

CONTROLLED BURNING AND MARDON SKIPPER: SUMMARY OF MARDON SKIPPER COON MOUNTAIN BURN SITE OCCUPANCY STUDY 2009-2013.

FINAL REPORT TO THE U.S. FOREST SERVICE, OREGON ZOO, AND U.S. FISH AND WILDLIFE SERVICE



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ABSTRACT

Xerces Society staff monitored the Coon Mountain mardon skipper (*Polites mardon*, W.H. Edwards, 1881) population in 2009, 2010, 2011 and 2013 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 subdivided into burned and unburned areas, and a 150 x 30 ft. 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 2009, and on three dates each year in 2010, 2011 and 2013. Although mardon skipper numbers have improved in the burned sites compared to 2009, significantly fewer mardon skippers are still found in burned areas compared to unburned areas in all transects and zones. Xerces recommends that no additional controlled burns within mardon habitat be conducted until populations in the burned area are not significantly different from unburned areas, which may take several more years.

INTRODUCTION

The mardon skipper, *Polites mardon*, is a rare butterfly in the Pacific Northwest of the United States of America. Its conservation status has been assessed as following: U.S. Federal Species of Concern, Washington State Endangered Species, Global Heritage Status Rank of G2G3, United States National Heritage Status Rank of N2N3, state rank of S1 in Washington and California, and S2 in Oregon, Forest Service Region 6 Sensitive Species, and a BLM Special Status Species. This butterfly was recently removed from the list of federal candidate species (USFWS 2012). Mardon skippers are grassland and open meadow obligates endemic to the states of Washington, Oregon, and California. Historic mardon skipper ranges are not known, as historical documentation of this butterfly is scarce, with most surveys only occurring in the past decade (Black & Vaughan 2005). Despite the lack of data, mardon skippers are thought to have been more widespread and abundant prior to the past 150 years of human development, livestock grazing, fire suppression, and invasion of grassland habitat by native and non-native vegetation.

The mardon skipper is known from four geographic areas: (1) southern Puget Sound, (2) the east side of the Cascade Mountains in Washington, (3) the Cascade Mountains in southern Oregon, and (4) Del Norte (north-coastal) California and the southern coast of Oregon (See Figure 1). 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*. However *P. m. mardon* from Del Norte County populations have not yet been carefully compared to series of typical *P. m. mardon* from Washington and the use of the name *P. m. mardon* for Californian populations should be considered tentative (Warren 2005).

HISTORY OF MARDON SKIPPER IN CALIFORNIA

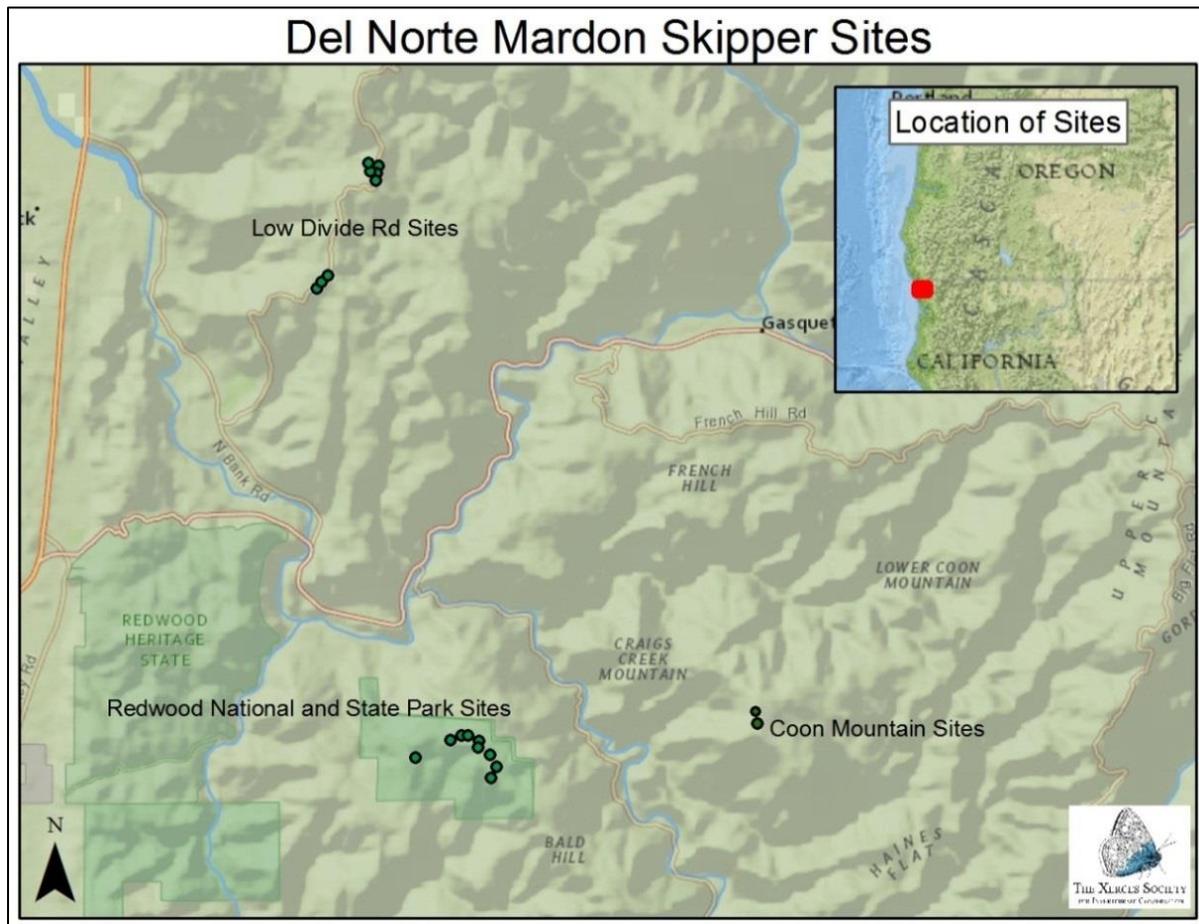
Mardon skippers were first described by W. H. Edwards (1881) from specimens taken near Tenino, Thurston County, Washington by H. K. Morrison (Dornfeld 1980). No additional populations were known outside of Washington State until June 1979, when Sterling and Eileen Mattoon discovered a population on High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

Surveys in 2003 at the High Divide Ridge site (now called the Low Divide Road sites) identified four principal grasslands (totaling approximately 4.5 acres) in which mardon skippers 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 2008). At the Little Bald Hills portion of Redwood National Park, Arnold (2006) observed mardon skippers in nine meadows throughout approximately 2,200 m 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 Rivers 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 Rivers NF). Mardon skippers were discovered in the Coon Mountain meadow complex on June 10, 2008 (Figure 2). This is believed to be the largest mardon 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, 2010, 2011 and 2013, discussed below.

FIGURE 1: RANGE-WIDE MAP OF MARDON SKIPPER DISTRIBUTION



FIGURE 2: MARDON SKIPPER SITES IN DEL NORTE COUNTY, CALIFORNIA



COON MOUNTAIN BURN STUDY

BACKGROUND

Fire has played an important role in many native ecosystems, and controlled burns are an increasingly common management tool. The Coon Mountain area has not had a natural fire in decades and small conifers and shrubs are encroaching in the open meadow areas and likely having a negative impact on meadow dependent species.

Fire as a management tool is based on the supposition that prairie species are adapted to wildfires, and thus can cope with regular burns (Harper *et al.* 2000; Swengel 2001). This is dependent, however, on there being adequate unburned areas that can provide a refuge and sources of colonizers for the burned habitat. In habitat fragments where populations are more isolated, prescribed burning can have much more deleterious effects as the probability of extirpation is high. For example, Harper *et al.* (2000) found that overall arthropod species richness decreased in burned prairie sites, as well as the abundance of all but one of the species measured. Their results suggest that burning a small habitat fragment in its entirety could risk extirpating some species because of limited

opportunities for recolonization from adjacent habitat. Rare butterflies can also be negatively impacted by prescribed burning. 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.

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 the mardon skipper population at this site. The team identified areas that should be burned and left untouched by fire. The team also designed a study to help determine the effects of the burn on the mardon skipper population. In late fall 2008, the U.S. Forest Service conducted a burn that impacted approximately 30-40% of the core area occupied by the mardon skipper.

Scott Hoffman Black and Logan Lauvray (Xerces) met with Brenda Devlin, Gary Falxa, Sheila M. Balent 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 the surveys and recorded the coordinates (Garmin Rino GPS, NAD83).

