Charmlee Park Firebreak

By:

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Introduction

Coastal sage scrub (CSS) is a plant community found in Southern California and down into Baja California. Over the last several decades, CSS and native California grasslands were heavily impacted by frequent anthropogenic activities such as plowing, disking, and shrub-harvesting. Predominantly formed by shrub life forms, CSS is found from the coastline and as far as 60 miles inland. The area of Charmlee Wilderness Park, originally inhabited by Chumash Native Americans, was later controlled by the Spanish Empire. The Spanish introduced cattle to the region and along with it, Old World invasive annual grasses. (Fleming, Diffendorfer, and Zedler. 2009). Due to the area's Mediterranean climate, the exotic annual grasses and black mustard plants flourished and overtook up to 90% of CSS habitat. (Bell & Muller, 1973) In Charmlee Wilderness Park, some fires have erupted within the past decades, notably among the few remaining patches of CSS life forms. A firebreak was plowed through a patch of CSS to prevent the spread of a fire. CSS life forms have managed to recover after the fire and beat back some areas of grasses as well as taking over what was the plowed firebreak. It seems that occurrence of a fire in CSS habitats gives CSS plants an edge in recovery over annual grasses since many CSS life forms are specially adapted to post-fire recovery. (Keeley, Fotheringham, and Baer-Keeley. 2005) The purpose of our study was to examine the diversity of CSS between undamaged, plowed, and burned areas along the former firebreak.

Material and Methods

On March 29, 2017, as a team we took the Botany Trail, past the oak groves on the east, and cut west from the East Meadow Trail along the path of the old fire break. This was where a natural experiment was conducted. The trail is located at 34° 03.17' North Latitude and 118° 53.01' West Longitude of Malibu, Los Angeles County. In the field of Charmlee Wilderness Park, East Meadow trail was located and shown using a handheld Garmin GPS units device. The width of the firebreak was approximately 10 meters wide. A 30-meter transect tape was used to set up a total of six transects, extending 10-meter tape on either side of the old firebreak. The tape was used to measure 1 meter intervals that intersect the firebreak at right angles (Rodrigue 2017). Therefore, in other words a 10-meter gap was measured into each of the three firebreak

zones; the CSS undamaged zone in the north, the plowed zone, then the burnt zone in the south. The specimen at each 1 meter interval was recorded. The main types of vegetation such as *Artemisia californica* (California Sage Bush), *Baccharis pilularis* (Coyote Bush), *Malosma laurina* (Laurel Sumac), and *Mimulus aurantiacus var. Pubescens* (Sticky Monkey) were observed within the region. After collecting a total number of plant species through each transect, a Goodness of Fit Test was applied on each single category variable coming from their own species population. This is a type of chi-square test which is used to deduce whether or not sample data are stable with a given hypothesized distribution (stattrek.com). Here we compared our observed counts of species against expected counts, that each species would be equally abundant in each of the three zones.

