across the habitat area, four each in burned and unburned areas. Xerces staff counted mardon skippers in each transect and in each zone on two independent monitoring dates in May and June 2009.

The 2009 mardon skipper surveys revealed a clear pattern of response to burning across all zones and transects. Although each of the four zones differed slightly in the quality of mardon habitat, higher mardon numbers were observed at each unburned transect compared to the burned transect within each zone. Counts for all four zones across both survey dates showed mardon numbers that were 3-27 times higher in unburned areas compared to burned areas on the same dates (mean = 12 times greater). With the exception of a single transect in zone 2, on a single date mardon counts for all transects were 6-19 times higher in the unburned compared to the

burned transect in the same zone (mean = 9.2 times higher). Individual zone and transect counts are presented below (See Black *et al.* 2009 for more detail).

**COON MOUNTAIN BURN STUDY 2010**

The sites were revisited on three dates in June and early July 2010 (June 21 and 27 and July 2). The study design was the same as in 2009.

**SURVEY PROTOCOL**

The burn site was divided into four zones. Each zone was then subdivided into burned and unburned areas.

**Transect Counts**

Two transects were set up in each zone, with one in burned and one in unburned habitat, for a total of eight transects across the habitat area. Flagging was placed down the center of a 150 ft transect, and 15 feet was measured out to each side from the center to give a transect width of 30 feet. All transects were placed in the best available habitat within the zone that accommodated the desired transect size. Xerces staff (Scott Hoffman Black) walked each transect slowly and counted all butterflies within the transect areas. Each transect required ~15 minutes to survey. Butterflies were not counted if they flew in from behind the observer to avoid the possibility of counting the same individual twice. Xerces staff completed counts three times during the mardon flight season, on June 21 and 27 and July 2, 2010. The site was also visited on June 11 but no mardon were seen due to the cool spring.

**Zone Counts**

In addition to transect monitoring, counts were completed over each entire zone using a modified Pollard Walk (Pollard 1977). Xerces staff walked through each zone slowly, taking about 5 minutes to walk 100 meters, looking back and forth on either side for approximately 20 to 30 feet out. Surveyors walked a path such that all area within the zone with apparently suitable habitat was covered by this visual field.

If the surveyor left the path to look more closely at a particular butterfly, he returned to the original point where he left the path to resume monitoring. When a suspected mardon skipper butterfly was encountered it was identified on the wing, or netted and examined to ensure identity when needed. No voucher specimens were taken at these sites. All data was recorded and particular activities such as nectaring or ovipositing were noted.

**Environmental Conditions**

All sites were surveyed during the following environmental conditions, which are considered optimum for mardon skipper flight activity:

Minimum temperature: Above 60$^{o}$F.

Cloud cover: Partly sunny or better. On cooler days, sunshine is very important in warming the butterflies' flight muscles and allowing them to take flight. On warmer days (above 60$^{o}$F) less direct sunlight is required for skipper activity, but cloud cover should be such that a

significant amount of sun comes through to help elevate the body temperature of basking butterflies.

Wind: Less than 10 MPH. On windy days, butterflies drop out of the air if they cannot maintain their direction and/or speed of flight.

Time of year: Surveys where conducted during mardon skipper's late spring flight period. Sites were visited on May 27 and June 7 in 2009. Due to wet and cold conditions mardon flight period was later in the Spring of 2010 and surveys were conducted on June 21 and 27 and July 2 in 2010.

**Surveys of New Potential Habitat**

An additional goal of this project was to check all of the historic sites near Low Divide Road (Formerly called the High Divide Road sites) and to survey additional meadows north and east of the known Coon Mountain sites to determine whether mardon are present. Sites were surveyed using the zone count protocol described above.

**RESULTS**

In both 2009 and 2010, mardon skipper surveys revealed a clear pattern of response to burning. Without exception, mardon numbers were higher at all dates in unburned transects and zones compared to burned transects and zones within the same survey meadow.

Counts for all four zones across all survey dates in 2009 and 2010 showed mardon numbers that ranged from 2.1 to 27 times higher in unburned zones compared to burned zones on the same dates (mean = 9.3 times greater for all zones, all dates; standard deviation = 8.1). For individual zones, differences between mardon numbers in unburned vs. burned zones were as follows: zone 1 = 5.1 times higher in unburned (SD = 1.5); zone 2 = 3.1 times higher in unburned (SD = 1.1); zone 3 = 12 times higher in unburned (SD = 9.7); and zone 4 = 16.8 times higher in unburned (SD = 7.9). Burned and unburned zones were of similar areas, though not identical in size. However, this same pattern was seen in the results of fixed-area transect surveys; with the exception of a single transect count (zone 2 transects on 5/27/2009) that showed mardon numbers in the burned zone transect 1.7 times greater than in the unburned zone transect, mardon numbers ranged from 3.5 to 19 times higher in unburned vs. burned transects on the same dates (mean = 8.6 times higher in unburned transects; SD = 3.9). While the magnitude of the difference varied from date to date, a clear pattern of consistently reduced numbers of mardon skipper in burned habitat areas is evident. Individual zone and transect counts are described below.

**Zone 1**

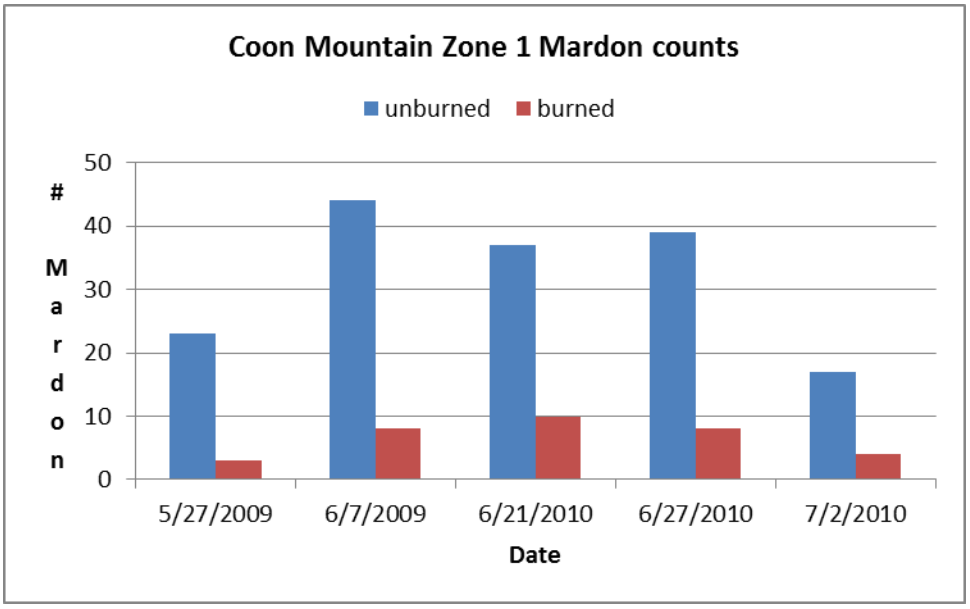
Zone 1 is located just to the east of road 17N07 (Appendix 1, Maps 1 and 2). In 2008 this site had a relatively high density of mardon skippers. In both 2009 and 2010, the number of mardon skippers remained much lower in the burned zone. Mardon numbers never exceeded a maximum of 10 in the burned zone on any date surveyed (6/21/2010), whereas they reached 44 in the unburned portion of the zone (6/7/2009). The average number of mardon in unburned regions of the zone was virtually unchanged across two years of surveys for both total zone counts (34 in 2009 and 31 in 2010) and transect counts (13 in 2009 and 12 in 2010). The same

