# Effects of prescribed fire for fuel reduction on *Solanum parishii* (Parish's horse-nettle)

2012

## Report to the Bureau of Land Management, Medford District

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Institute for Applied Ecology

## PREFACE

This report is the result of a cooperative Challenge Cost Share project between the Institute for Applied Ecology (IAE) and the USDI Bureau of Land Management. IAE is a non-profit organization dedicated to natural resource conservation, research, and education. Our aim is to provide a service to public and private agencies and individuals by developing and communicating information on ecosystems, species, and effective management strategies and by conducting research, monitoring, and experiments. IAE offers educational opportunities through internships. Our current activities are concentrated on rare and endangered plants and invasive species.

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**Cover photograph**: *Solanum parishii* habitat at Hukill Hollow and a *S. parishii* flower.


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# Effects of prescribed fire for fuel reduction on *Solanum parishii* (Parish's horse-nettle)

**REPORT TO THE BUREAU OF LAND MANAGEMENT, MEDFORD DISTRICT**

## INTRODUCTION

**Figure 1.** *Solanum parishii* (Parish's Horse-nettle)

*Solanum parishii* (Parish's horse-nettle; Figure 1), is a rare plant of southern Oregon that occurs in Jackson, Josephine, and Curry counties (Figure 2). *Solanum parishii* is considered imperiled in Oregon (List 2), but secure elsewhere in its range, which includes both Oregon and California (ORBIC 2010). Most known occurrences are on lands managed by federal agencies, including the USDI Bureau of Land Management and the USDA Forest Service. Previous studies have shown that this species is among a group of plants that may benefit from wildfires (Copeland 2005), but a clear understanding of how fire affects survival and reproduction of the species after controlled burns is lacking. Several native species of *Solanum* are known to respond positively to fire (e.g. Wink and Wright 1973), possibly due to stimulation of seed germination from heat or smoke exposure (Koduru et al. 2006, Kandari et al. 2011). This project evaluates the effects of fire and fire intensity on this species through comparisons of replicated burned and unburned plots at two sites in southern Oregon. This report also provides guidance for fuel reduction planning.

*Solanum parishii* is an herbaceous perennial that becomes more or less woody with age. Individuals are less than 100 cm tall, much-branched and generally glabrous, though sparse, simple hairs may be present. Stems are clearly angled to ribbed. Leaves are lanceolate to elliptic with wavy to entire margins and 2 to 7 cm long. They are usually unlobed and sessile or gradually tapering to their bases. The blue-purple (to white) flowers are clustered in umbel-like inflorescences in which pedicels are longer than peduncles. Fruits are berries 7-10 mm in diameter that turn green to purple with age. *Solanum parishii* occurs in dry chaparral and shrublands, oak and pine woodlands, and pine forests throughout its range from southern Oregon to Baja California at elevations less than 2,000 m. Individuals typically occur in small populations (less than 10 plants) scattered across the landscape.

# METHODS

## *Solanum parishii* monitoring

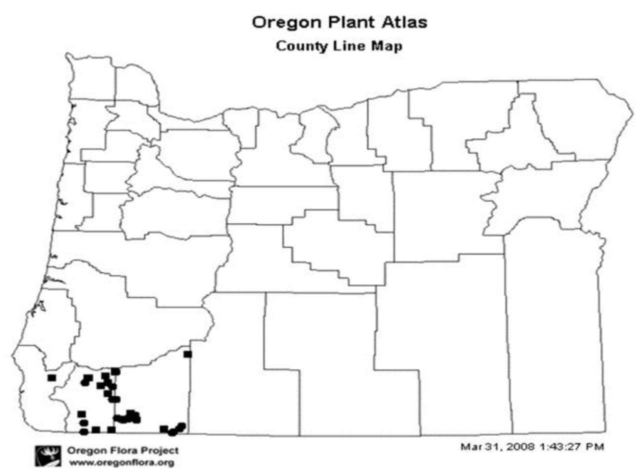


**Figure 2.** Distribution of *Solanum parishii* in Oregon

Field sites for this project included Hukill Hollow and Woodrat Mountain, both located in the Squires Peak – Woodrat Mountain area of the Ashland Resource Area, Medford District BLM. At each site, 3m by 6m plots were established in June 2009, with 23 plots at Hukill Hollow and 17 at Woodrat Mountain (Appendix A). The long axis of each plot was oriented parallel to the slope (up and downhill). Each corner was monumented with a 1m piece of rebar sunk 45 to 60 cm into the ground. A numbered metal tag was wired around the upslope right rebar (as determined when standing at the bottom of the plot and facing upslope); this rebar also served as the origin (0, 0) when measuring plant distances within the plot (see below), with the 3 m side representing the x-axis and the 6 m side representing the y-axis. Plots were situated to include at least two *S. parishii* individuals in their upper halves. As fires carried uphill, this orientation provided the greatest likelihood that a fire started in the downhill portion of a plot would evenly burn the area immediately surrounding the *S. parishii* plants. Half of the plots at each site were randomly assigned to the burn treatment, while the other half were controls, being either excluded from burn areas or protected from burning. Green flagging was tied around each of the rebar corners of control plots while orange or pink flagging was tied around each of the rebar corners of burn plots. A GPS point was recorded at the plot's origin.

Within the plots, each plant was mapped onto a grid (Appendix A). The maximum and perpendicular widths and the number of fruits and/or flowers of each plant were recorded. Reproductive effort was calculated as the sum of fruits and flowers, based on the assumption that all flowers recorded had the potential to mature into fruits. Herbivory by mammals and/or insects was recorded as present or absent. Mammal damage was defined as stems that were either clipped or stripped of leaves, while insect damage was defined as irregular damage to leaves and/or stems, including ragged leaf margins and leaf holes. The cover of shrubs, forbs and grasses was estimated both in the immediate vicinity of each plant and for the plot as a whole. Total vegetative cover was also estimated for the entire plot. All plant and cover measurements were repeated in 2010 (pre-burn), in 2011 (1st year post-burn), and in 2012 (2nd year post-burn). Plant community cover measurements at the species level were added to the sampling methods in 2012. The percent cover of each species present inside the entire plot was recorded in order to provide more detailed plant community information for the final year of monitoring (2012).

**Figure 3.** Temperature indicating paint on burned (right) and unburned (left) plot tags.

Controlled burns were conducted by the Medford BLM on November 4, 2010. Prior to burning, tags marked with temperature indicating paint were placed next to at least one *S. parishii* plant in each plot. Temperature indicating paints can determine the range of a fire's temperature because the paint will bubble or melt if its maximum temperature is reached or exceeded (Figure 3). Paints used for this fire register temperatures between 175°F and 1300°F. Two tags were placed by each plant, one at ground level, and another 5 cm above the ground. The average of these tags was used to estimate the temperature of the fire. Tags were retrieved approximately two weeks post-fire. Firsthand accounts of the controlled burns indicate that patchy fuels at Woodrat Mountain produced marginal burns, while Hukill Hollow burned slightly better (A. Rebischke, *personal communication*). One burn plot at Hukill Hollow was switched with a control plot due to proximity to fire hoses.

## Data Analysis

Due to differences in population characteristics for both sites, we tested the effects of fire on each site separately (Newton et al. 2010). We used 2-factor ANOVA (R Development Core Team 2009) to test for the response of mean size of *S. parishii*, using year and burn status (burned or control) as fixed factors with data from 2010 (pre-fire) and 2012 (2$^{nd}$ year post-fire). Mean size for *S. parishii* was log-transformed in order to meet assumptions of normality. When a significant main factor effect was found, we used a single factor ANOVA to test for differences in mean size of *S. parishii* for that factor. To test for the response of reproductive effort, we used a general linear model with a negative binomial distribution (log link), using year and burn status as predictors. To test for effects of fire on survival of *S. parishii* between 2010 and 2012, we used logistic regression (family = binomial), modeling each site separately. Survival was a binary value, indicating if individual plants were present in both 2010 and 2012. We assumed that size prior to fire might influence survival of *S. parishii*, so we used mean size pre-fire (2010) as a covariate. We considered $P < 0.10$ to be significant.