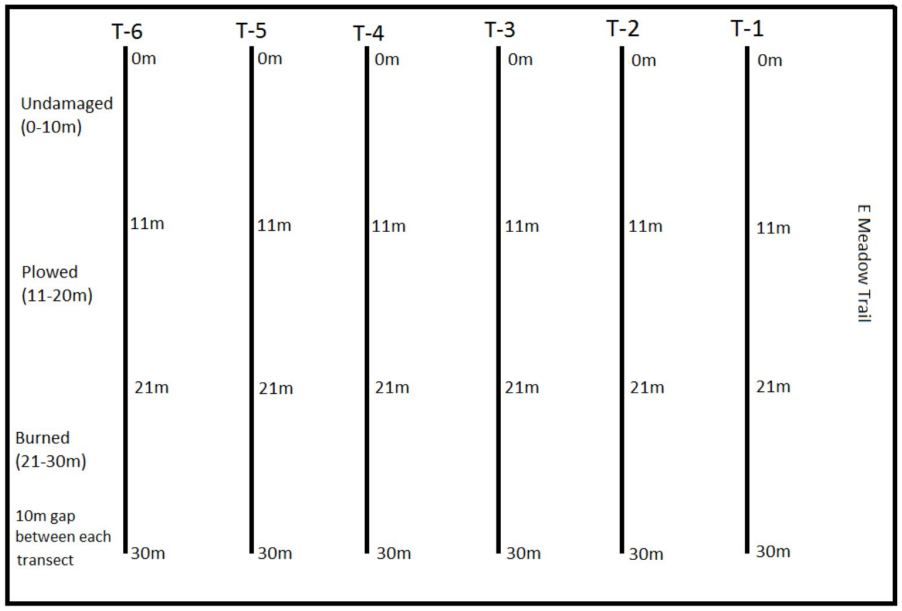


Figure 1

Results

The objective of this field investigation was to determine if there was a significant difference between three different selections along East Meadow Trail in which were undamaged (0-10m), plowed (11-20m) and burned (21-30m). We had a total of 14 different species however, we decided to only use the top dominant five species that were collected over 14 times. Before our Chi-Square Test we did a Goodness of Fit Test using Vassarstats to ensure our species were well fit for the test; our results are shown in the table below (Table 1). After this test we were

able to do our first Chi-Square.

In all three zones, *Artemisia californica* was the most common species found. However, it was not the majority species in the burned areas. Whereas the species comprised approximately 70% of species observed in both the undamaged and plowed areas, it only made up just 36.8% of species in the burned area. Thus the burned areas displayed a much higher diversity in CSS life forms compared to the undamaged or plowed zones. Furthermore, many of the other species we did not input into our calculations because of low headcounts were found in the burned zone.

Another interesting observation was the greater exposure of bare soil in the undamaged zone, with 20.7% of observations recorded as soil. This is in contrast to a near absence of bare soil from the plowed area. This is surprising considering CSS's usual inability to recover in plowed soils. However, even though the plowed areas showed less bare ground, the relative diversity among the different species doesn't differ greatly against the undamaged zone since *Artemsia californica* was still the majority species. Significant differences in representation of Coyote Brush were also observed between the three different zones. It is also worth noting that many dead Coyote Brush specimens were scattered between the zones but only living examples were counted.

Species	**Chi-square**	**Df**	**P-Value**
Artemisia californica	6.79	2	0.0335
soil	9.25	2	0.0098
Mimulus aurantiacus	4.63	2	0.0988
Baccharis pilularis	6.14	2	0.0464
Malosma laurina	4.43	2	0.1092

Table 1: Goodness of Fit Summarization (for more detail refer to Appendix A)

Test 1

For the undamaged area *Artemisia californica* and bare soil were overrepresented while *Mimulus aurantiacus*, *Baccharia pilularia*, and *Malosma laurina* were underrepresentwed. For the plowed area *Artemisia californica* and *Malosma laurina* were overrepresented while . bare soil, *Mimilus aurantiacus*, *Baccharia pilularia* were underrepresented. For the burned area *Artemisia californica* was underrepresented while bare soil, *Mimulus aurantiacus*, *Baccharia pilularia, Malosma laurina* were overrepresented. In order to conclude a significant difference between these three sites, we used the statistical use of a Chi-square t test. The effect size was 0.303 which means it is weak and the power was 0.814 which means our sample size was large enough to detect a modest effect. Based on the result (see Figure 2 for statistical details) gathered when comparing the three areas, there is significant differences in the species mix between the three zones. Thus, we reject the null hypothesis. The chi-squared test was conducted to further support the acception of the alternative hypothesis. However, we weren't comfortable with our result because several of the valuables for the expected species counts were under 5. So we did decided to do a second test.

AR 1	VAR 2			*
	a	b	c	
os	41	37	21	99
:p	34.383	30.826	33.790	
	d	e	f	
os	12	1	11	24
:p	8.335	7.473	8.192	
	g	h	i	
os	2	5	9	16
:p	5.557	4.982	5.461	
	j	k	l	
os	2	3	9	14
:p	4.862	4.359	4.778	
	m	n	o	
os	1	6	7	14
:p	4.862	4.359	4.778	
	58	52	57	167

Percentage of expected counts < 5	46.67 %
(if > 20%, collapse data rows)	
Number of expected counts ≤ 1	0
(if there are any, collapse rows)	