was true of average mardon numbers in burned habitat, with the burned area of zone 1 averaging 6 mardon in 2009 and 7 in 2010, and burn transect counts averaging 2 mardon in 2009 and 1 in 2010.

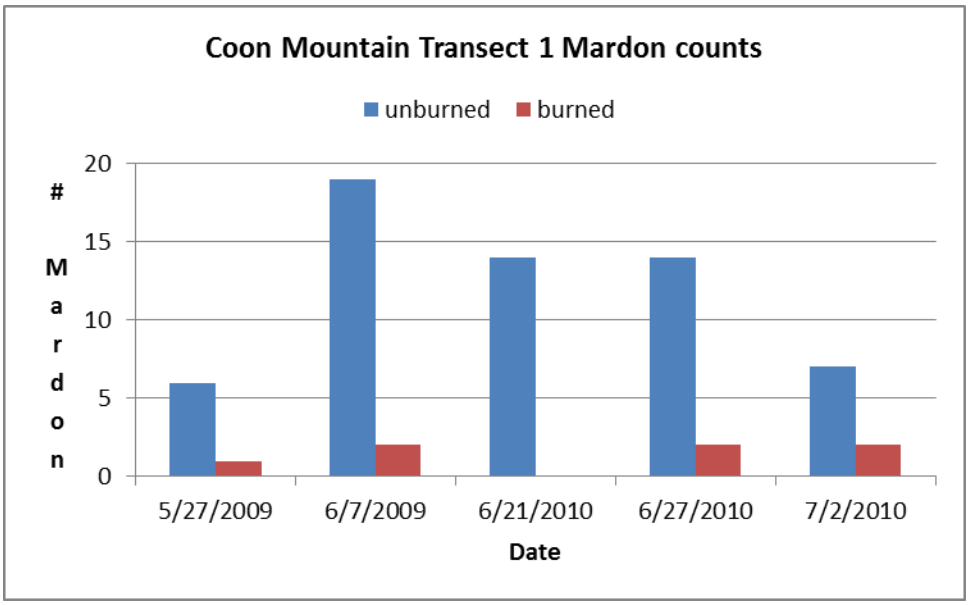
Average mardon skipper numbers were 6.7 times higher in the unburned zone in 2009 and 4.4 times higher in 2010. This result is not due to simple differences in the total area of the burned and unburned zones. Transect counts, which are conducted on a fixed area (150 x 30 ft), showed an even more dramatic difference, with mean mardon numbers 6.5 times higher in the unburned transect in 2009 and 12 times higher in 2010. Overall, mardon were present at extremely low numbers in the burned habitat in this zone in 2009, and had not recovered to the levels seen in unburned habitat by the following year.

**Figure 1. Zone 1 burn site mardon skipper counts, 2009 and 2010**

**1A. Whole zone counts**



**1B. Transect counts**



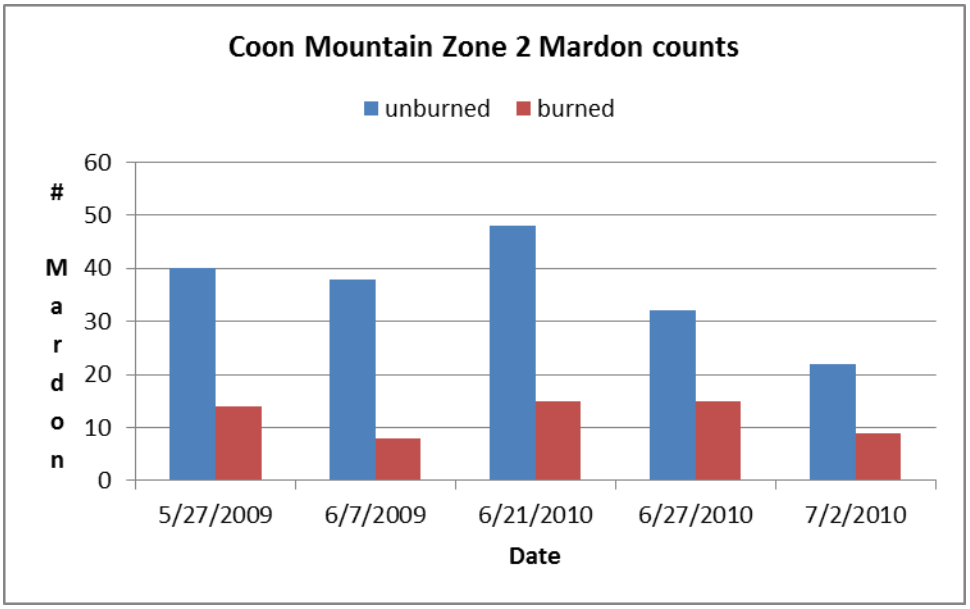

**Zone 2**

Zone 2 is directly east of zone 1. (Appendix 1, Maps 1 and 2). Some areas within the meadow are too wet for mardon skipper, but the majority has high quality mardon habitat and had a relatively high density of mardon skipper in the 2008 count. The burned habitat in zone 2 had the highest average number of mardon among all four burned habitat zones surveyed (maximum of 15 on 6/21/2010 and 6/27/2010). However, the number of mardon skippers in both 2009 and 2010 was much lower in the burned habitat of zone 2 compared to the unburned habitat, with a maximum of 48 mardon counted in the unburned zone on 6/21/2010. The average number of mardon in unburned regions of the zone was similar across the two years of surveys for both total zone counts (39 in 2009 and 34 in 2010) and transect counts (9 in 2009 and 12 in 2010). Average mardon numbers in the burned area of zone 2 were almost unchanged across the two survey years (11 mardon in 2009 and 13 in 2010), while the average burn transect counts were lower in 2010 (mean = 1 mardon) compared to 2009 (mean = 4 mardon).