Differences in plant community between burned and unburned treatments (in 2012) were tested with multi-response permutation procedure (MRPP; Mielke and Berry 2001) using the Sørensen distance measure, in PC-ORD.

# RESULTS

## Effects of fire on *Solanum parishii*

*Solanum parishii* plants were larger in burned plots the first year after the burn at Hukill Hollow ($P$=0.09), but not at Woodrat Mountain ($P$=0.11) (Gray et al. 2011). Plants in burned plots at Hukill Hollow were about 70% larger in area the year after the burn while those in control plots were about 15% larger (Figure 4). Plant reproductive effort was unaffected by fire in the first year after the burn at both sites ($P \geq 0.60$) (Figure 5), and plant survival also did not differ by treatment at either site that year ($P \geq 0.52$) (Table 1). In 2012, the second year after the burn, no effects of fire were detected at either site on plant area, reproductive effort, or survival ($P \geq 0.25$ in all cases, Appendices B-G).

Most plots at both sites experienced fires in excess of 225°F, but less than 400°F, with a range of at least 175° to 575°F at Hukill Hollow and at least 225° to 575°F at Woodrat Mountain. Mean temperatures for Hukill Hollow tended to be greater than at Woodrat Mountain (294° and 269°F, respectively).

## Effects of year on *Solanum parishii*

Year of observation was the only factor to have significant effects on size and fecundity of *S. parishii* between 2010 and 2012. Mean size of *S. parishii* decreased between years at

Woodrat Mountain (Figure 4; *P* = 0.008, Appendix C), but did not change significantly between years at Hukill Hollow (Appendix B). Across burned and unburned plots, mean area of *S. parishii* at Woodrat Mountain decreased from 773 $cm^2$ to 252 $cm^2$ in just one year (2011 to 2012), while at Hukill Hollow mean area of *S. parishii* decreased from 953 $cm^2$ to 833 $cm^2$ from 2011 to 2012 (Table 2). Decreases in mean area over the course of this study were substantial. At Woodrat Mountain plants declined in size by 62% from 2010 to 2012. Hukill Hollow remained more stable and experienced a net increase of 20% mean area between 2010 and 2012 (Table 2). These changes in plant size over time were not related to the prescribed burns.

At both sites, reproductive effort decreased from 2010 to 2012, but this decrease occurred across both burned and control treatments (Figure 5; *P* <0.001, Appendix D, Appendix E). Survivorship did not differ by year or treatment (burned or unburned; Appendix F, Appendix G). Mean reproductive effort at both sites was at its lowest in 2012 over the four years of this study.

Mortality of *S. parishii* was higher in 2012 than in any previous year in the study (Table 1). Eleven *S. parishii* died at Hukill Hollow between 2011 and 2012, and Woodrat Mountain had 20 mortalities. These losses were substantially higher than from 2010 to 2011 (4 at Hukill Hollow and 5 at Woodrat Mountain) and were not related to the controlled burns.

Insect and mammal herbivory impacted both populations of *S. parishii* (Table 2). From 2011 to 2012, insect herbivory increased notably at both sites, with a near 200% increase from pre-burn to post-burn state. Immediately after the fire (from 2010 to 2011), insect herbivory decreased at both sites but mammal herbivory increased. In 2012, herbivory increased greatly; 100% of plants at Hukill Hollow and Woodrat Mountain experienced insect herbivory. Mammal herbivory was observed on 66% of plants at Woodrat Mountain and 53% at Hukill Hollow in 2012.

**Table 1.** Plant recruitment and mortality of *S. parishii* at Hukill Hollow and Woodrat Mountain from 2009-2012.

| | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2009 | 2010 | | | 2011 | | | 2012 | | |
| **Site** | Total Alive | New | Dead | Total Alive | New | Dead | Total Alive | New | Dead | Total Alive |
| Hukill Hollow | **70** | 1 | 5 | **66** | 7 | 4 | **69** | 1 | 11 | **64** |
| Woodrat Mountain | **48** | 1 | 2 | **51** | 2 | 5 | **48** | 3 | 20 | **38** |

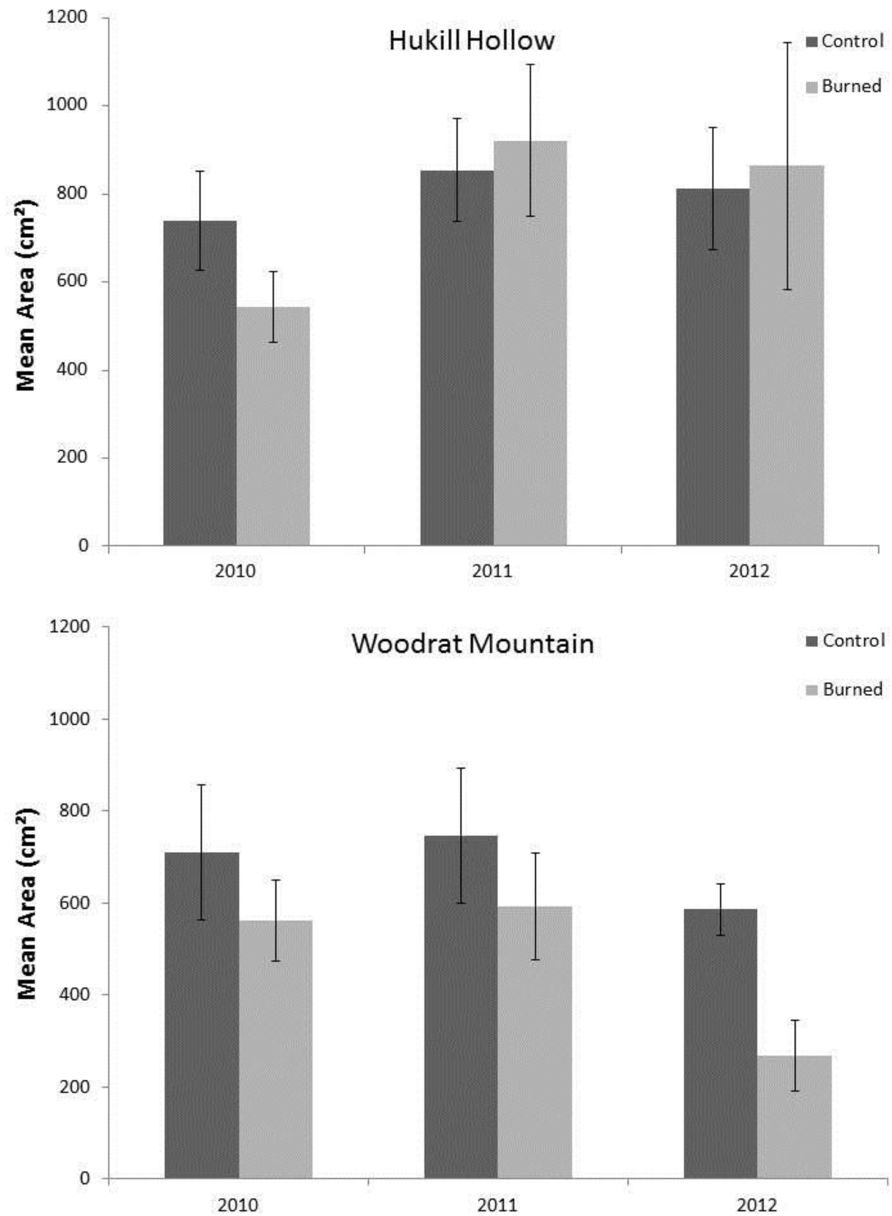


**Figure 4.** Mean area ($cm^2$) for *S. parishii* at Hukill Hollow and Woodrat Mountain for burned and control plots, pre-burn (2010) and post-burn (2011 & 2012). Error bars represent 1 SE.