Cell	O	O sq.	E	O sq./E
a	41	1681	34.383	48.890
b	37	1369	30.826	44.410
c	21	441	33.790	13.051
d	12	144	8.335	17.276
e	1	1	7.473	0.134
f	11	121	8.192	14.771
g	2	4	5.557	0.720
h	5	25	4.982	5.018
i	9	81	5.461	14.832
j	2	4	4.862	0.823
k	3	9	4.359	2.065
l	9	81	4.778	16.951
m	1	1	4.862	0.206
n	6	36	4.359	8.258
o	7	49	4.778	10.254
				197.659

X^2_{calc}	30.659
alpha	0.05
df	8
X^2_{crit}	15.507
prob	0.000
k (min r or c)	3
Cramér's phi or V (effect size measure) φ_c or w	0.303
Noncentrality (λ)	15.329
Estimated power (1-β)	0.841

Figure 2

Test 2

For our second test we combined the last three most common dominant species into one group to see if we could get better results. For the undamaged area there was 41 observed *Artemisia californica* and bare soil were still overrepresented. As for combined dominant species (*Mimulus aurantiacus*, *Baccharia pilularia*, and *Malosma laurina*) they were underrepresented. For the plowed area *Artemisia californica* was overrepresented while bare soil was underrepresented. As for the combined dominant species there was 14 observed and 13.701 expected and thus a close fit. For the burned area *Artemisia californica* was underrepresented whereas bare soil and the combined dominant species were overrepresented. In order to conclude a significant difference between these three sites, we used the statistical use of a Chi-square t test. The effect size was 0.295, which means it is weak and the power was 0.880, which means it is strong. Based on the result (see Figure 3 for statistics) gathered when comparing the three areas this states that the area is significant. Thus, we reject the null hypothesis. The chi-squared test was conducted to further support the acception of the alternative hypothesis. This test was much more suitable because all the expected species counts were above 5.

X^2	Enter data and *alpha* in yellow cells only			
VAR 1	VAR 2			*
	a	b	c	
Obs	41	37	21	99
Exp	*34.383*	*30.826*	*33.790*	
	d	e	f	
Obs	12	1	11	24
Exp	*8.335*	*7.473*	*8.192*	
	g	h	i	
Obs	5	14	25	44
Exp	*15.281*	*13.701*	*15.018*	
*	58	52	57	167

Percentage of expected counts < 5	0.00 %
(if > 20%, collapse data rows)	
Number of expected counts ≤ 1	0
(if there are any, collapse rows)	

Outputs in blue cells				
Cell	O	O sq.	E	O sq./E
a	41	1681	34.383	48.890
b	37	1369	30.826	44.410
c	21	441	33.790	13.051
d	12	144	8.335	17.276
e	1	1	7.473	0.134
f	11	121	8.192	14.771
g	5	25	15.281	1.636
h	14	196	13.701	14.306
i	25	625	15.018	41.617
				196.091
			X^2_{calc}	**29.091**
			alpha	**0.05**
			df	**4**
			X^2_{crit}	**9.488**
			prob	**0.000**
			k (min r or c)	3
			Cramér's phi or V (effect size measure) φ_c or w	0.295
			Noncentrality (λ)	14.545
			Estimated power (1-β)	0.897
			Corrected power (Rodrigue)	**0.880**

Figure 3

Discussion

In both Chi-square tests the results proved to be higher than the critical value showing that there is significance. The p-value was also smaller than the alpha, so the null hypothesis was rejected. In the next test the effect size seemed to have a slightly weaker value; however, the power was greater than 0.8 in both tests which ensures that our results are significant and there is a difference between the undamaged, plowed, and burned areas. The undamaged area (Figure 4) is dominated by *Artemisia californica* and also has a high percentage of pure soil. This high percentage of soil may be due to *Artemisia* releasing toxins that prevents other native species from growing. *Artemisia californica* is also known to have difficulty recovering on soil where a mechanical disturbance has occurred like plowing. Figure 5 is a graph of the area that has been damaged by plowing. This area is also being dominated by *Artemisia* which contradicts previous research of California sage scrub. The fire recovery area (Figure 6) is shown to have more of a concentration of native species and here *Artemisia californica* is no longer the dominant species but still a prominent one. In this particular site in Charmlee, CSS is managing to restore itself over ground that had been plowed and *Artemesia* is having difficulty recovering in the area that has been impacted with fire.(Keeley, Fotheringham, and Baer-Keeley. 2005). In the burned area, *Artemisia* is a prominent plant but it is no longer the dominant plant. The diversity of other native species is much higher in the burnt area than the undamaged and plowed areas. This may be due to *Artemisia* being a slower recovering plant in fire areas so its population is lower than the other plant populations.