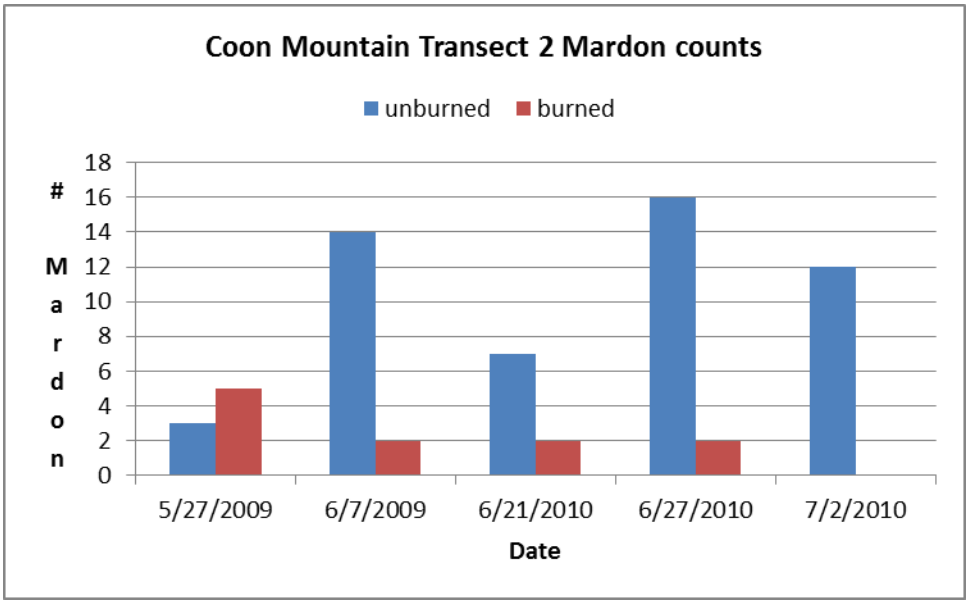
Average mardon skipper numbers were 3.5 times higher in the unburned zone in 2009 and 2.6 times higher in 2010. The magnitude of the difference in average mardon numbers in the fixed-area transect counts was more variable, but mardon numbers were still greater on average in unburned transects in 2009 (2.3 times higher in the unburned transect) and especially in 2010 (12 times higher). Overall, even though mardon numbers in burned habitat were highest on average in zone 2 compared to burned areas of the other three zones surveyed, the population remained smaller than in the unburned areas of the zone and had not recovered to the levels seen in unburned habitat by 2010.

**Figure 2. Zone 2 burn site mardon skipper counts, 2009 and 2010**

**2A. Whole zone counts**




**2B. Transect counts**




**Zone 3**

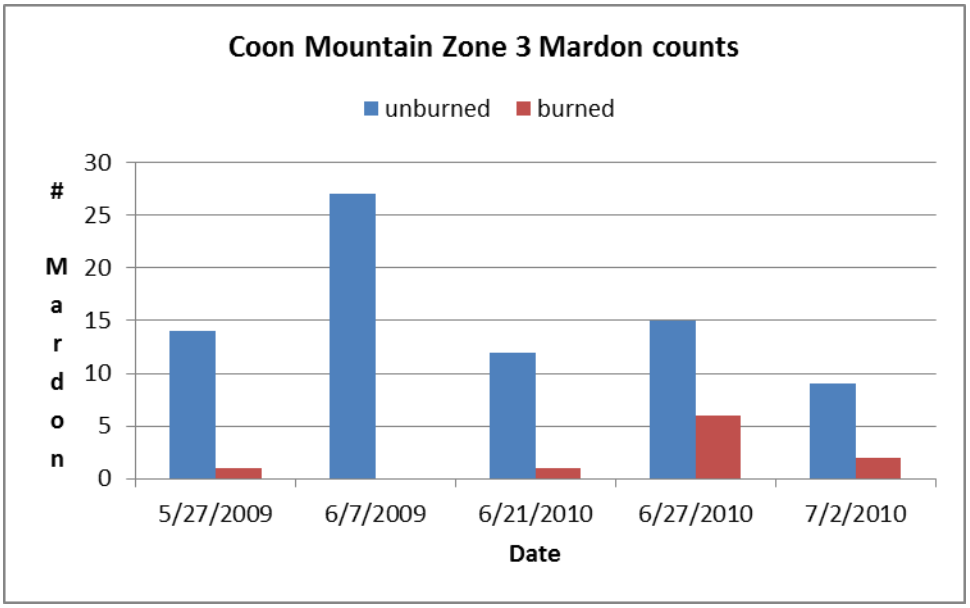
Zone 3 is located just to the south of zone 1 (Appendix 1, Maps 1 and 2). It is a linear habitat area that is much smaller than zones 1 or 2, although the burned and unburned zones are of a comparable area to each other. The habitat in the non-burn area had more fescue and nectar sources than the habitat in the burned portion of the site, although mardon were found in moderate numbers throughout this area in our 2008 surveys. In both 2009 and 2010, the number of mardon skippers remained much lower in the burned zone. Mardon numbers never exceeded a maximum of 6 in the burned zone on any date surveyed; this maximum zone count occurred on

a single date (6/27/10), and on all other survey dates the zone counts ranged from only two to no mardon at all. In contrast, even though the unburned zone 3 habitat consists of a smaller area than zone 1 or 2, the maximum number of mardon counted during a single zone survey was of the same order of magnitude as the maximum numbers in the larger zones (27 in the unburned portion of zone 3 on 6/7/2009). The average number of mardon in unburned regions of the zone varied more across years for the total zone counts (21 in 2009 and 12 in 2010) compared to the fixed-area transect counts (mean = 8 in 2009 and 2010). Mardon numbers in burned habitat increased slightly on average across the survey period, with the burned area of zone 3 averaging 0.5 mardon in 2009 and 3 in 2010, and burn transect counts averaging 0.5 mardon in 2009 and 1 in 2010.