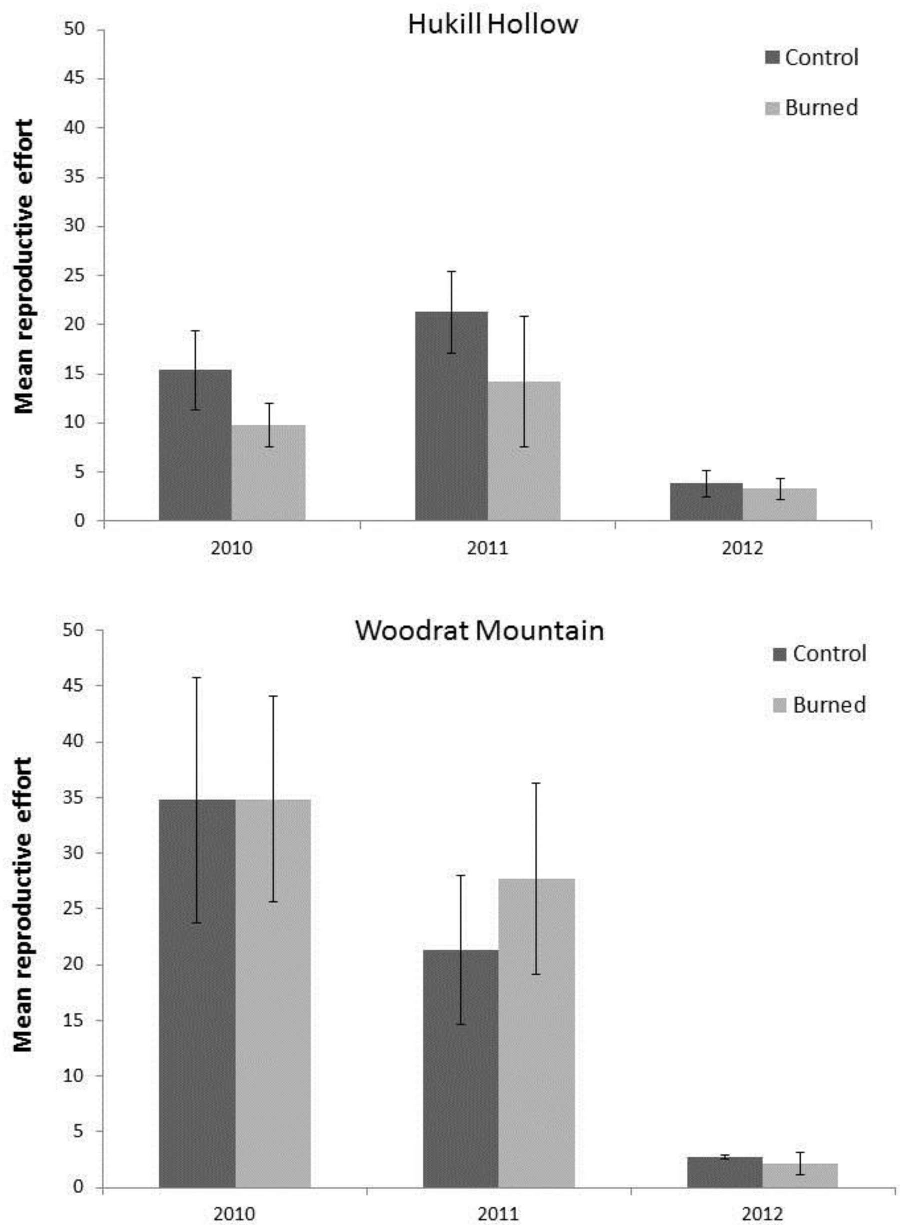


**Figure 5.** Mean reproductive effort for *S. parishii* at Hukill Hollow and Woodrat Mountain for burned and control plots, pre-burn (2010) and post-burn (2011 & 2012). Error bar represent 1 SE.

**Table 2.** *Solanum parishii* characteristics at Hukill Hollow and Woodrat Mountain. Area per plant was determined by calculating the area of the ellipse formed by a plant's maximum and perpendicular widths. Reproductive effort is calculated as flowers plus fruits. Total cover was a separate ocular estimation, not the addition of the different vegetative categories. "Ann. gram." refers to annual graminoids and "Per. gram." refers to perennial graminoids. Percent change refers to pre (2010) and post-burn (2012) comparisons.

| | | | | Herbivory (% of population) | | % cover (near plant) | | | % cover (plot) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | Year | Mean area (cm² ± 1 SE) | Mean reproductive effort ± 1 SE | Insect | Mammal | Shrub | Gram. | Litter | Shrub | Ann. gram | Per. gram | Litter | Total |
| **Hukill Hollow** | **2009** | 693.9 ± 81.4 | 12.4 ± 3.0 | 76 | 53 | 12.9 | 9.2 | 62.1 | 19.1 | 11.1 | 0.3 | 68.7 | 39.7 |
| | **2010** | 687.3 ± 68.4 | 13.5 ± 2.9 | 45.5 | 71.2 | 16.6 | 9.2 | 55.5 | 20.0 | 11.5 | 0.9 | 67.2 | 39.7 |
| | **2011** | 953.4 ± 106.5 | 16.7 ± 2.8 | 29 | 65.2 | 10.2 | 1 | 22.6 | 25.6 | 6.8 | 0.0 | 31.7 | 50.0 |
| | **2012** | 833.0 ± 167.5 | 3.6 ± 0.9 | 100.0 | 53.1 | 12.7 | 5.9 | 16.5 | 29.1 | 16.8 | 0.0 | 33.5 | 64.6 |
| % Change | | 21.2 | -73.3 | 119.8 | -25.4 | -23.5 | -35.9 | -70.3 | 45.5 | 46.1 | -100 | -50.1 | 62.7 |
| **Woodrat Mountain** | **2009** | 702.3 ± 87.2 | 31.7 ± 13.1 | 96.0 | 79.0 | 5.8 | 19.4 | 83.7 | 9.8 | 16.5 | 1.6 | 83.8 | 45.4 |
| | **2010** | 664.9 ± 89.6 | 36.2 ± 7.9 | 49.0 | 56.9 | 5.4 | 21.4 | 83.0 | 12.9 | 15.8 | 1.3 | 61.3 | 46.6 |
| | **2011** | 772.9 ± 100.6 | 21.9 ± 5.2 | 40.0 | 65.0 | 5.6 | 4.0 | 33.8 | 12.8 | 5.2 | 1.0 | 31.9 | 35.4 |
| | **2012** | 252.6 ± 59.9 | 1.2 ± 0.6 | 100.0 | 65.8 | 7.8 | 4.7 | 32.8 | 17.1 | 7.1 | 1.0 | 34.1 | 47.4 |
| % Change | | -62.0 | -96.7 | 104.1 | 15.6 | 44.4 | -78.0 | -60.5 | 32.5 | -55 | -23 | -44 | 1.71 |