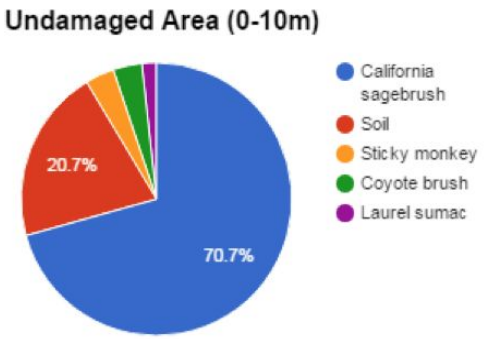


Figure 4

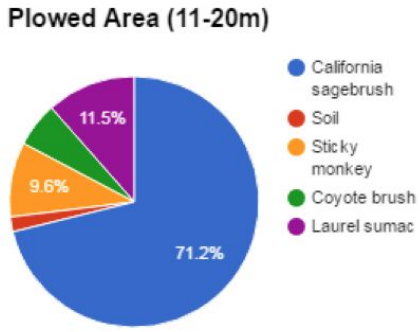


Figure 5

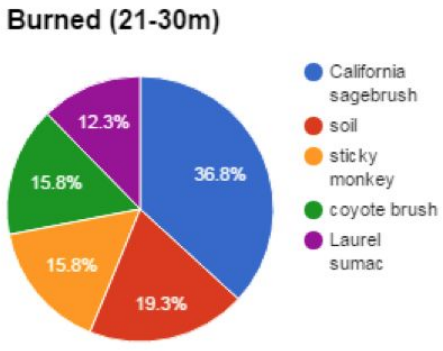


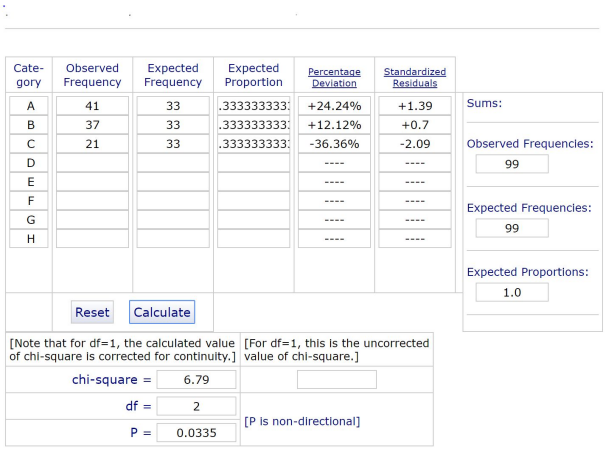
Figure 6

Conclusion

Based on the data and tests performed, California sage scrub species can self-restore on soil that has been through strong plowing and affected by fire. Statistically, *Artemisia californica* is the dominant species in the undamaged area which was expected but it was also dominant in the plowed areas. This finding contradicts previous research that states CSS has difficulty recovering after mechanical disturbances. The data also shows a high concentration of native species in the burnt area give suggestion that these species may be making it slightly more difficult for *Artemisia* to dominate. Or it may be due to *Artemisia californica* being a slowly recovering species in burnt areas, that is the reason for its low population.

During the fieldwork at Charmlee Park several biases were encountered. These included the park's terrain, cliffs and boulders which interfered with the conduct of transects. Large boulders or cliffs . Additionally, our field research found 13 native species but only five were used because the other species were not found as frequently. It would be interesting to see future researchers use a belt transect method next time analyzing the area. This method consists of transecting and quadrants combined which gives a better idea of the frequency in native species and percent cover.