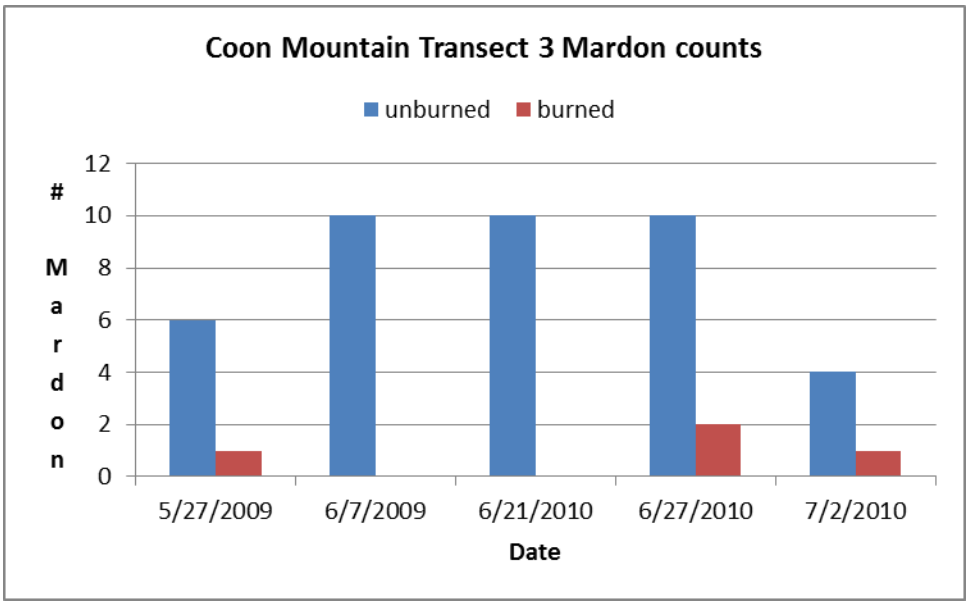
Average mardon skipper numbers were 42 times higher in the unburned zone in 2009 and 4 times higher in 2010. Fixed-area transect counts showed a similar trend, with mean mardon numbers 16 times higher in the unburned transect in 2009 and 8 times higher in 2010. Overall, mardon were present at extremely low numbers in the burned habitat in this zone in both years, but there are slight indications that the population may be beginning to recover.

**Figure 3. Zone 3 burn site mardon skipper counts, 2009 and 2010**

**3A. Whole zone counts**



**3B. Transect counts**



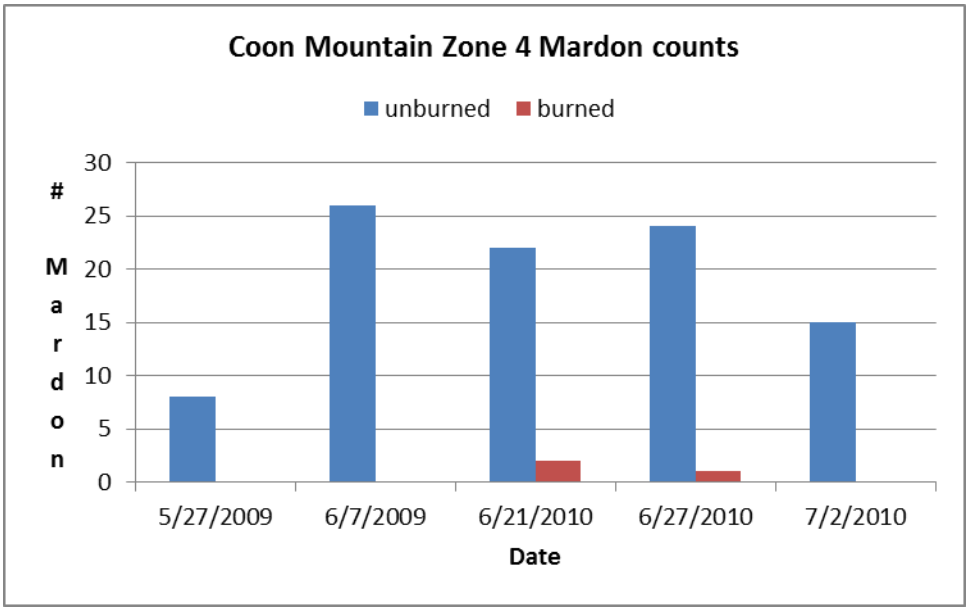

**Zone 4**

Zone 4 includes the southern-most meadow in this complex and is located southeast of zone 3. (Appendix 1, Maps 1 and 2). The habitat in the non-burn area has more fescue and nectar sources than the habitat in the burned portion of the site although mardon were found in moderate numbers throughout this area in our 2008 surveys. This meadow had the smallest numbers of mardon in the burned habitat among all 4 zones surveyed for both whole-zone and transect counts. Mardon numbers never exceed a maximum of two during any survey in the zone 4 burned habitat, and most survey dates yielded no mardon sightings. While it is true that zone 4 is another small area of habitat, similar to zone 3, numbers of mardon in the unburned area were much higher, with a maximum of 26 counted in the unburned zone (6/7/2010). The mean number of mardon in unburned regions of the zone was similar across the two years of surveys for both total zone counts (17 in 2009 and 20 in 2010) and transect counts (13 in 2009 and 10 in 2010). In contrast, the burned habitat surveyed in zone 4 completely lacked mardon in 2009. In 2010, mardon were present but at very low numbers (1-2 total for zone or transect counts), and on the final survey date in 2010 mardon were again absent from this burned zone.

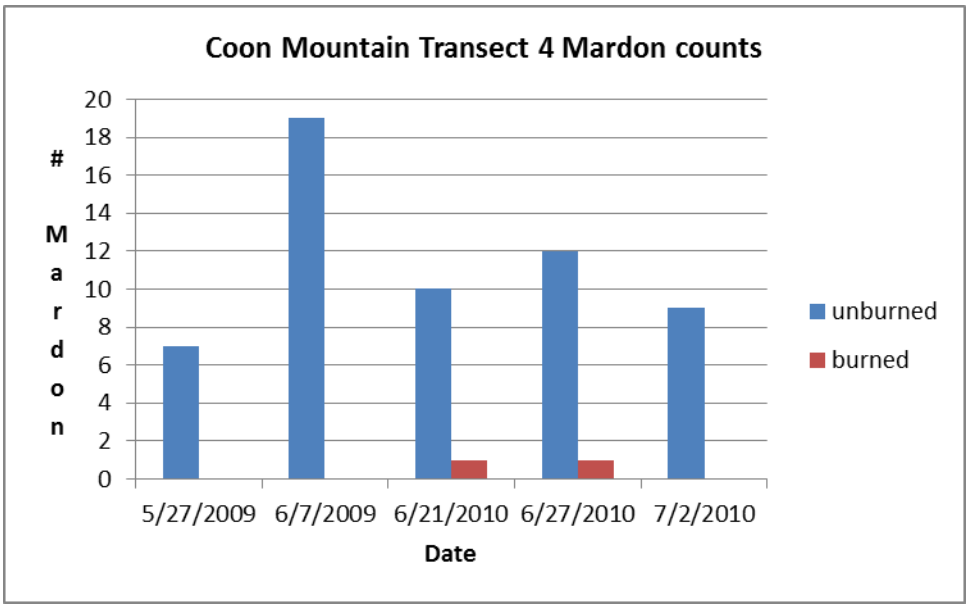
Although both the burned and unburned habitat in zone 4 comprises only a small area, the mardon population in the unburned area appears stable and similar in average size to that seen in other, larger survey zones. However, both zone and transect counts indicated that no mardon were present in the burned habitat in zone 4 in 2009. Although mardon appear to have returned to this habitat in 2010 the population is extremely small, with mean mardon numbers 20 times higher in the unburned zone and 14 times higher in the unburned fixed-area transect in 2010. Overall, mardon were present at extremely low numbers in the burned habitat in this zone in 2009, they are either not recovering compared to the levels seen in unburned habitat by the following year or recovering extremely slowly.