To study the effects of the burn, we divided the site into four monitoring zones. We subdivided each zone into burned and unburned areas, and a 150 x 30 ft. 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 two times during the mardon flight season in 2009 (May 27th and June 7th), three times during the flight season in 2010 (June 21st, June 27th, and July 2nd), three times during the flight season in 2011 (June 19th, June 23rd, and July 2nd), and three times during the flight season in 2013 (May 25th, June 2nd, and June 6th).

SURVEY PROTOCOL

TRANSECT COUNTS

We set up two transects in each zone, with one in burned and one in unburned habitat, for a total of eight transects across the habitat area. We placed flagging down the center of a 150 ft. transect, and 15 feet were measured out to each side from the center to give a transect width of 30 feet. We placed all transects 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.

ZONE COUNTS

In addition to transect monitoring, we completed counts over each 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. Surveyors walked a path such that all areas within the zone with apparently suitable habitat were covered by this visual field. We counted every butterfly that was encountered, and did not count butterflies that flew in from behind observers.

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 we encountered a suspected mardon skipper butterfly it was

identified on the wing, or netted and examined to ensure identity. No voucher specimens were taken at these sites. In addition to counting butterflies, we noted butterfly behavior (i.e. nectaring or ovipositing).

ANALYSIS

To detect if there were differences between burned and unburned zones we conducted a 2 –way repeated measures analysis of variance (ANOVA). We pooled transect counts within years and considered years and treatment (burned vs. unburned) as the two factors; transects were the repeated measures. We conducted all analyses using R (R Core Team 2012).

ENVIRONMENTAL CONDITIONS

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

Minimum temperature: Above 60°F.

Cloud cover: Partly sunny to clear. On cooler days, sunshine is very important in warming the butterflies' flight muscles and allowing them to take flight. On warmer days (above 60°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.

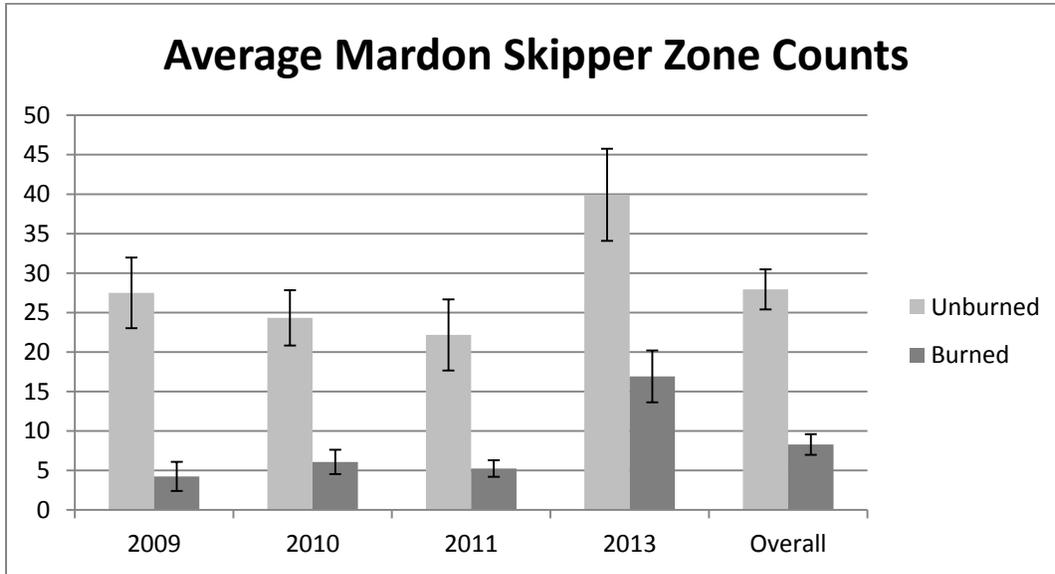
Time of year: We conducted surveys during the mardon skipper's late spring flight period. Flight season varied across the four years. In 2009 and 2013 it occurred in late May and early June, and in 2010 and 2011 it occurred in late June and early July.

RESULTS

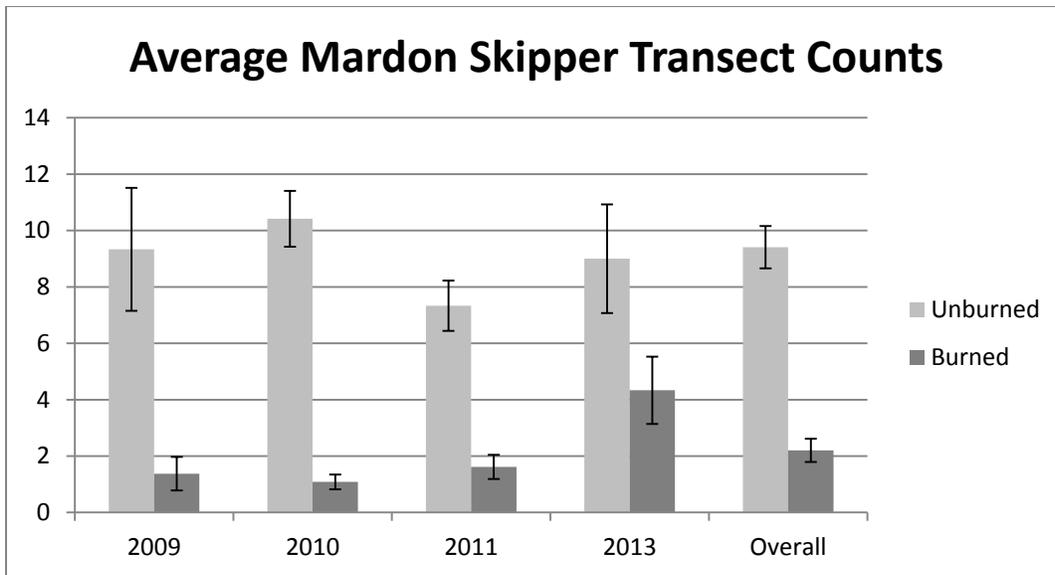
In 2009, 2010, 2011 and 2013, mardon skipper surveys revealed a clear pattern of response to burning. With the exception of one transect count on 6/2/2013, mardon numbers were higher on all dates in unburned transects and zones compared to burned transects and zones within the same survey meadow. Counts for all four zones across all survey dates in 2009, 2010, 2011 and 2013 showed mardon numbers that ranged from 1.7 to 27 times higher in unburned zones compared to burned zones on the same dates. Over four years of data collection, the average number of mardon skippers in unburned zones was 27.5 in 2009, 24.3 in 2010, 22.16 in 2011, and 39.9 in 2013 (See Figure 3). Burned areas had an average of 4.25 mardon skippers in 2009, 6.08 in 2010, 5.25 in 2011, and 16.91 in 2013 (See Figure 3). Individual zone and transect counts are described below.

FIGURE 3: MEAN MARDON SKIPPER COUNTS, 2009, 2010, 2011 AND 2013 (ERROR BARS ARE +/- 1 SE).

3A. ZONE COUNTS



3B. Transect counts



ZONE 1

Zone 1 is located just to the east of road 17N07 (Appendix 1, Maps 1, 2, 3 and 4). In 2008, this site had a relatively high density of mardon skippers based on a one-day count. In all survey years (2009, 2010, 2011 and 2013), the number of mardon skippers remained lower in the burned area of the zone (Figure 4A and B). Mardon numbers