Appendix A



Cate-gory	Observed Frequency	Expected Frequency	Expected Proportion	Percentage Deviation	Standardized Residuals
A	41	33	.3333333333	+24.24%	+1.39
B	37	33	.3333333333	+12.12%	+0.7
C	21	33	.3333333333	-36.36%	-2.09
D				----	----
E				----	----
F				----	----
G				----	----
H				----	----

Sums:

Observed Frequencies: 99

Expected Frequencies: 99

Expected Proportions: 1.0

Reset Calculate

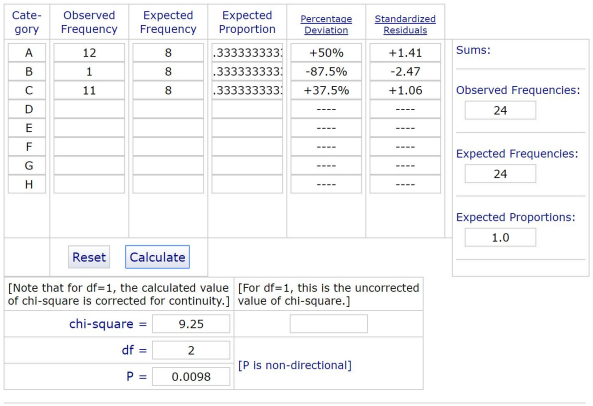
[Note that for df=1, the calculated value of chi-square is corrected for continuity.] [For df=1, this is the uncorrected value of chi-square.]

chi-square = 6.79

df = 2

P = 0.0335 [P is non-directional]

We use the goodness test to for each dominant species before doing our Chi-square test in which we compare them to each other. We used the same expected proportion of .3333333 for all of the dominant species. When calculating the blah test for Artemisia californica for each three section the chi-square was 6.79, degree of free was 2 and the p was 0.0335.



Cate-gory	Observed Frequency	Expected Frequency	Expected Proportion	Percentage Deviation	Standardized Residuals
A	12	8	.3333333333	+50%	+1.41
B	1	8	.3333333333	-87.5%	-2.47
C	11	8	.3333333333	+37.5%	+1.06
D				----	----
E				----	----
F				----	----
G				----	----
H				----	----

Sums:

Observed Frequencies: 24

Expected Frequencies: 24

Expected Proportions: 1.0

Reset Calculate

[Note that for df=1, the calculated value of chi-square is corrected for continuity.] [For df=1, this is the uncorrected value of chi-square.]

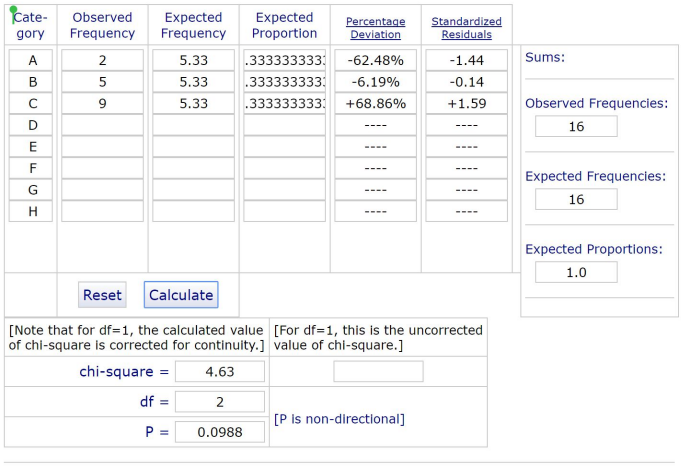
chi-square = 9.25

df = 2

P = 0.0098 [P is non-directional]

When doing the test for soil in each three section the chi-square was 9.25, df was 2 and p was 0.0098.