Table 2, continued

| Site | Year | Mean area (cm² ± 1 SE) | Mean reproductive effort ± 1 SE | Herbivory (% of population) | | % cover (near plant) | | | % cover (plot) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Insect | Mammal | Shrub | Gram. | Litter | Shrub | Ann. gram. | Per. gram. | Litter | Total |
| **Total** | **2009** | 697.3 ± 59.7 | 22.5 ± 7.1 | 84.0 | 64.0 | 10.0 | 13.4 | 70.9 | 15.2 | 13.4 | 0.8 | 75.1 | 42.1 |
| | **2010** | 677.6 ± 54.5 | 23.4 ± 3.1 | 31.3 | 65.0 | 11.7 | 14.5 | 67.5 | 17.0 | 13.3 | 1.1 | 64.7 | 42.6 |
| | **2011** | 878.7 ± 75.3 | 18.9 ± 2.7 | 33.0 | 65.0 | 8.3 | 2.3 | 27.2 | 20.2 | 6.1 | 0.4 | 31.8 | 43.8 |
| | **2012** | 582.5 ± 106.2 | 2.5 ± 0.6 | 100.0 | 57.8 | 10.8 | 5.4 | 22.6 | 24.0 | 12.7 | 0.4 | 33.8 | 57.3 |
| % Change | | -14.0 | -89.3 | 219.5 | -11.1 | -7.6 | -62.8 | -66.5 | 41.2 | -4.5 | -63.6 | -47.8 | 34.5 |

## Plant community response to fire and year

Plant functional groups and their associated covers followed similar trends across sites and over the years of this study regardless of treatment (Figure 6). At both sites, shrub cover in close proximity to *S. parishii* individuals tended to be greater in burned than in control plots, but this difference was also apparent *before* the fire treatment (Figure 6). Grass cover tended to decrease between 2010 and 2011 in both control and burned plots; in 2012 mean grass cover increased slightly from the 2011 value. Litter cover decreased greatly from 2010 to 2012 at both sites and across both treatment types. Trends in functional group cover across both sites and treatments suggest that these are likely a reflection of climate and not necessarily a result of fire effects.

In 2012, burned and unburned plant plots did not differ by plant community ($p$ =0.55, MRPP). Woodrat Mountain had more native species than Hukill Hollow in 2012, with 81% of the plant community composed of natives, the majority of which (34%) were native shrubs. Native species in Hukill Hollow composed 52% of the plant community and primarily native shrubs with very few native forbs or grasses. While Woodrat Mountain had many native forb species, Hukill Hollow was lacking those, and had greater numbers of exotic grasses. The most abundant species at Woodrat Mountain were native, including *Ceanothus cuneatus, Eriophyllum lanatum, Vulpia myuros, Mondardella odoratissima,* and *S. parishii*. Also present were non-native grasses including *Bromus hordeaceous* and *Bromus tectorum*. Hukill Hollow had virtually no native graminoid cover, and the most abundant native species was C. *curneatus*. High abundance of exotic grasses at the site included *B. hordeaceous, B. tectorum, B. japonicus, Taeniatherum caput-medusae,* and *Vulpia bromoides*.

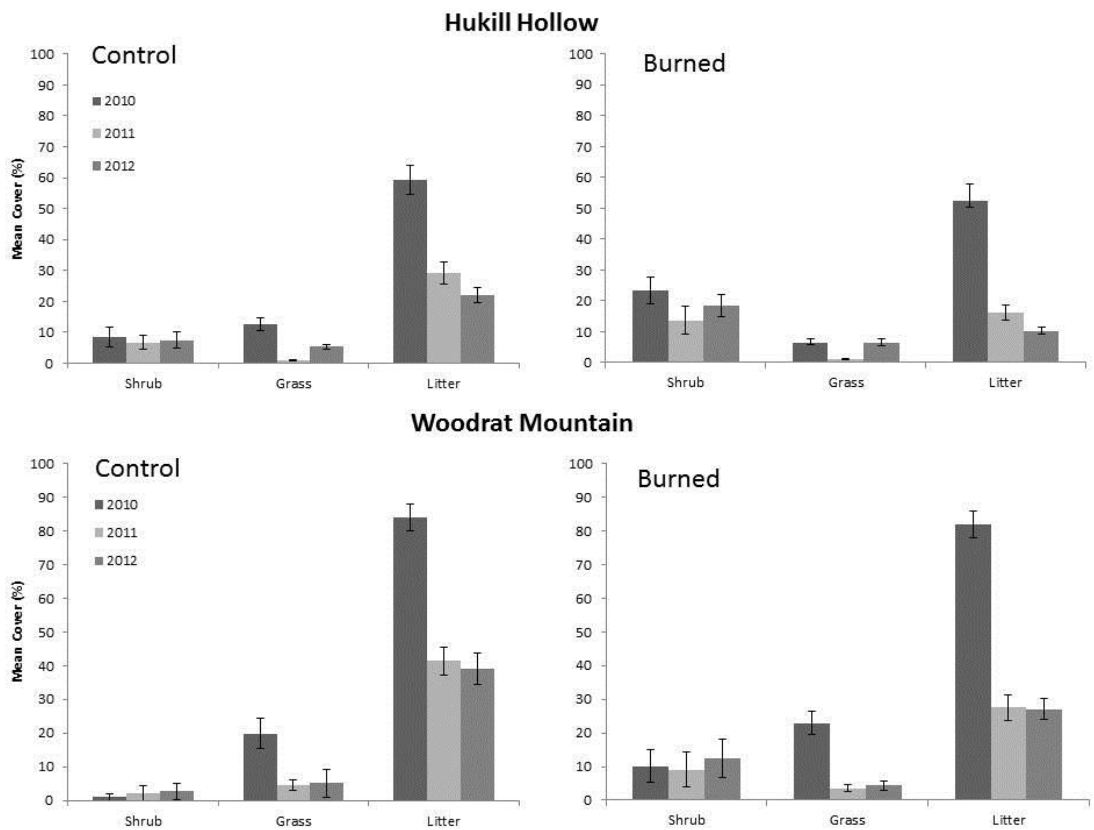


**Figure 6.** Percent cover of the plant community surrounding *S. parishii* individuals in burned plots pre-burn (2010) and post-burn (2011 & 2012) at Hukill Hollow and Woodrat Mountain. Error bars represent 1 SE.

# DISCUSSION

In 2011, we found increases in size of *S. parishii* in burned plots at Hukill Hollow, and no differences at Woodrat Mountain (Gray et al. 2011). These results suggested that fire effects were likely light and patchy and that potentially a lag effect of fire on *S. parishii* might occur. In 2012, we observed no such lag-effect, and found no fire effects on mean size, reproductive status, or survival of *S. parishii*. In fact, time was the only factor to affect growth and reproductive status of *S. parishii*, suggesting that differences in climate between 2010 and 2012 were driving observed changes within these populations.

*Solanum parishii* exhibited more mortality in 2012 than combined mortality in 2010 and 2011 (Table 1), though this was unrelated to treatment. In addition, mean area of *S. parishii* decreased at Woodrat Mountain and reproductive effort declined substantially at both sites, compared to 2011 values. These declines in 2012 are potentially the result of an odd year climatically; fall of 2011 was much drier than in previous years and was followed by an unseasonably wet winter in 2012 (Figure 7). The significant effect of year across burned and unburned plots suggest that climate differences may have been driving population trends of *S. parishii* at Hukill Hollow and Woodrat Mountain.