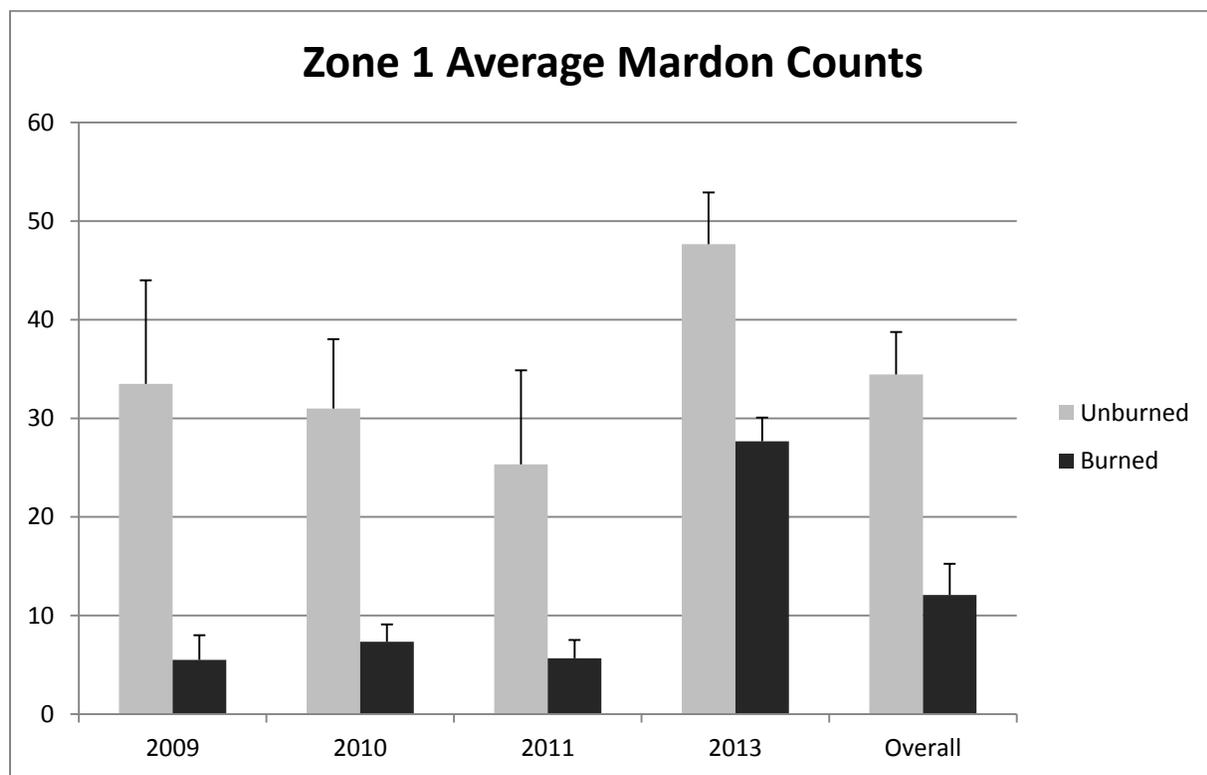
reached a maximum of 31 in the burned zone (6/6/2013), whereas they reached up to 56 in the unburned portion of the zone (6/6/2013).

During the first three survey years, the average number of mardon in unburned regions decreased in zone counts (34 in 2009, 31 in 2010, and 25 in 2011). However, the average number of mardon in unburned regions of the zone increased in 2013 to 48. In burned habitat, the burned area of zone 1 averaged 6 mardon in 2009, 7 in 2010, 6 in 2011, and 28 in 2013

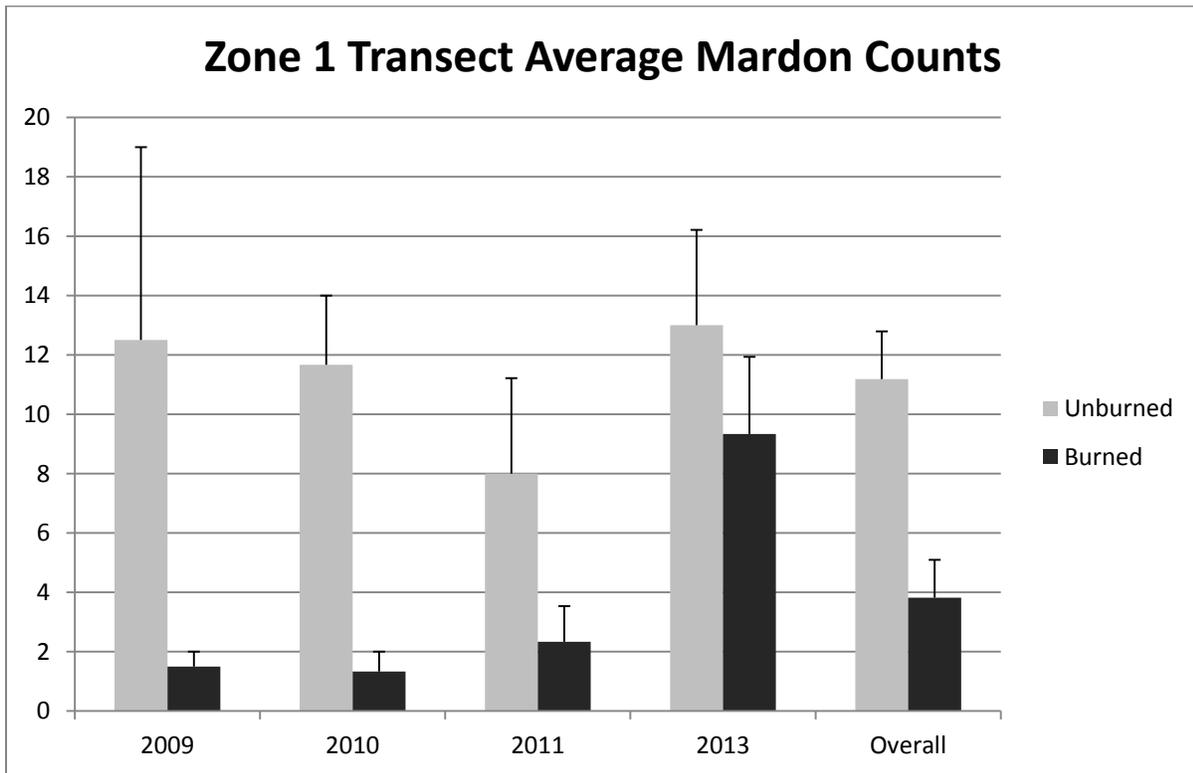
The average unburned transect counts in zone 1 were consistent through all four years (13 in 2009, 12 in 2010, 8 in 2011 and 12 in 2013). Burned transect counts averaged 2 mardon in 2009, 1 in 2010, 2 in 2011, and increased to 9 in 2013.

FIGURE 4: ZONE 1 BURN SITE MARDON SKIPPER COUNTS, 2009, 2010, 2011 AND 2013 (ERROR BARS ARE +1 SE).

4A. WHOLE ZONE COUNTS



4B. TRANSECT COUNTS



ZONE 2

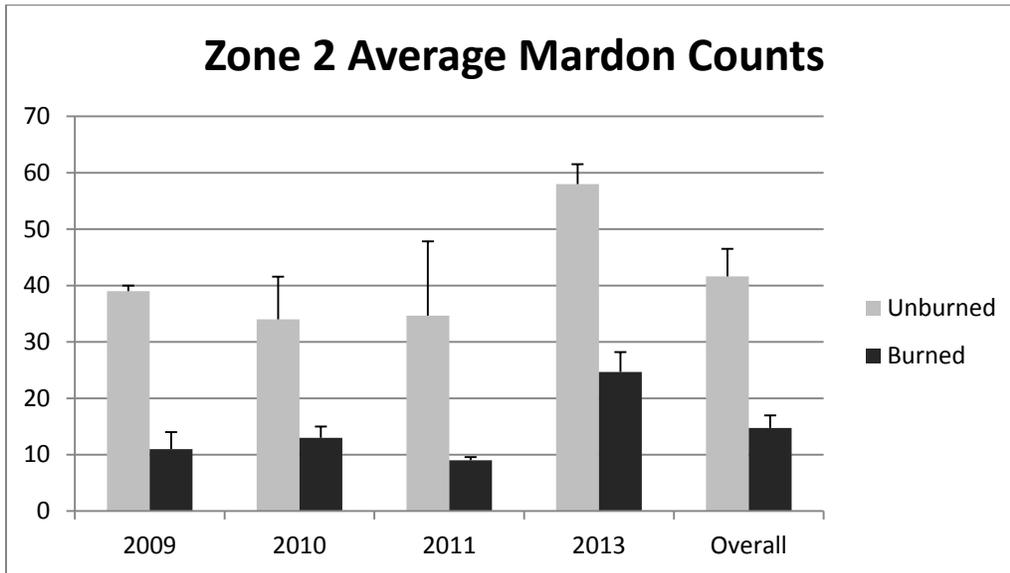
Zone 2 is directly east of zone 1 (Appendix 1, Maps 1, 2, and 3). Some areas within the meadow are too wet for the mardon skipper, but the majority has high quality mardon habitat and had a relatively high density of mardon skippers in the 2008 one-day count. The burned habitat in zone 2 had the highest average number of mardon among all four burned habitat zones surveyed (maximum of 30 on 6/6/2013). However, the number of mardon was much lower in the burned habitat of zone 2 compared to the unburned habitat in all years (maximum of 62 mardon on 6/2/2013, Figure 5A and B).