**Figure 4. Zone 4 burn site mardon skipper counts, 2009 and 2010**

**4A. Whole zone counts**




**3B. Transect counts**




**Searches at Low Divide Road**

On June 11, 2010 Xerces staff surveyed historic mardon meadows adjacent to Low Divide Road. We found two historic meadows that were still occupied by mardon skipper. We counted 22 mardon skipper at the main mardon meadow closest to Low Divide Road and 45 mardon at the larger adjacent meadow. We found no mardon in two additional meadows that had previously been reported as occupied (Haggard 2003) (See Appendix 1, Map 3). There may be the potential to provide a connection between meadows to encourage re-colonization at one site.

**Searches at Coon Mountain**
Several meadows adjacent to the main Coon Mountain meadows were searched on 6/27/10. Mardon were found at one site that is just north of the main mardon complex. (N 41$^{o}$ 46.555' / W 123$^{o}$ 57.938) This site was first identified in 2009. This meadow is visible from the road leaving the main Coon Meadow complex. Three mardon were found toward the bottom of the meadow.

**DISCUSSION**
The results of this study consistently show that after two years there are substantially fewer butterflies in the burned areas of Coon Mountain meadows compared to unburned regions. In 2010 all zone and transect counts showed fewer mardon skippers in the burned areas. The burned areas of zones 1 and 2 are being re-colonized faster than zones 3 and 4. zones 3 and 4 both contained mardon in 2008, but only one skipper was found in the burned area of zone 3 in 2009, and the burned area of zone 4 lacked mardon entirely. In 2010 nine mardon were found (over three sampling dates) in the burned portion of zone 3 and three were found in the burned portion of zone 4. The study does show that mardon are slowly recolonizing the burned areas as the numbers of mardon in burned transects and zones were above those of the 2009 survey. All burned zones on all dates had more mardon in 2010 than in 2009.

This clear pattern of difference in mardon numbers between burned and unburned areas strongly suggests that further study of the effects of controlled burning on existing mardon skipper habitat, size of protected core habitat needed in areas subject to controlled burns, and the rate and level of re-colonization from protected core habitat areas after burning must be investigated actively before continued burning is done.

The effects of fire on vegetation and vertebrate communities are more widely understood than the effects of fire on invertebrates. Burning in habitat areas may benefit, harm, or have no significant impact on invertebrates, depending on the life history of specific taxa (Gibson *et al*. 1992). Swengel (1996) and Swengel and Swengel (2001) found that fire had consistent negative effects on prairie specialist butterfly species, and that these effects persisted for 3-5 years post-burning. Using a modeling approach, Schultz and Crone (1998) found that burning no more than one-third of the habitat every year would maximize the average annual population growth rate of Fender's Blue (*Icaricia icarioides fenderi*). Burning meadows that contain populations of mardon skipper may kill all butterflies within the fire area, as this species is thought to overwinter as a caterpillar at the base of its host plant, and is thus highly susceptible to ground fires.

Burned areas must be re-colonized by butterflies flying in from unburned parts of the meadow, but the rate and extent of this re-colonization for mardon skippers has not been investigated and is currently unknown. During adult flight, mardon skippers avoid heavily forested habitats and are assumed to have limited dispersal abilities (Beyer & Schultz 2010; Beyer & Black 2007; Runquist 2004). More vagile butterflies, such as the Fender's blue mentioned above, will likely re-colonize more rapidly than species such as mardon skipper. Also, areas with smaller core populations may take longer to colonize than other areas with larger population size. For instance, zones 1 and 2 had the highest mardon numbers in Xerces' 2008 count, and some butterflies were present in the burned areas of these zones in 2009 and 2010. In contrast, zones 3 and 4 had only moderate numbers of mardon in 2008, and fewer mardon were found in the

burned areas in these zones in 2009 and 2010. The long linear nature of zones 3 and 4 compared to the shorter, more polygonal shape zones 1 and 2 may also be a factor as it is a shorter distance to disperse through zones 1 and 2 that it is to disperse through 3 and 4.

*Forest Encroachment*

The removal and alteration of the natural disturbance regimes (such as fire suppression), that once maintained low shrub and conifer seedling establishment rates, has led to the loss and degradation of forest-meadow ecosystems (Coop & Givinish 2007; Norman & Taylor 2005). Forest encroachment not only reduces the amount of open habitat, but closes off corridors between meadows reducing butterfly dispersal (Roland & Matter 2007). During the adult flight, mardon skippers avoid heavily forested habitats, avoid forest edges and trees during oviposition, and are assumed to have limited dispersal abilities (Beyer & Schultz 2010; Beyer & Black 2007; Runquist 2004). Large dense shrubs likely have a similar adverse impact as encroaching trees to the habitat and behaviors of this butterfly.

**Figure .** Tree encroachment at Coon Mountain. By Scott Hoffman Black

It is likely that conifer encroachment is negatively impacting mardon habitat at Coon Mountain.

## RECOMMENDATIONS

A careful and well-researched prescribed burning regimen should provide the correct combination of timing, intensity, and size that is appropriate for the management area and will result in long-term stability of mardon skipper populations. Knowledge of how butterflies

respond to fire is integral to designing an effective fire management strategy. The Xerces Society makes the following recommendations:

- Continue mardon skipper monitoring program at Coon Mountain to understand the rate and timing of full re-colonization of burned areas by skippers.
- No additional burns in mardon meadows should be implemented until surveys indicate that mardon have completely re-colonized the previous burn areas.
- Future fires should not burn more than 1/3 of the core habitat in any given year, and less if possible.
- As a fire moves through an area it may leave small patches unburned. These skips should be left intact as potential micro-refuges.
- A comprehensive monitoring program should be put in place to accompany any plans for continuing burns to determine the immediate and long-term impacts on mardon populations.
- Measures must be taken to avoid actions that could degrade existing habitat and kill individual skippers in the course of implementing a burn plan, as a result of heavy equipment use and additional or excessive foot traffic by burn staff in mardon meadows.