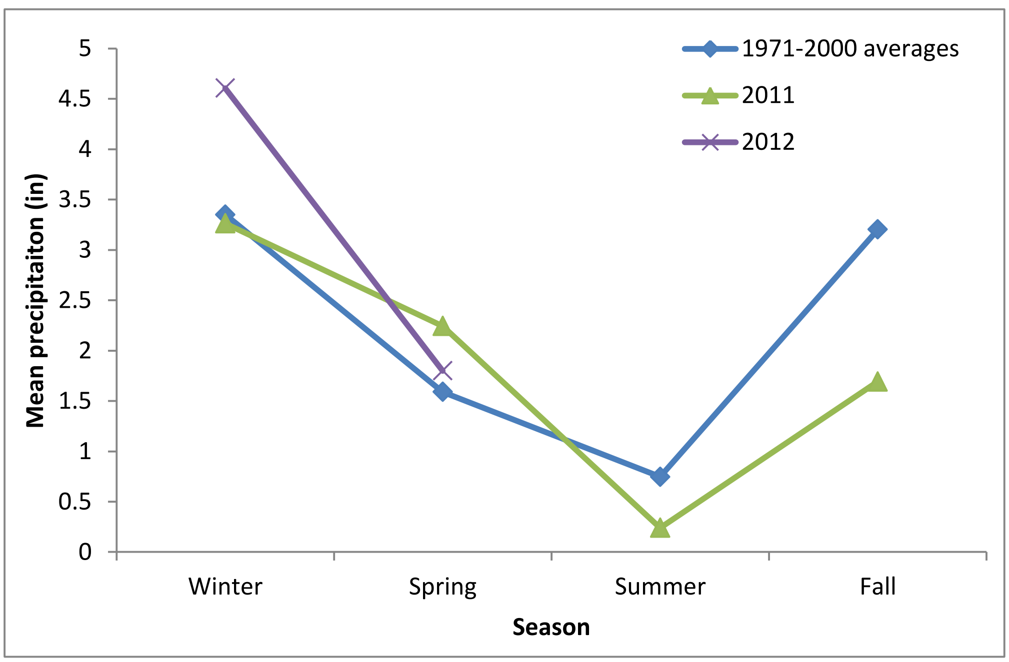


**Figure 7.** Mean precipitation (in) by season in 2011 and 2012, relative to precipitation normals from 1971-2000 (Prism Climate Group 2006)

The short-term neutral to positive effects of prescribed burning on *S. parishii* observed here suggest that this species tolerates fire and may have some ephemeral benefits in some locations. Wildfires are unlikely to pose a threat to this species in habitats similar to those included in this study. A more intensive burn might have resulted in more measurable fire effects. Firsthand accounts suggest that the prescribed fire was patchy, and was described as "marginal" at Woodrat Mountain, and data from fire tags suggest that the burn temperatures tended to be slightly higher at Hukill Hollow than at Woodrat Mountain. We did not observe any lag-time effects post-burn and cover of various plant functional groups followed similar trends at both sites unrelated to the burn treatments.

**Figure 8.** *Solanum parishii* habitat at Hukill Hollow in southwestern Oregon

Our data suggests that controlled fire could be a useful tool for managers as it was shown to have a neutral to positive effect on populations of this rare species, but implementing it as a management tool may be unwarranted and present risks of weed invasion. In fact, the presence of invasive annual grasses (15% cover at Woodrat Mountain and 38% cover at Hukill Hollow) suggests that controlled fire might result in further unintended invasion. The fire ecology of chaparral systems in southern Oregon is poorly understood, and recent findings suggest that that fire suppression has not altered age structure of the C. *cuneatus* overstory (Duren and Muir 2010). In southwestern Oregon, invasion has been facilitated by removal of shrub cover following large-scale fuel-reduction events (Perchemlides et al. 2008, Duren and Muir 2010). The risk of further invasion following fire seems to outweigh any potential benefits of prescribed fire for this species.

*Solanum parishii* exhibited strong environmental stochasticity over the four years of this study from 2009 to 2012. The observed changes in population dynamics of this rare species associated with climate suggest that climate change or other climate cycles could affect population trends of *S. parishii*. Chaparral in southwestern Oregon is near the northernmost-limit of this vegetation type (Figure 8, Duren and Muir 2010), and the populations studied are near the northernmost-limit of the species' range; it is unknown how changes in climate might affect habitat and persistence of *S. parishii* over time. Likewise, *S. parishii* occurs at elevations less than 600 m throughout its range. Many species have already shifted their distributions uphill in response to climate change in Europe, at a rate of 29 meters per decade (Lenoir et al. 2008).

The variation in populations of this species through time coupled with the potential for seasonal variation in climate to affect the populations suggests that climate change should be a focus of management activities surrounding this rare species. In addition, the abundance of invasive species, especially annual grasses, points out the need for weed control in existing populations and surrounding habitats.

## Future studies

Due to the relatively low intensity and patchiness of the burns observed in this study, future research may focus on the effects of higher intensity fires on populations of *S. parishii*. Future research on this species may also focus on long term population monitoring. Demographic plots would be helpful for evaluating the effects of climate variation and climate change on this species, and for tracking general population health at known sites.

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# APPENDIX A. Directions, Maps, gear list, and datasheets