The average number of mardon in unburned regions of the zone was similar across the first three years of surveys for total zone counts (39 in 2009, 34 in 2010, and 35 in 2011) and slightly higher in 2013 (58). Average mardon numbers in the burned area of zone 2 were similar across the first three survey years (11 mardon in 2009, 13 in 2010, and 9 in 2011), but increased to 25 in 2013.

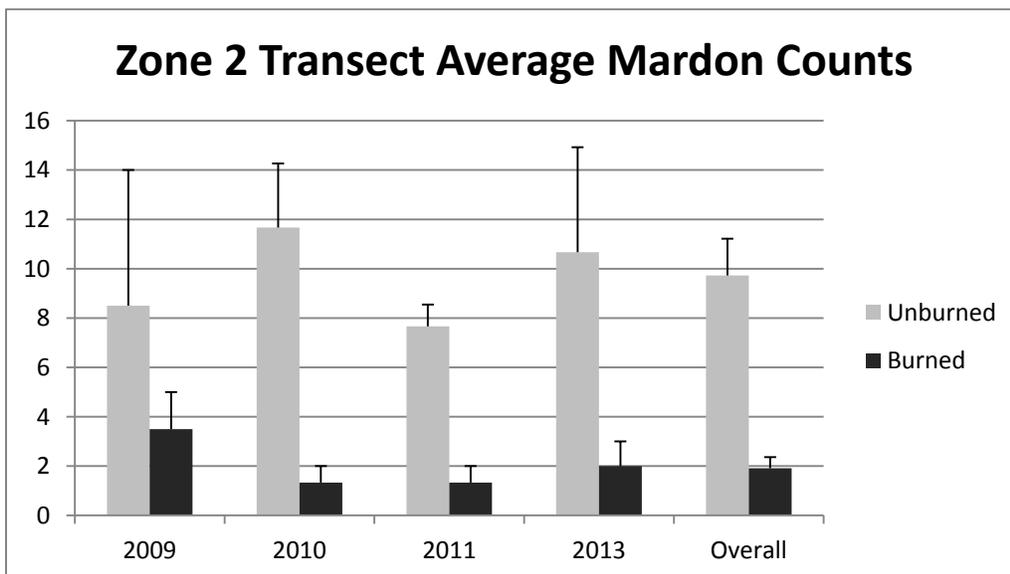
The average number of mardon in unburned transects was similar across all four years (9 in 2009, 12 in 2010, 8 in 2011, and 11 in 2013). The average number of mardon in burned transects was highest in 2009 (4 mardon), lower in 2010 and 2011 (1 mardon) and intermediate in 2013 (2 mardon).

FIGURE 5: ZONE 2 BURN SITE MARDON SKIPPER COUNTS, 2009, 2010, 2011 AND 2013 (ERROR BARS ARE +1 SE).

5A. WHOLE ZONE COUNTS



5B. TRANSECT COUNTS



ZONE 3

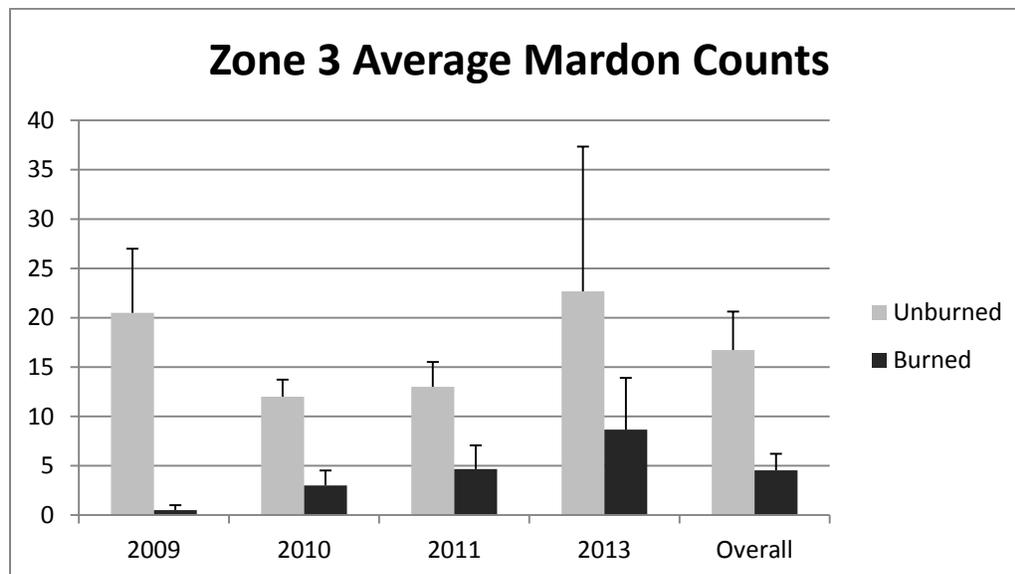
Zone 3 is located just to the south of zone 1 (Appendix 1, Maps 1, 2, and 3). It is a linear habitat area that is much smaller than zones 1 or 2, although the burned and unburned zones are of a comparable area to each other. The habitat in the non-burn area had more fescue and nectar sources than the habitat in the burned portion of the site, although mardon were found in moderate numbers throughout this area in the 2008 survey. For all survey years, 2009, 2010, 2011 and 2013, the number of mardon skippers remained much lower in the burned zone. Mardon numbers never exceeded a maximum of 19 in the burned zone on any date surveyed; this maximum zone count occurred on a single date (6/6/2013), and on all other survey dates the zone counts ranged from only 8 to no mardon at all (Figure 6A and B). 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 (52 in the unburned portion of zone 3 on 6/6/2013).

The average number of mardon in unburned regions of the zone varied across years for the total zone counts (20.5 in 2009, 12 in 2010, 13 in 2011, and 22.7 in 2013). 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, 3 in 2010, 4.7 in 2011, and 8.7 in 2013.

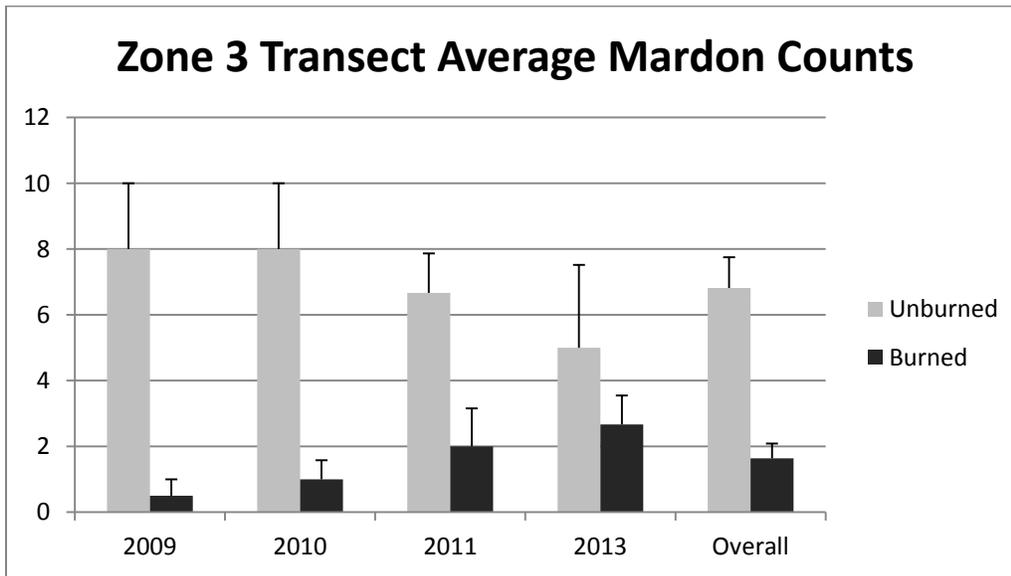
Unburned transect counts in zone 3 were consistent across years (mean = 8 in 2009 and 2010, 6.7 in 2011, and 5 in 2013). Transect counts in the burned area increased two-fold between survey years 2009 to 2010 (from 0.5 to 1, respectively) and from 2010 to 2011 (from 1 to 2, respectively). Transect counts increased by 1.3 (to 6.7) from 2011 to 2013.

FIGURE 6: ZONE 3 BURN SITE MARDON SKIPPER COUNTS, 2009, 2010, 2011 AND 2013 (ERROR BARS ARE + 1 SE).