In areas where tree and shrub encroachment are occurring, small trees and problematic shrubs should be removed. A plan should be developed that removes trees using methods that incorporate sensitivity to butterflies life history. The plan should include the following:

- In general only small trees under 4" Diameter at Breast Height (DBH) should be removed from the open meadow portion of the site.
- Wherever possible hand cutting with chainsaws or handsaws is optimal.
- All downed wood and branches should be dragged out of the meadow.
- Care must be taken to avoid actions that could degrade habitat and kill individual skippers as a result of heavy equipment use, people trampling meadows, scattering or piling of trees or branches in meadows, or burning of piles in or adjacent to the core area of the site.

## LITERATURE CITED


Arnold, R.A. 2006. Report on 2005 mardon skipper surveys in Del Norte county, CA. Entomological Consulting Services, Ltd. Pleasant Hill, CA 18 pp.

Beyer, L. and S. H. Black. 2007. Site utilization by adults and larvae of mardon skipper butterfly (*Polites mardon*) at four sites in Washington and Oregon. Final Report to the Forest Service and BLM from the Xerces Society.

Beyer, L.J., Schultz, C.B. 2010. Oviposition selection by a rare grass skipper Polites mardon in montane habitats: Advancing ecological understanding to develop conservation strategies. *Biological Conservation* 143:862-872.

Black, S. H., and D. M. Vaughan. 2005. Species Profile: *Polites mardon*. *In*: Shepherd, M. D., D. M. Vaughan, and S.H. Black (eds), *Red List of Pollinator Insects of North America*. CD-ROM Version 1 (May 2005). The Xerces Society for Invertebrate Conservation, Portland, OR.

Black, S. H., S. Jepsen, and L. Lauvray. 2008. Report to the U.S. Fish and Wildlife Service, Surveys for *Polites mardon* in Del Norte County of Northern California. The Xerces Society for Invertebrate Conservation, Portland, OR.

Black, S. H., Mazzacano C. and Lauvray L. 2009. Mardon skipper survey of Coon Mountain burn site: Report to the U.S. Fish & Wildlife Service and the U.S. Forest Service. The Xerces Society for Invertebrate Conservation, Portland, OR. 17 pp.

Coop, J. D., and T. J. Givinish. 2007. Spatial and temporal patterns of recent forest encroachment in monane grasslands of the Valles Caldera, New Mexico, USA. *Journal of Biogeography* 34: 914-927.

Dornfeld, E. J. 1980. Butterflies of Oregon. Timber Press, Forest Grove, Oregon.

Gibson, C. D., V. K. Brown, L. Losito, and G. C. McGavin. 1992. The response of invertebrate assemblies to grazing. Ecography 15(2): 166-76.

Haggard, J. 2003. Status report: Mardon skipper (*Polites mardon mardon*) in Del Norte County, CA. Haggard Wildlife Consulting, Fieldbrook, CA. 22 pp.

Mattoon, S. O., J. F. Emmel, and T. C. Emmel. 1998. The distribution of *Polites mardon* (Lepidoptera: Hesperiidae) in North America, and description of a new subspecies from southern Oregon. Pages 767-774 *in* T. C. Emmel, (ed.), *Systematics of western North American butterflies*. Mariposa Press, Gainesville, Florida. 878 pp.

Norman, S. P., and A. H. Taylor. 2005. Pine forest expansion along a forest-meadow ecotone in northeastern California, USA. *Forest Ecology and Management* 215:51-68.

Pollard, E. 1977. A method for assessing changes in the abundance of butterflies. Biological Conservation 12:115-134.

Roland, J., and S. F. Matter. 2007. Encroaching forests decouple alpine butterfly population dynamics. *Proceedings of the National Academy of Sciences* 104:13702-13704.

Runquist, E. 2004. Unpublished report and presentation: Workshop on the ecology and status of the mardon skipper (*Polites mardon*), an unusual Pacific Northwest butterfly. Ashland, Oregon.

Schultz, C. B. and E. E. Crone. 1998. Burning prairie to restore butterfly habitat: a modeling approach to management tradeoffs for the Fender's blue. Restoration Ecology 6(3): 244-252.

Swengel, A. B. and S. R. Swengel. 2001. Effects of prairie and barrens management on butterfly faunal composition. Biodiversity and Conservation 10(10): 1757-1785.

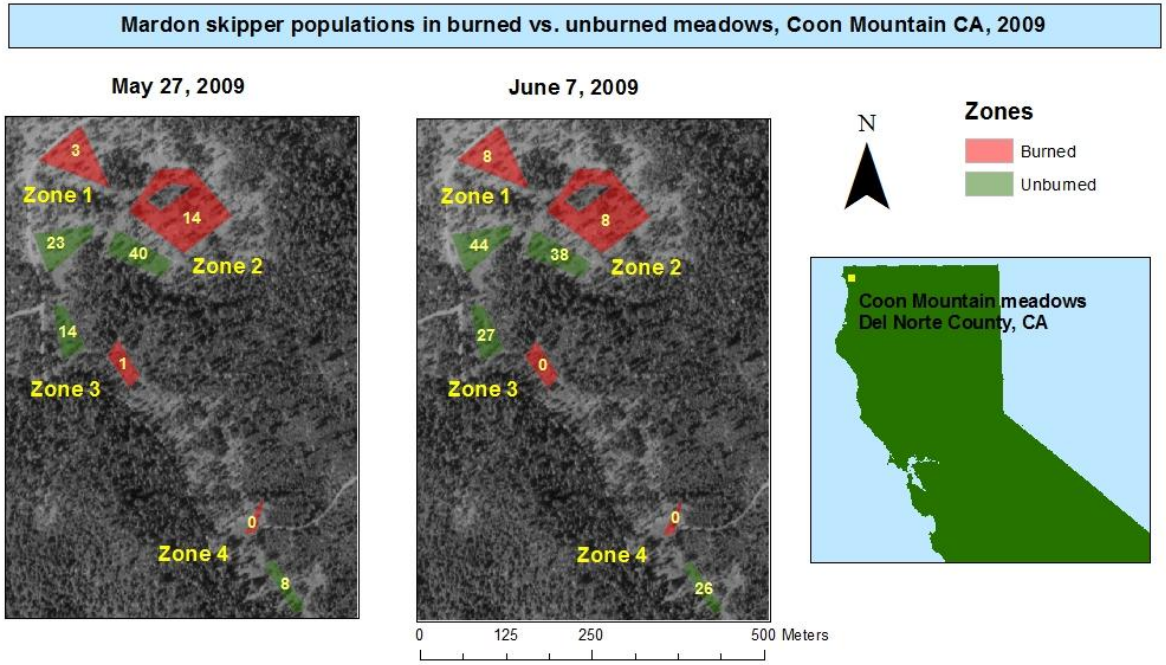
Swengel, A. B. 1996. Effects of fire and hay management on abundance of prairie butterflies. Biological Conservation 76: 73–85.