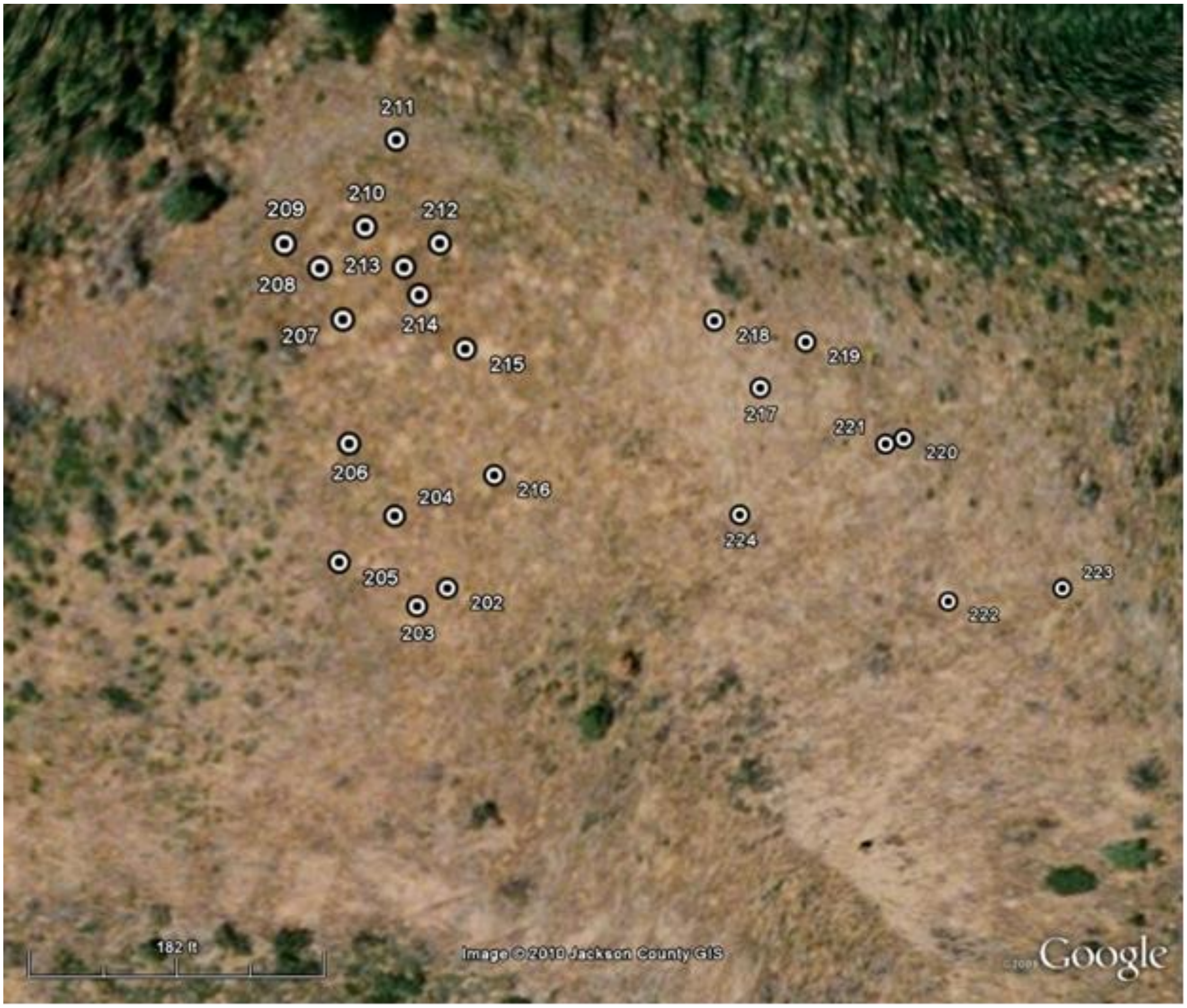
BOTH SITES REQUIRE GATE KEYS

Directions to field sites:

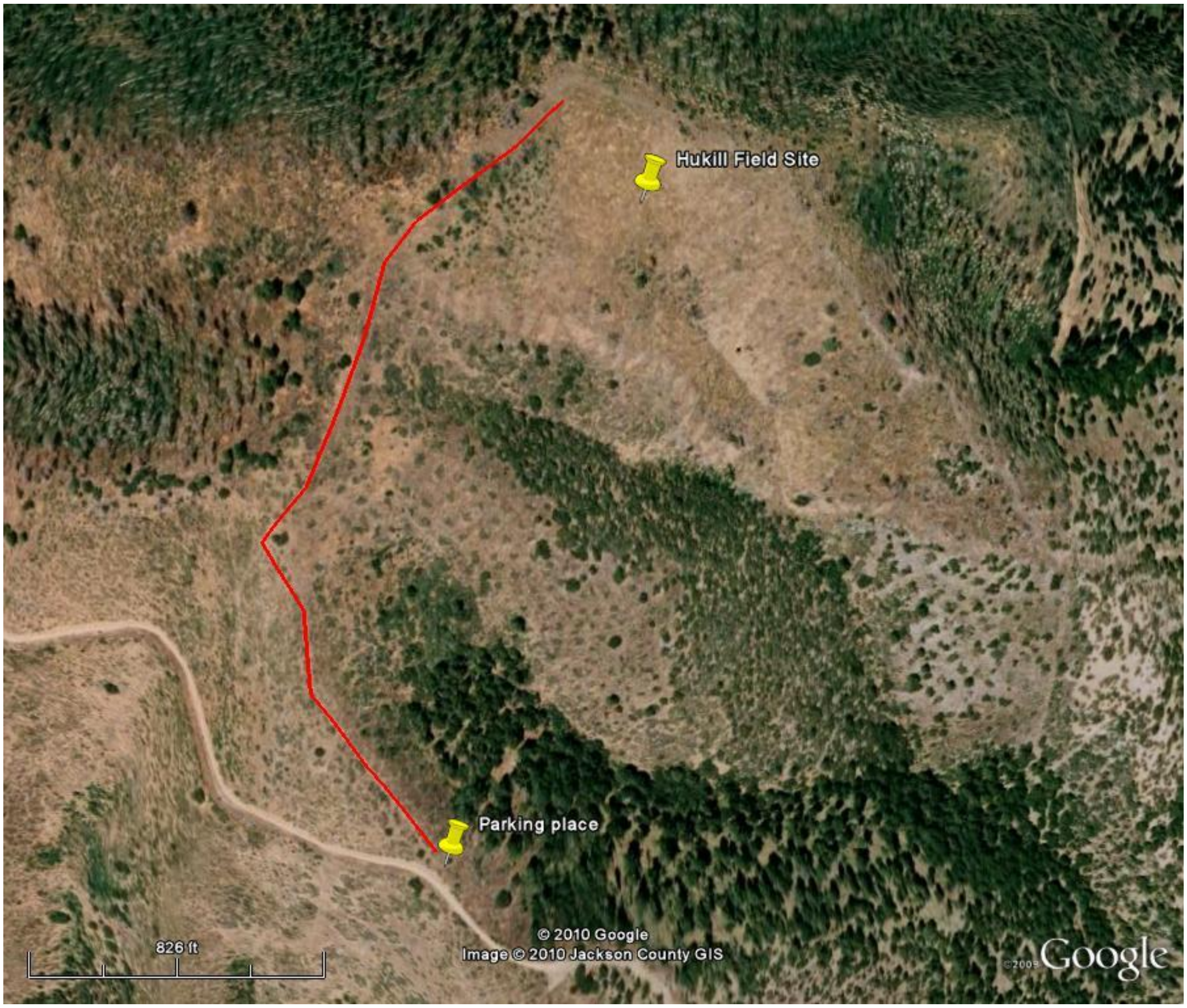
Note: Distances are estimates only, please check them and update as needed in 2010. There is an Ashland Resource Area transportation map with the driving routes and field sites marked in red. Other information on this map is for CYFA.

Woodrat Mountain: From downtown Jacksonville, take S. Oregon St. (aka County Road 584, Applegate St.) south. After 0.2 miles, road slights left and turns into Cady Road. After 1.8 (total), turn left onto Sterling Creek Road (County Road 787). From this junction, drive south ~4.6 miles and turn right onto BLM road 38-2-29 (Woodrat Mtn. Rd). After about 0.7 miles you will take the left fork and must go through a locked gate. After an additional 0.6 miles take the right fork. Drive an additional 0.6 miles, staying left at any junction. You should stay on top of the ridge until the road dead-ends. From the park place, the SOPA site is a short hike to the south, use GPS coordinates and aerial maps. There are several flat camping spots on top of the ridge (though sites are without shade). To reach plots, hike along ridge.