6A. WHOLE ZONE COUNTS



6B. TRANSECT COUNTS



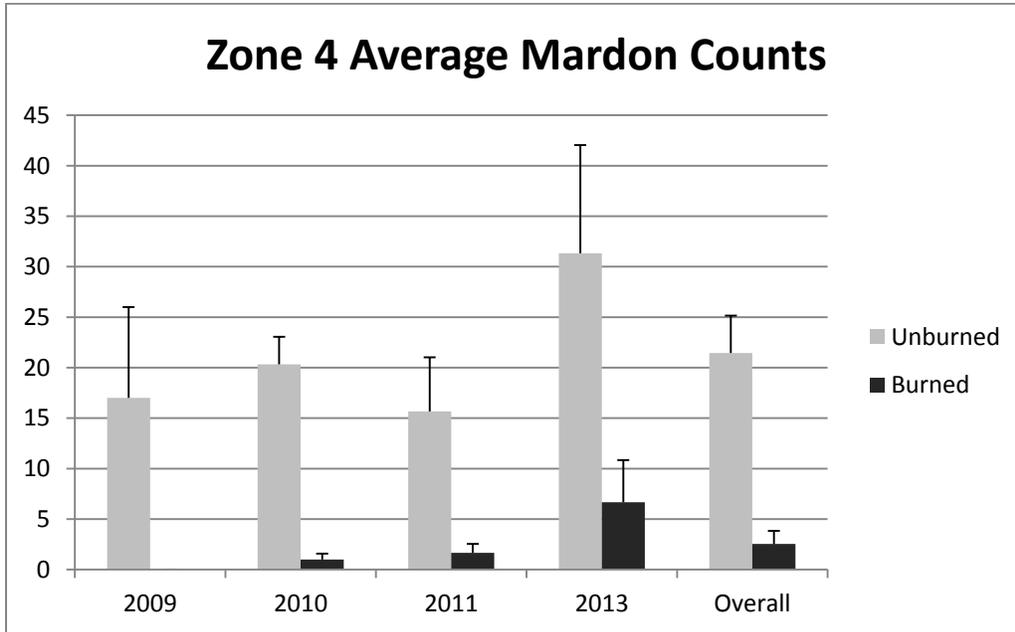
ZONE 4

Zone 4 includes the southern-most meadow in this complex and is located southeast of zone 3 (Appendix 1, Maps 1, 2, 3 and 4). 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 survey. This meadow had the smallest numbers of mardon in the burned habitat among all four zones surveyed for both whole-zone and transect counts. Mardon numbers did not exceed a maximum of 3 during any survey in the zone 4 burned habitat until the final zone count in 2013, with a total of 15. Over a third of the 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 49 counted in the unburned zone (6/6/2013) (Figure 7A and B).

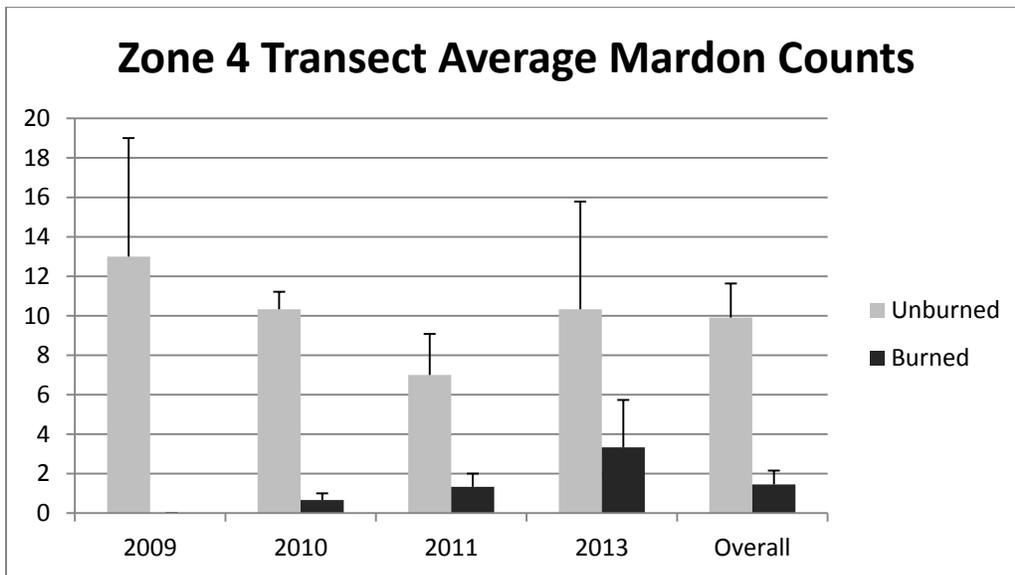
The mean number of mardon in unburned regions of the zone was similar across the first three years of surveys for total zone counts (17 in 2009, 20 in 2010, and 16 in 2011), and increased to 31 in 2013. In contrast, the burned habitat surveyed in zone 4 completely lacked mardon in 2009. In 2010 and 2011, mardon were present but average counts were very low (1 in 2010, 1.66 in 2011). However, in 2013 mardon skipper numbers increased in the burned zone, with an average of 6.66 mardon skippers. In unburned areas, the mean number of mardon in transect counts decreased slightly from 2009 to 2011 (13 in 2009, 10 in 2010, and 7 in 2011) and increased again in 2013 (10). Transects in burned areas had low average counts in 2009 to 2011 (0 in 2009, 0.67 in 2010, and 0.67 in 2011) and a slightly higher average in 2013 (4).

FIGURE 7: ZONE 4 BURN SITE MARDON SKIPPER COUNTS, 2009, 2010, 2011 AND 2013.

7A. WHOLE ZONE COUNTS



7B. TRANSECT COUNTS



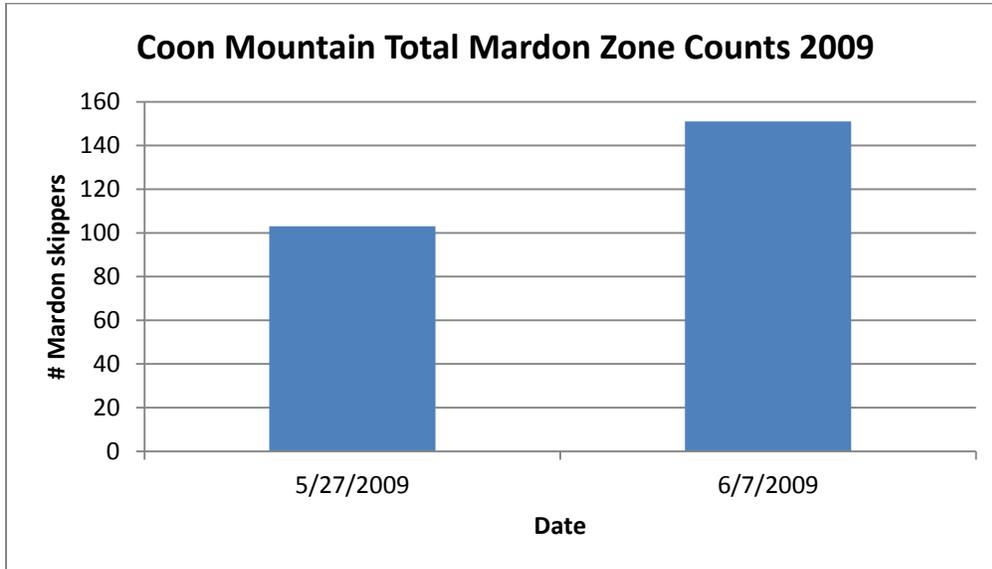
TOTAL POPULATION COUNTS AT COON MOUNTAIN

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).

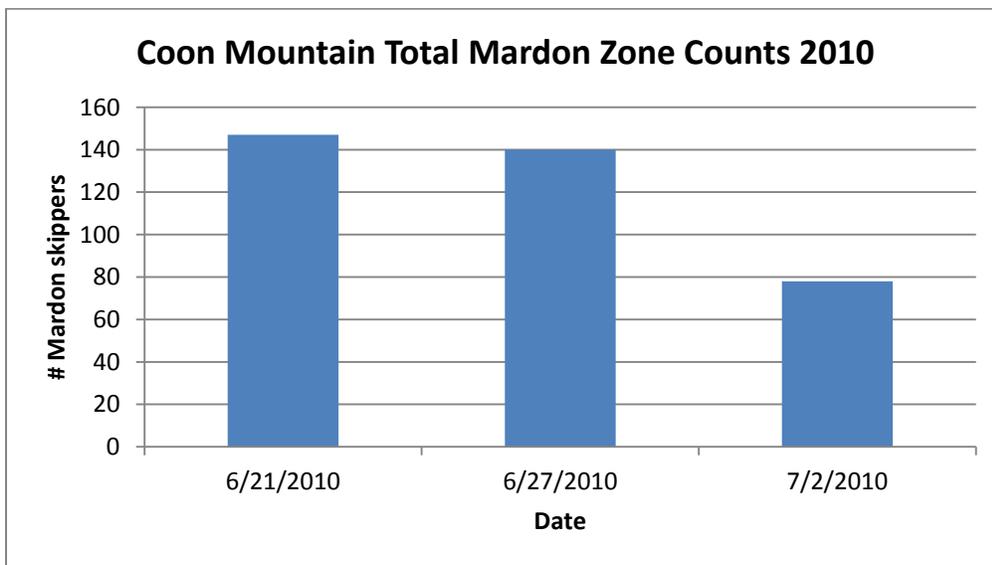
Total mardon population numbers across all four zones and for burned and unburned zone counts were combined to show the number of total butterflies throughout the flight period during all four survey years (Figure 8A, 8B, 8C, and 8D). The highest one-day count was 151 in 2009, 147 in 2010, 168 in 2011, and 313 in 2013. The population across this area seems stable and is still considered the largest population in California.