**PERSONAL COMMUNICATION**

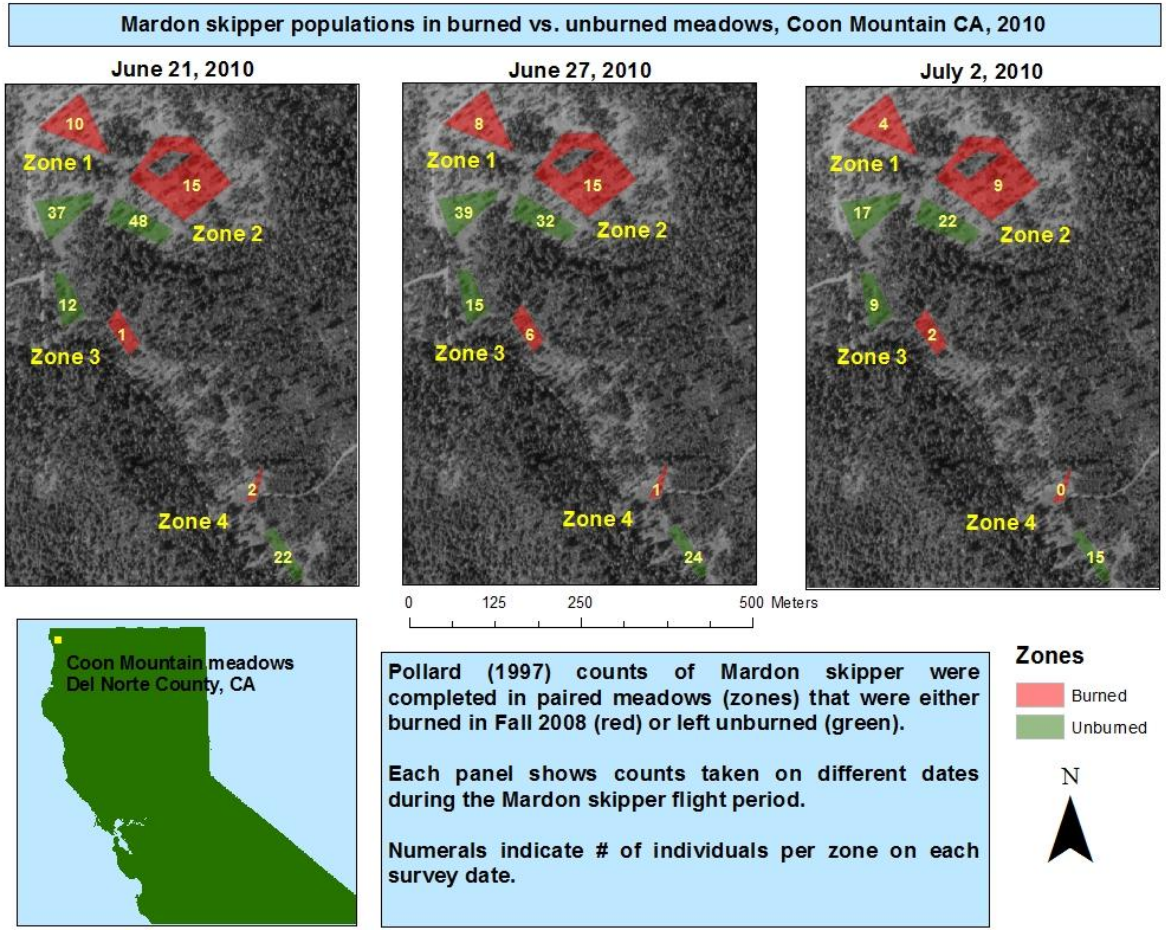
Gary Falxa, Biologist, USFWS

**APPENDIX 1: MAPS**

Map 1

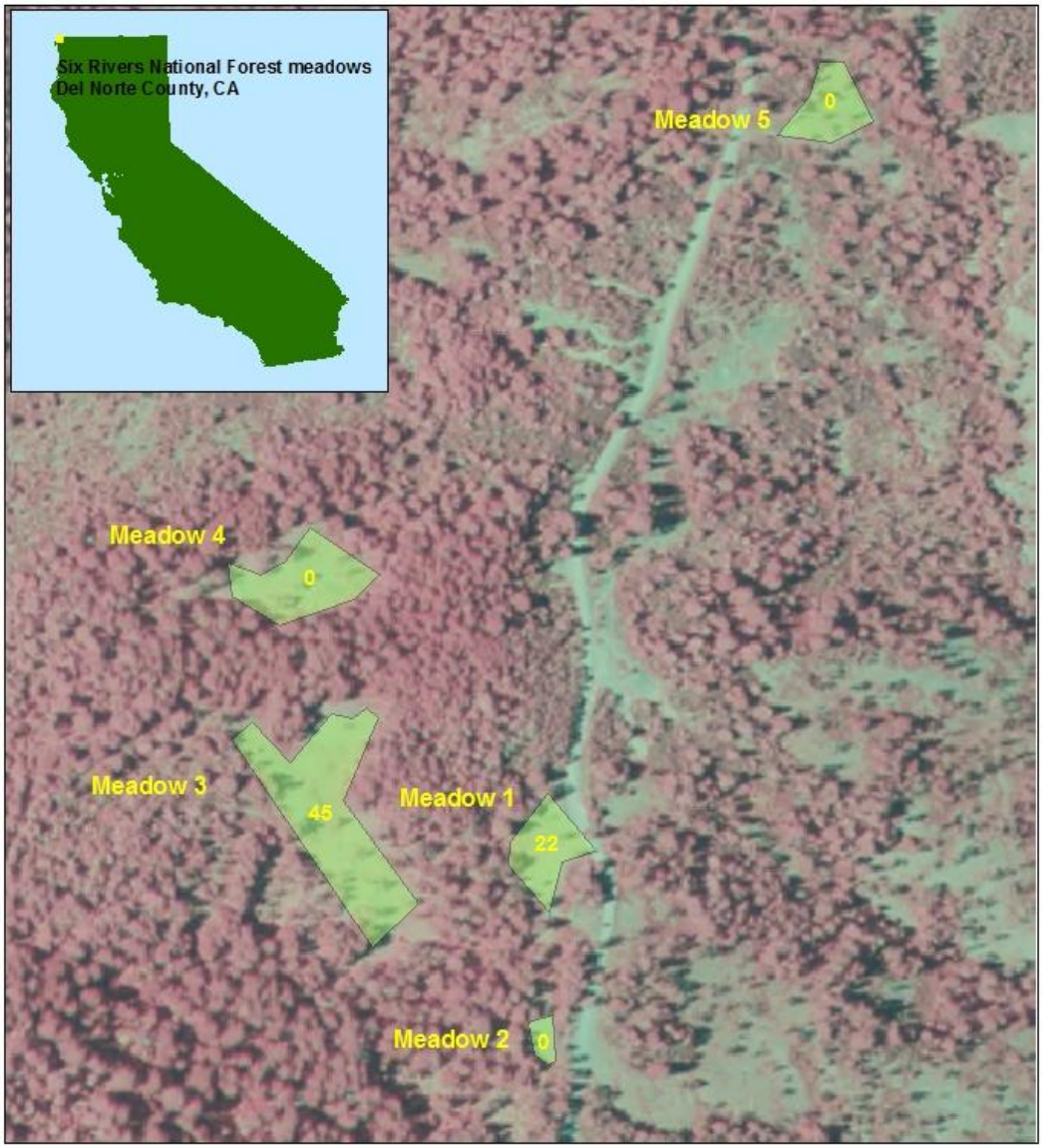


Map 2


Mardon skipper populations in burned vs. unburned meadows, Coon Mountain CA, 2010
June 21, 2010
June 27, 2010
July 2, 2010
Zone 1
Zone 2
Zone 3
Zone 4
10
15
37
48
12
1
2
22
8
15
39
32
15
6
1
24
4
9
17
22
9
2
0
15
0
125
250
500 Meters
Coon Mountain meadows
Del Norte County, CA
Pollard (1997) counts of Mardon skipper were completed in paired meadows (zones) that were either burned in Fall 2008 (red) or left unburned (green).
Each panel shows counts taken on different dates during the Mardon skipper flight period.
Numerals indicate # of individuals per zone on each survey date.
Zones
Burned
Unburned
N

Map 3

**Mardon Skipper populations the Low Divide meadows, Six Rivers National Forest CA, 2010**




**Pollard (1997) counts of Mardon skipper were completed on June 11, 2010, in meadows in the Six Rivers National Forest, adjacent to Low Divide Road.**

**Numerals indicate # of individuals found in each meadow.**

## APPENDIX 2: TABLES

Table 1: Mardon skipper habitat zone and transect locations.

| Survey region | Polygon coordinates[1] | Transect coordinates[2] |
|---|---|---|
| Zone 1 unburned | 1. N 41.77428 W 123.97115<br>2. N 41.77369 W 123. 97084<br>3. N 41.77423 W 123.97008<br>4. N 41.77440 W 123.97001 | Start: N 41 46.459 W 123 58.205<br>End: N 41.774117 W 123.970467 |
| Zone 1 burned | 1. N 41.77483 W 123.96980<br>2. N 41.77487 W 123.96979<br>3. N 41.77570 W 123.97035<br>4. N 41.77523 W 123.97112 | Start: N 41.774750 W 123.969767<br>End: N 41.775100 W 123.970150 |
| Zone 2 unburned | 1. N 41.77401 W 123.96990<br>2. N 41.77434 W 123.96973<br>3. N 41.77386 W 123.96866<br>4. N 41.77367 W 123.96883 | Start: N 41.774050 W 123.969517<br>End: N 41.774283 W 123.969967 |
| Zone 2 burned | 1. N 41.77399 W 123.96848<br>2. N 41.77448 W 123.967641<br>3. N 41.77513 W 123.96835<br>4. N 41.77513 W 123. 96893 | Start: N 41.775167 W 123.968833<br>End: N 41.774800 W 123.969167 |
| Zone 3 unburned | 1. N 41.77274 W 123.97016<br>2. N 41.77256 W 123.97057<br>3. N 41.77335 W 123.97076<br>4. N 41.77333 W 123.97058 | Start: N 41.772817 W 123.970483<br>End: N 41.773250 W 123.970567 |