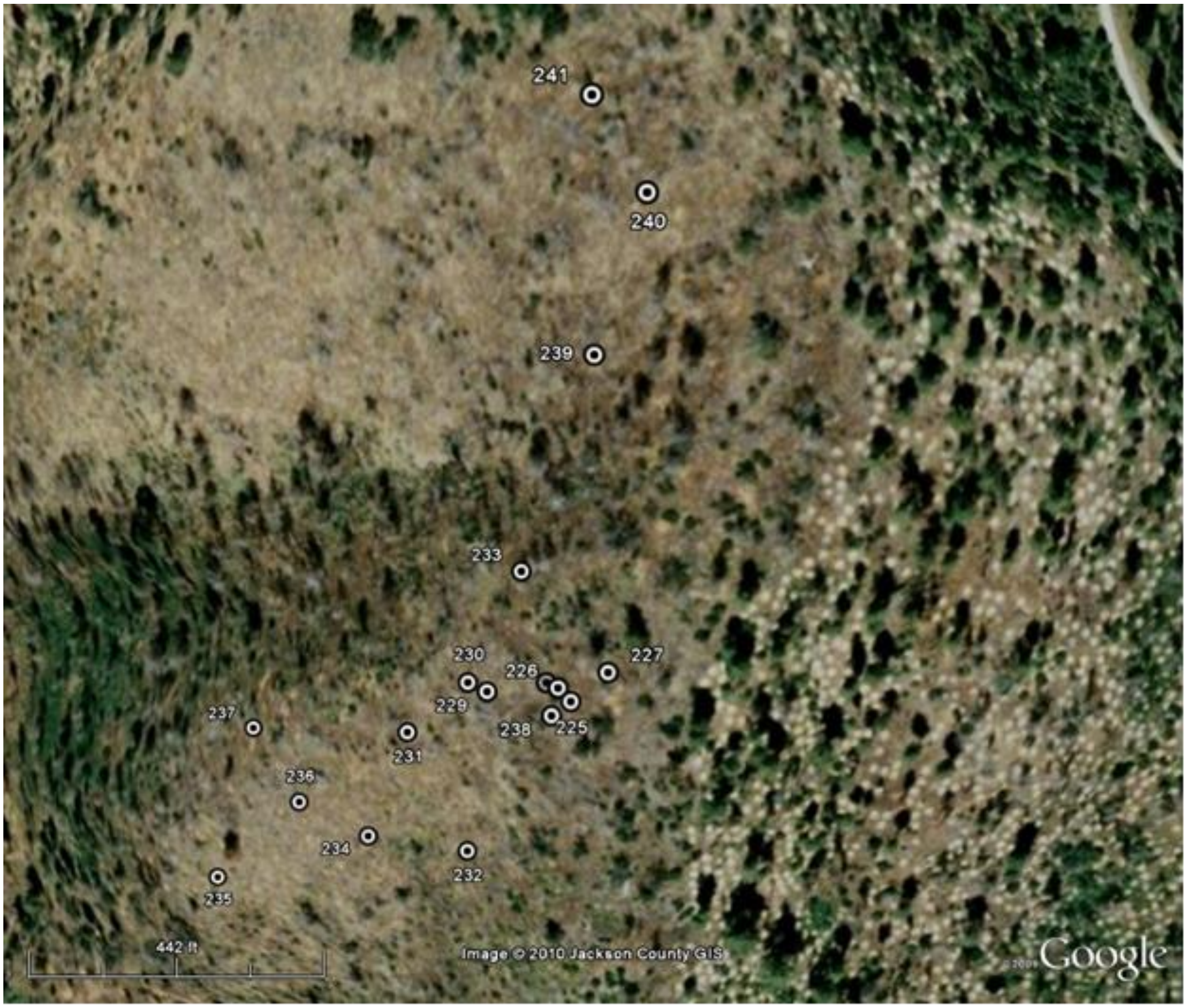
Hukill Hollow: Follow directions to Woodrat Mountain site, but instead of turning right onto BLM road 38-2-29, continue on Sterling Creek Road an additional 4.4 miles, where you take a right onto dirt road 39-2-7. After ~0.6 miles, turn left. At 0.1 mile past this turn there is a gate that may or may not be locked, but bring a key either way. Drive ~1.8 miles and pull off and park on the left at what looks like an old overgrown road. From parking place, walk approximately 50m, then hike up the ridge to the right, following an old trail (following the ridge), use aerial photos and GPS coordinates.



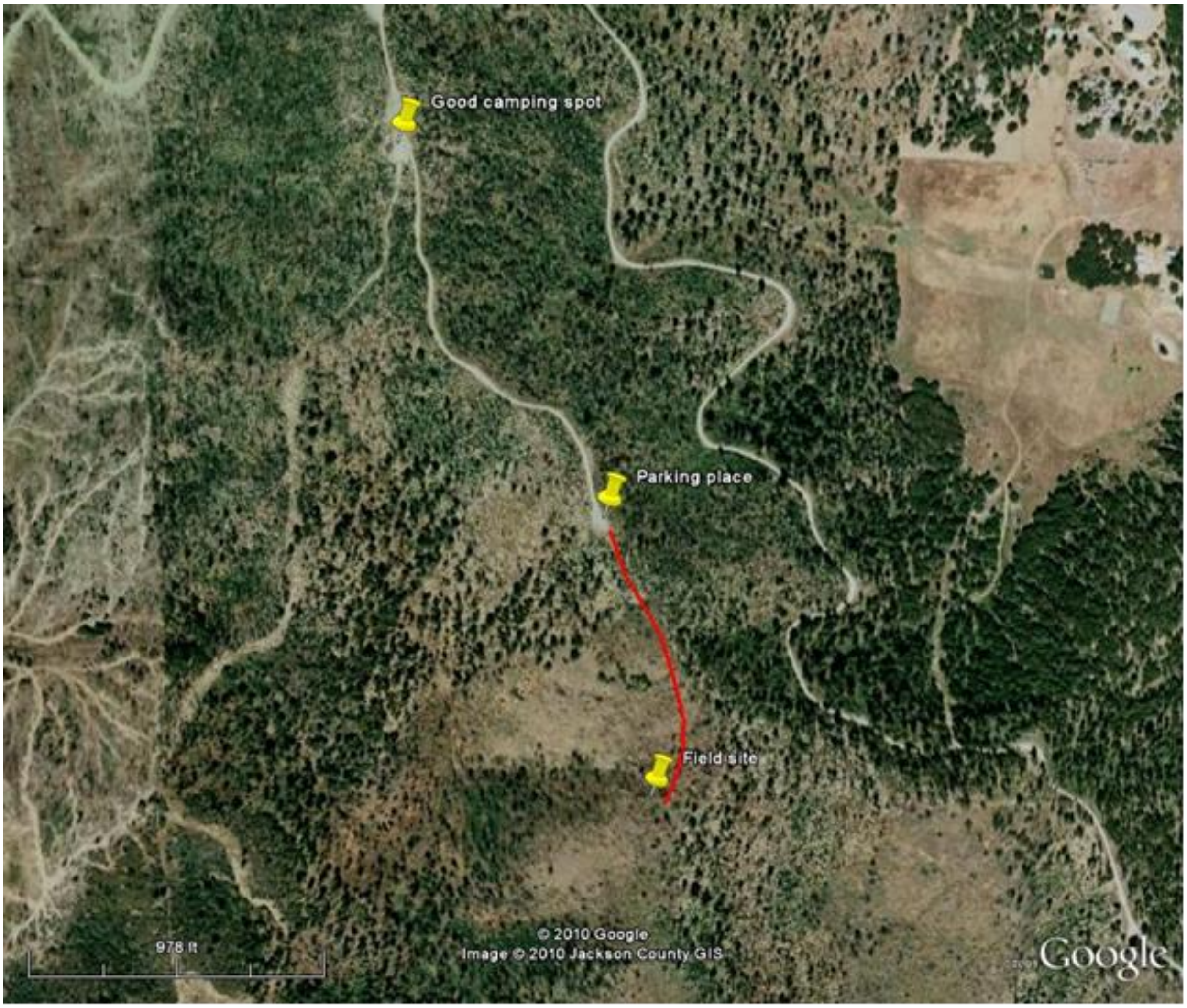

Hukill Hollow plot layout. Points are estimates, actual plots are within 25 feet. Parking place and route to walk to plots is marked in next photo.




Parking place and route to walk (red line) to field site at Hukill Hollow, north is towards the top of the photo. There are two potential parking areas to access Hukill Hollow. The turnout at the SE area is smaller, but the hike is less steep and shrubby than the second (NW) access.




Woodrat Mountain plot layout. Points are estimates, actual plots are within 25 feet. The label "228" is hidden behind the label "226," but the point is shown. Parking place and route to walk to plots is marked in next photo.




Parking place and route to walk (red line) to field site at Woodrat Mountain. North is towards the top of the photo.