FIGURE 8: TOTAL MARDON SKIPPER ZONE COUNTS, UNBURNED AND BURNED COMBINED.

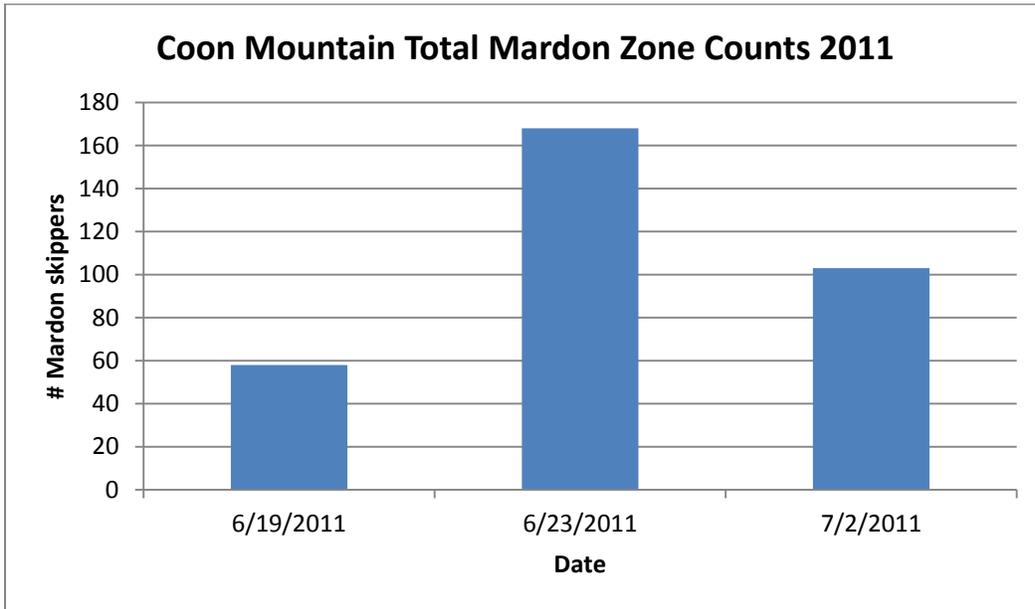
8A. 2009 TOTAL ZONE COUNTS



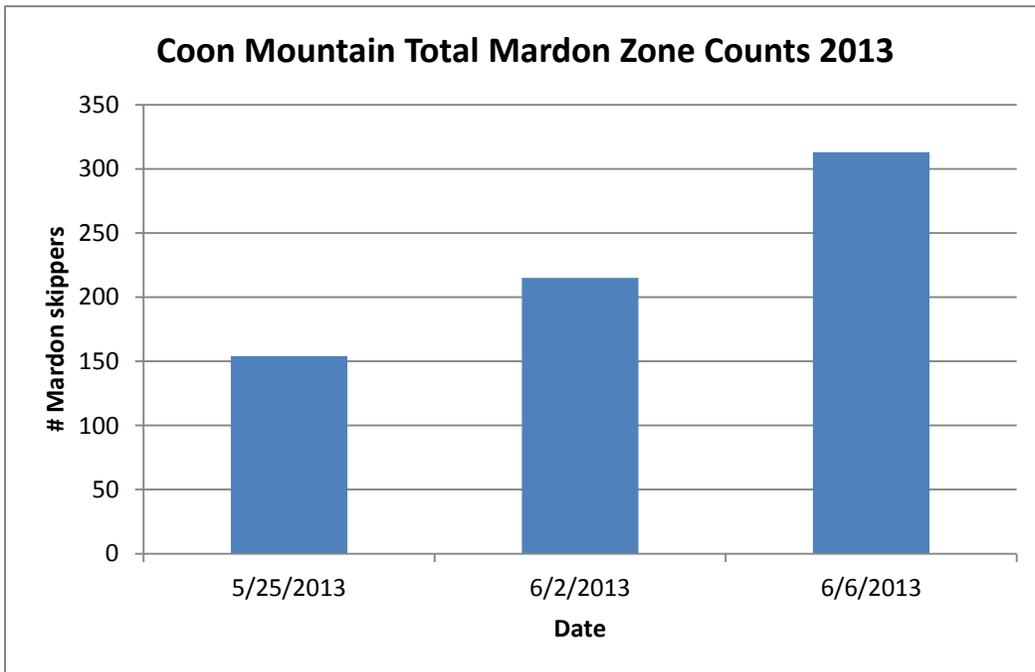
8B. 2010 total zone counts



8C. 2011 TOTAL ZONE COUNTS



8D. 2013 TOTAL ZONE COUNTS



DIFFERENCES BETWEEN BURNED AND UNBURNED AREAS

Transects in unburned areas had a significantly higher number of mardon skippers than burned areas ($F=77.96$, $p=5.27 \times 10^{-9}$). Mardon skipper counts also differed significantly from year to year ($F=4.79$, $p=0.00938$). However, the interaction of time (years) and treatment did not show a significant effect ($F=1.565$, $p=0.22381$). In each year average counts in unburned areas exceeded the counts in burned areas. By 2013 the differences between burned and unburned zones were less severe, but there is still a significantly higher number of mardon skippers in unburned areas (Figure 3B).

DISCUSSION

The results of this study shows significantly fewer butterflies in the burned areas of Coon Mountain meadows compared to unburned regions after one, two, three, and five years following the burn event. With the exception of one transect count on 6/2/2013 (in zone 3, with 3 mardon in burned and 2 in unburned transects), for all dates mardon skipper numbers were higher 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, 2010, 2011 and 2013 showed mardon numbers that ranged from 1.7 to 27 times higher in unburned zones compared to burned zones on the same dates.

When we pool transect data within years, both burning and time have a significant effect on mardon skipper abundance. The fact that there is no interaction effect between time and burning suggests that the effect of burning on mardon skippers is real and not confounded by annual variation in butterfly populations. One thing worth noting is that mardon skipper populations in burned areas do appear to be making a comeback after 5 years (See Figure 3). This accentuates the need to leave substantial habitat when using fire as a management tool for mardon skippers. Leaving enough habitat so that a large enough butterfly population remains to sustain a prolonged (although ideally short-term) decrease in habitat quality is essential. This would argue against using fire as a management tool for mardon skippers in small patches of habitat, or in habitats with low baseline population counts. In these cases, the results of this study suggest that the risk of extirpation from fire is too high.

FOREST ENCROACHMENT

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.

PRESCRIBED FIRE

As stated above, fire suppression can lead to invasion and maturation of shrubs and trees and an increase and ultimately loss and degradation of forest-meadow ecosystems (Black *et al.* 2011, Coop & Givinish 2007; Norman & Taylor 2005). Eventually, continued succession results in the degradation and loss of the grasslands (Schultz & Crone 1998; Panzer 2003). Prescribed burning is therefore a useful tool for restoring and maintaining grassland habitat but a balance should be struck between improving habitat with fire and the impact prescribed burning has on non-target insects.

Fire as a management tool is based on the supposition that prairie species are adapted to wildfires, and thus can cope with regular burns (e.g., Harper *et al.* 2000; Swengel 2001; Panzer 2002; Hartley *et al.* 2007). This is dependent, however, on there being adequate unburned areas adjacent that can provide sources of colonizers into the burned habitat. In small fragments where populations are more isolated, prescribed burning can have much more deleterious effects on the population due to a lack of colonizing capacity. For example, Harper *et al.* (2000) found that overall arthropod species richness decreased in burned prairie sites, as well as the abundance of all but one of the species measured. Their results suggest that burning a small habitat fragment in its entirety could risk extirpating some species because of limited recolonization from adjacent habitat.