| Zone 3 burned | 1. N 41.77221 W 123.96941<br>2. N 41.77 239 W 123.96923<br>3. N 41.77288 W 123.96966<br>4. N 41.77266 W 123.96985 | Start: N 41.772833 W 123.969733<br>End: N 41.772383 W 123.969483 |
| Zone4 unburned | 1. N 41.76994 W 123.96706<br>2. N 41.77003 W 123.96691<br>3. N 41.76936 W 123.96628<br>4. N 41.76927 W 123.96645 | Start: N 41.769800 W 123.966700<br>End: N 41.769417 W 123.966533 |
| Zone 4 burned | 1. N 41.77035 W 123.96718<br>2. N 41.77032 W123.96740<br>3. N 41.77084 W 123.96705<br>4. N 41.77073 W 123.96705 | Start: N 41.770717 W 123.967200<br>End: N 41.770333 W 123.967250 |

[1]Coordinates indicate to corners of zone polygon. Note that the coordinates given for the zone 2 burned survey area do not indicate a small "donut hole" of unsuitable habitat at the northeast end of the polygon that was omitted from surveying. See maps in Appendix 1 for additional detail.

[2]Coordinates indicate the start and endpoints of the center line of the transect. Surveys were conducted along 15 feet on either side of the midpoint.

Table 2. Mardon skipper counts, 2009 & 2010

| **Mardon skipper counts, total zone numbers** | | | | | | |
|---|---|---|---|---|---|---|
| **Zone** | **condition** | **Date** | | | | |
| | | **5/27/2009** | **6/7/2009** | **6/21/2010** | **6/27/2010** | **7/2/2010** |
| | unburned | 23 | 44 | 37 | 39 | 17 |
| **Zone 1** | burned | 3 | 8 | 10 | 8 | 4 |
| | unburned | 40 | 38 | 48 | 32 | 22 |
| **Zone 2** | burned | 14 | 8 | 15 | 15 | 9 |
| | unburned | 14 | 27 | 12 | 15 | 9 |
| **Zone 2** | burned | 1 | 0 | 1 | 6 | 2 |
| | unburned | 8 | 26 | 22 | 24 | 15 |
| **Zone 4** | burned | 0 | 0 | 2 | 1 | 0 |
| | | | | | | |
| **Mardon skipper, transect counts[1]** | | | | | | |
| **Transect[1]** | | **Date** | | | | |
| | | **5/27/2009** | **6/7/2009** | **6/21/2010** | **6/27/2010** | **7/2/2010** |
| | unburned | 6 | 19 | 14 | 14 | 7 |
| **Zone 1** | burned | 1 | 2 | 0 | 2 | 2 |
| | unburned | 3 | 14 | 7 | 16 | 12 |
| **Zone 2** | burned | 5 | 2 | 2 | 2 | 0 |
| | unburned | 6 | 10 | 10 | 10 | 4 |
| **Zone 3** | burned | 1 | 0 | 0 | 2 | 1 |
| | unburned | 7 | 19 | 10 | 12 | 9 |
| **Zone 4** | burned | 0 | 0 | 1 | 1 | 0 |

[1] Each count indicates the number of mardon in a 150 x 30 ft fixed-area survey. Individual transects were marked and counted within the burned and unburned habitat areas of each numbered zone.