*Solanum parishii* plots, treatment assignments, and GPS coordinates. Coordinates are in Nad83. 0 indicates control, 1 indicates burn treatment. * indicates change in treatment during application.

| Site | Plot # | Burn treatment | Easting | Northing |
|---|---|---|---|---|
| Hukill Hollow | 202 | 0 | 501039 | 4672558 |
| Hukill Hollow | 203 | 1 | 501036 | 4672554 |
| Hukill Hollow | 204 | 0 | 501033 | 4672571 |
| Hukill Hollow | 205 | 0 | 501023 | 4672563 |
| Hukill Hollow | 206 | 0 | 501026 | 4672584 |
| Hukill Hollow | 207 | 1 | 501026 | 4672606 |
| Hukill Hollow | 208 | 1 | 501023 | 4672614 |
| Hukill Hollow | 209 | 1 | 501017 | 4672618 |
| Hukill Hollow | 210 | 0 | 501031 | 4672622 |
| Hukill Hollow | 211 | 0 | 501034 | 4672639 |
| Hukill Hollow | 212 | 1 | 501043 | 4672619 |
| Hukill Hollow | 213 | 0 | 501036 | 4672615 |
| Hukill Hollow | 214 | 1 | 501039 | 4672610 |
| Hukill Hollow | 215 | 1 | 501046 | 4672602 |
| Hukill Hollow | 216 | 1 | 501051 | 4672579 |
| Hukill Hollow | 217 | 0 | 501103 | 4672597 |
| Hukill Hollow | 218 | 1* | 501094 | 4672609 |
| Hukill Hollow | 219 | 1 | 501113 | 4672606 |
| Hukill Hollow | 220 | 1 | 501134 | 4672587 |
| Hukill Hollow | 221 | 1 | 501130 | 4672586 |
| Hukill Hollow | 222 | 0 | 501147 | 4672552 |
| Hukill Hollow | 223 | 0* | 501172 | 4672555 |

| | | | | |
|---|---|---|---|---|
| Hukill Hollow | 224 | 0 | 501101 | 4672571 |
| Woodrat Mtn | 225 | 1 | 501 897 | 4673450 |
| Woodrat Mtn | 226 | 1 | 501893 | 4673453 |
| Woodrat Mtn | 227 | 1 | 501907 | 4673458 |
| Woodrat Mtn | 228 | 0 | 501890 | 4673455 |
| Woodrat Mtn | 229 | 0 | 501873 | 4673451 |
| Woodrat Mtn | 230 | 0 | 501867 | 4673453 |
| Woodrat Mtn | 231 | 1 | 501849 | 4673437 |
| Woodrat Mtn | 232 | 0 | 501866 | 4673402 |
| Woodrat Mtn | 233 | 1 | 501882 | 4673484 |
| Woodrat Mtn | 234 | 0 | 501835 | 4673403 |
| Woodrat Mtn | 235 | 1 | 501783 | 4673385 |
| Woodrat Mtn | 236 | 0 | 501812 | 4673412 |
| Woodrat Mtn | 237 | 1 | 501795 | 4673433 |
| Woodrat Mtn | 238 | 1 | 501891 | 4673446 |
| Woodrat Mtn | 239 | 0 | 501902 | 4673542 |
| Woodrat Mtn | 240 | 0 | 501916 | 4673578 |
| Woodrat Mtn | 241 | 0 | 501902 | 4673600 |

**Gear list:**

(NOTE: this list may not encompass everything you need, update as needed)

KEY FOR GATES

Gazetteer

Ashland Resource Area transportation map (the one with the SOPA sites marked)

Aerial maps showing plot locations

Plot GPS coordinates (in data Xcel spreadsheet)

Jepson/Kozloff

GPS

Camera

Extra Batteries

Previous year's report

Previous year's datasheets

Blank datasheets (Rite-in-Rain if necessary)

Pencils

Clipboard/Tatum (2)

Rulers (4)

Meter tapes (small okay, at least 2)

Extra 2-3' rebar for replacement

Flagging (pink/orange, green)

Small sledge

Camping gear box

Water jugs

Health and safety box

Tables

Chairs

Food box

Cooler

*Solanum parishii* burn study

Site: ______________________________

Names: ______________________________

Date: ______________________________

Plot #: ______

GPS coord: ____________________________________

BURN or NO BURN (circle one)

Total % cover (plot)

shrubs: ________________

annual grams: ________________

litter: ________________

total vegetation: ________________

per. grams: ________________

| y=0 | 1.5 | 3 | 4.5 | 6 m | |
|---|---|---|---|---|---|
| x=0<br>upslope | | | | | down- slope |
| 1.5 | | | | | |
| 3 m | | | | | |

| | | | | | | | herbivory | | % cover (around plant) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant # | x coord. | y coord. | max width (cm) | perp. width (cm) | frts | flws | insect | mamm al | shrub | grass | litter | notes |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

**Appendix B.** Analysis of variance (ANOVA) table for the response of log mean area ($cm^2$) of *S. parishii* at Hukill hollow pre-burn (2010) and post-burn (2012).

| | Df | SS | MS | F value | *P* value |
|---|---|---|---|---|---|
| Year | 1 | 0.311 | 0.311 | 0.19 | 0.66 |
| Burnstatus | 1 | 2.201 | 2.201 | 1.35 | 0.25 |
| Burnstatus:Year | 1 | 3.513 | 3.513 | 2.15 | 0.15 |
| Residuals | 126 | 205.833 | 1.634 | | |

**Appendix C.** Analysis of variance (ANOVA) table for the response of log mean area ($cm^2$) of *S. parishii* at Woodrat Mountain, predicted by year. Predictors with a *p*-value < 0.10 are in bold.

| | Df | SS | MS | F value | *P* value |
|---|---|---|---|---|---|
| Year | 1 | 9.011 | 9.011 | 7.30 | **0.008** |
| Residuals | 87 | 107.427 | 1.235 | | |

**Appendix D.** Summary of a negative binomial regression for the response of reproductive effort for *S. parishii* at Hukill Hollow, predicted by year. Predictors with a *p*-value < 0.10 are in bold.

| | Estimate | SE | Z value | *P* value |
|---|---|---|---|---|
| Intercept | 1183.93 | 337.28 | 3.51 | <0.001 |
| Year | -0.59 | 0.17 | -3.50 | **<0.001** |

Appendix E. Summary of a negative binomial regression for the response of reproductive effort for *S. parishii* at Woodrat Mountain, predicted by year. Predictors with a *p*-value < 0.10 are in bold.

| | Estimate | SE | Z value | *P* value |
|---|---|---|---|---|
| Intercept | 3039.45 | 373.57 | 8.14 | <0.001 |
| Year | -1.51 | 0.19 | -8.13 | **<0.001** |

Appendix F. Summary of a logistic regression for the response of survival (between 2010 & 2012, binary) of *S. parishii* at Hukill Hollow.

| Coefficient | Estimate | SE | Z value | *P* value |
|---|---|---|---|---|
| (Intercept) | -1.43 | 0.69 | -2.09 | 0.04 |
| Burnstatus | -0.33 | 0.95 | -0.35 | 0.73 |
| Area (2010) | -0.00 | 0.00 | -1.13 | 0.26 |
| Burnstatus: Area (2010) | 0.00 | 0.00 | 1.31 | 0.19 |

Appendix G. Summary of a logistic regression for the response of survival (between 2010 & 2012, binary) of *S. parishii* at Woodrat Mountain.

| Coefficient | Estimate | SE | Z value | *P* value |
|---|---|---|---|---|
| (Intercept) | -0.46 | 0.55 | -0.84 | 0.40 |
| Burnstatus | -0.31 | 0.88 | -0.35 | 0.72 |
| Area (2010) | 0.00 | 0.00 | 0.23 | 0.82 |
| Burnstatus: Area (2010) | -0.00 | 0.01 | -0.47 | 0.64 |