Fire can have serious impacts on population levels and unless there are adequate refuges from the fire or adjacent habitat, recolonization of a burned site may not be feasible (Black *et al.* 2009, 2011). Timing of burns is also critical and should not be carried out when target pollinators are in a larval or critical foraging stage.

To ensure a healthy population of mardon skipper, burned areas must be recolonized by butterflies flying in from unburned parts of the meadow. During adult flight, mardon skippers are assumed to have limited dispersal abilities (Beyer & Schultz 2010; Beyer & Black 2007; Runquist 2004). Also, areas with smaller core populations may take longer to colonize than other areas with larger population sizes.

RECOMMENDATIONS FOR FUTURE MANAGEMENT AT COON MOUNTAIN

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:

- 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 one-third 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.
- While implementing a burn plan, measures must be taken to avoid actions that could degrade existing habitat and kill individual skippers, including heavy equipment use and additional or excessive foot traffic by burn staff in mardon meadows.
- Every 3-5 years a mardon skipper survey at Coon Mountain should be completed in order to understand the rate and timing of full re-colonization of burned areas by skippers.

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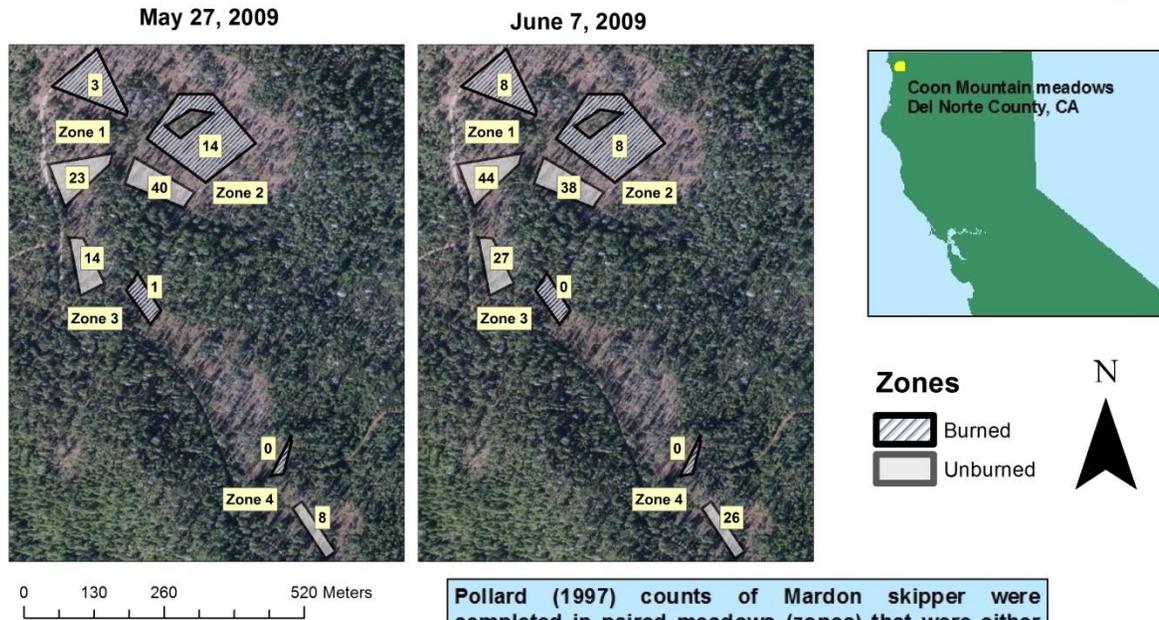
PERSONAL COMMUNICATION

Gary Falxa, Biologist, USFWS 2008

APPENDIX 1: MAPS

MAP 1: 2009 SURVEYS

Mardon skipper populations in burned vs. unburned meadows, Coon Mountain CA, 2009



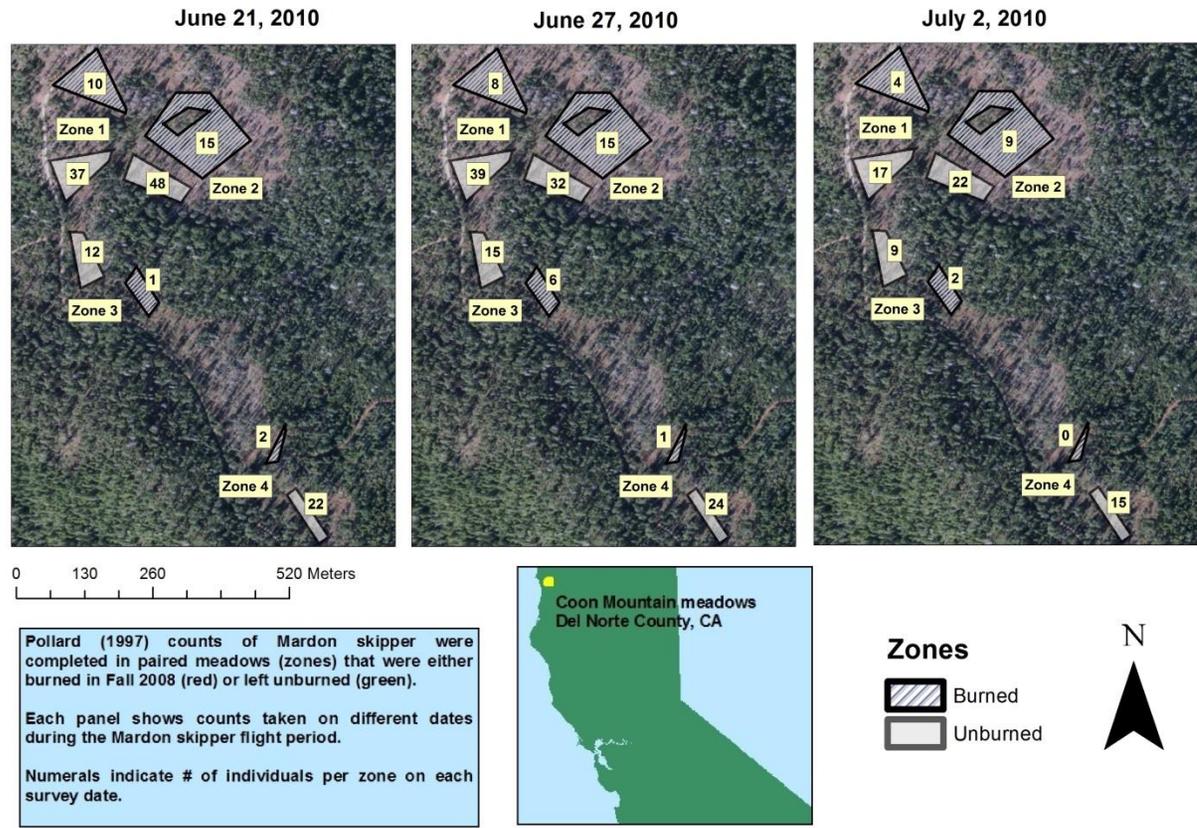
Pollard (1997) counts of Mardon skipper were completed in paired meadows (zones) that were either burned in Fall 2008 (red) or left unburned (green).

Each panel shows counts taken on different dates during the Mardon skipper flight period.

Numerals indicate # of individuals per zone on each survey date.

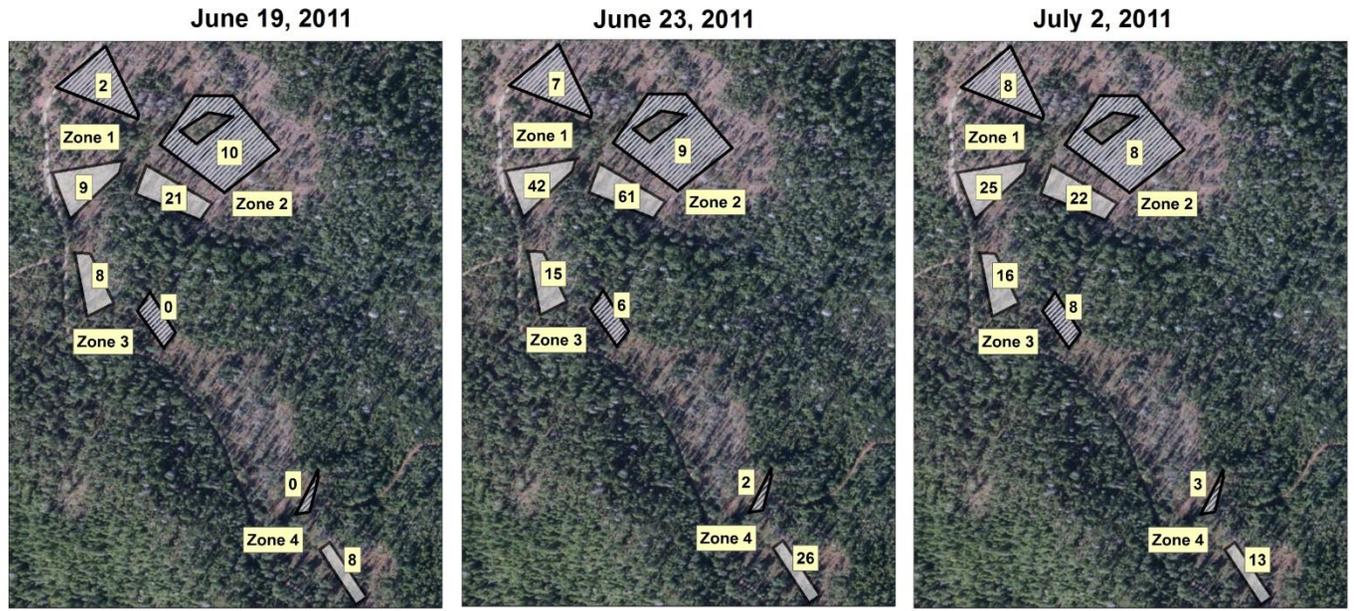
MAP 2: 2010 SURVEYS

Mardon skipper populations in burned vs. unburned meadows, Coon Mountain CA, 2010



MAP 3: 2011 SURVEYS

Mardon skipper populations in burned vs. unburned meadows, Coon Mountain CA, 2011



0 130 260 520 Meters

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.

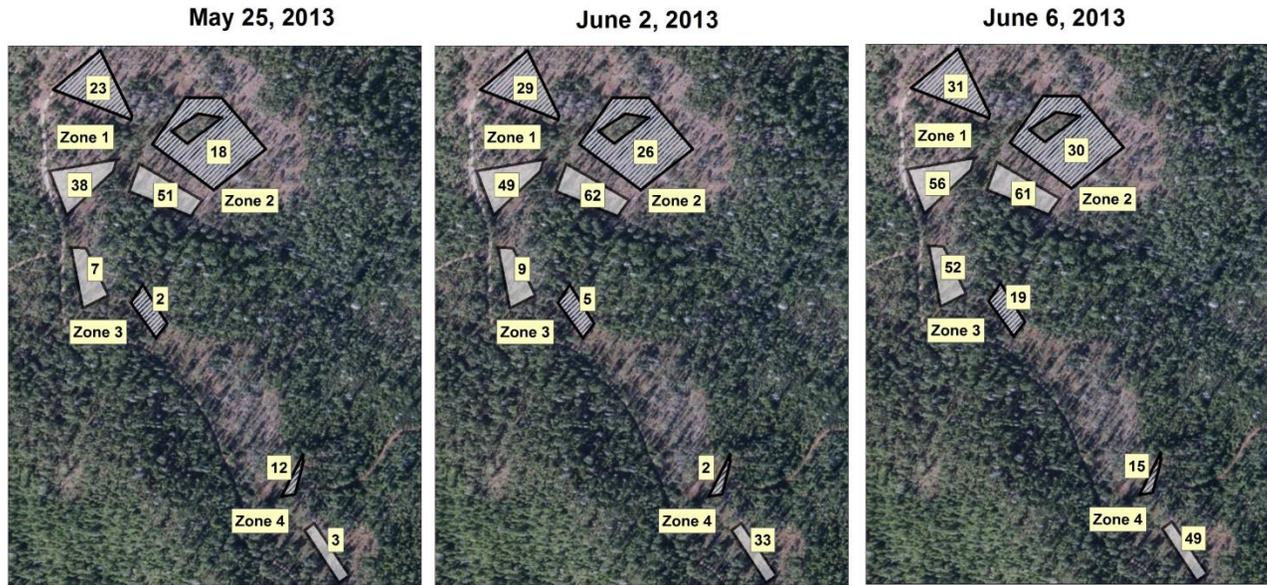


Zones
 Burned
 Unburned



MAP 4: 2013 SURVEYS

Mardon skipper populations in burned vs. unburned meadows, Coon Mountain CA, 2013



0 130 260 520 Meters

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



APPENDIX 2: TABLES

TABLE 1. MARDON SKIPPER HABITAT ZONE AND TRANSECT LOCATIONS.

Survey region	Polygon coordinates ¹	Transect coordinates ²
Zone 1 unburned	N 41.77428 W 123.97115 N 41.77369 W 123.97084 N 41.77423 W 123.97008 N 41.77440 W 123.97001	Start: N 41 46.459 W 123 58.205 End: N 41.774117 W 123.970467
Zone 1 burned	N 41.77483 W 123.96980 N 41.77487 W 123.96979 N 41.77570 W 123.97035 N 41.77523 W 123.97112	Start: N 41.774750 W 123.969767 End: N 41.775100 W 123.970150
Zone 2 unburned	N 41.77401 W 123.96990 N 41.77434 W 123.96973 N 41.77386 W 123.96866 N 41.77367 W 123.96883	Start: N 41.774050 W 123.969517 End: N 41.774283 W 123.969967
Zone 2 burned	N 41.77399 W 123.96848 N 41.77448 W 123.967641 N 41.77513 W 123.96835 N 41.77513 W 123.96893	Start: N 41.775167 W 123.968833 End: N 41.774800 W 123.969167
Zone 3 unburned	N 41.77274 W 123.97016 N 41.77256 W 123.97057 N 41.77335 W 123.97076 N 41.77333 W 123.97058	Start: N 41.772817 W 123.970483 End: N 41.773250 W 123.970567
Zone 3 burned	N 41.77221 W 123.96941 N 41.77 239 W 123.96923 N 41.77288 W 123.96966	Start: N 41.772833 W 123.969733 End: N 41.772383 W 123.969483

	N 41.77266 W 123.96985	
Zone4 unburned	N 41.76994 W 123.96706 N 41.77003 W 123.96691 N 41.76936 W 123.96628 N 41.76927 W 123.96645	Start: N 41.769800 W 123.966700 End: N 41.769417 W 123.966533
Zone 4 burned	N 41.77035 W 123.96718 N 41.77032 W123.96740 N 41.77084 W 123.96705 N 41.77073 W 123.96705	Start: N 41.770717 W 123.967200 End: N 41.770333 W 123.967250

¹Coordinates indicate the 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.

²Coordinates 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, 2011 & 2013

Mardon skipper counts, total zone numbers												
Zone	Condition	Date										
		5/27/2009	6/7/2009	6/21/2010	6/27/2010	7/2/2010	6/19/2011	6/23/2011	7/2/2011	5/25/2013	6/2/2013	6/6/2013
Zone 1	unburned	23	44	37	39	17	9	42	25	38	49	56
	burned	3	8	10	8	4	2	7	8	23	29	31
Zone 2	unburned	40	38	48	32	22	21	61	22	51	62	61
	burned	14	8	15	15	9	10	9	8	18	26	30
Zone 3	unburned	14	27	12	15	9	8	15	16	7	9	52
	burned	1	0	1	6	2	0	6	8	2	5	19
Zone 4	unburned	8	26	22	24	15	8	26	13	12	33	49
	burned	0	0	2	1	0	0	2	3	3	2	15
Mardon skipper, transect counts ¹												
Transect ¹	Condition	Date										
		5/27/2009	6/7/2009	6/21/2010	6/27/2010	7/2/2010	6/19/2011	6/23/2011	7/2/2011	5/25/2013	6/2/2013	6/6/2013
Zone 1	unburned	6	19	14	14	7	3	14	7	7	14	18
	burned	1	2	0	2	2	0	3	4	5	9	14
Zone 2	unburned	3	14	7	16	12	6	9	8	5	8	19
	burned	5	2	2	2	0	2	0	2	1	4	1

Mardon skipper, transect counts (continued)												
Transect	Condition	Date										
		5/27/2009	6/7/2009	6/21/2010	6/27/2010	7/2/2010	6/19/2011	6/23/2011	7/2/2011	5/25/2013	6/2/2013	6/6/2013
Zone 3	unburned	6	10	10	10	4	6	9	5	3	2	10
	burned	1	0	0	2	1	0	2	4	1	3	4
Zone 4	unburned	7	19	10	12	9	3	10	8	3	7	21
	burned	0	0	1	1	0	0	2	2	0	2	8

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.