When doing the test for *Aurantiacus mimulus* the chi-square was 4.63, df was 2 and p was



Cate-gory	Observed Frequency	Expected Frequency	Expected Proportion	Percentage Deviation	Standardized Residuals
A	2	5.33	.333333333	-62.48%	-1.44
B	5	5.33	.333333333	-6.19%	-0.14
C	9	5.33	.333333333	+68.86%	+1.59
D				----	----
E				----	----
F				----	----
G				----	----
H				----	----

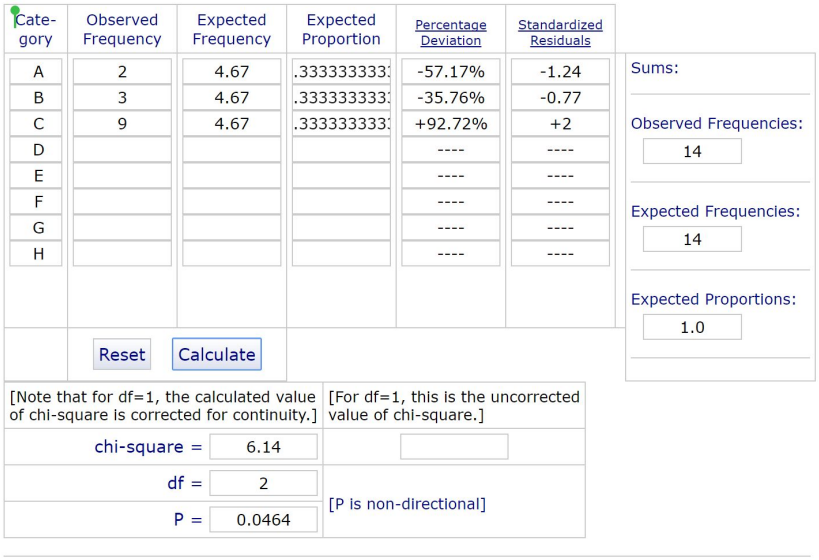
Sums:
Observed Frequencies: 16
Expected Frequencies: 16
Expected Proportions: 1.0

Reset Calculate

[Note that for df=1, the calculated value of chi-square is corrected for continuity.] [For df=1, this is the uncorrected value of chi-square.]

chi-square = 4.63
df = 2
P = 0.0988
[P is non-directional]

0.0988.



Cate-gory	Observed Frequency	Expected Frequency	Expected Proportion	Percentage Deviation	Standardized Residuals
A	2	4.67	.333333333	-57.17%	-1.24
B	3	4.67	.333333333	-35.76%	-0.77
C	9	4.67	.333333333	+92.72%	+2
D				----	----
E				----	----
F				----	----
G				----	----
H				----	----

Sums:
Observed Frequencies: 14
Expected Frequencies: 14
Expected Proportions: 1.0

Reset Calculate

[Note that for df=1, the calculated value of chi-square is corrected for continuity.] [For df=1, this is the uncorrected value of chi-square.]

chi-square = 6.14
df = 2
P = 0.0464
[P is non-directional]

When doing the test for *Baccharis pilularis* the chi-square was 6.14, df was 2 and the p was 0.0464.

Cate-gory	Observed Frequency	Expected Frequency	Expected Proportion	Percentage Deviation	Standardized Residuals
A	1	4.67	.3333333333	-78.59%	-1.7
B	6	4.67	.3333333333	+28.48%	+0.62
C	7	4.67	.3333333333	+49.89%	+1.08
D				----	----
E				----	----
F				----	----
G				----	----
H				----	----

Sums:

Observed Frequencies: 14

Expected Frequencies: 14

Expected Proportions: 1.0

Reset Calculate

[Note that for df=1, the calculated value of chi-square is corrected for continuity.]		[For df=1, this is the uncorrected value of chi-square.]
chi-square =	4.43	
df =	2	[P is non-directional]
P =	0.1092	

When doing the test for *Malosma laurina* the chi-square was 4.43 df was 2 and p was 0.1092.
http://vassarstats.net/

Cate-gory	Observed Frequency	Expected Frequency	Expected Proportion	Percentage Deviation	Standardized Residuals
A	41	33	.3333333333	+24.24%	+1.39
B	37	33	.3333333333	+12.12%	+0.7
C	21	33	.3333333333	-36.36%	-2.09
D				----	----
E				----	----
F				----	----
G				----	----
H				----	----

Sums:

Observed Frequencies: 99

Expected Frequencies: 99

Expected Proportions: 1.0

Reset Calculate

[Note that for df=1, the calculated value of chi-square is corrected for continuity.]		[For df=1, this is the uncorrected value of chi-square.]
chi-square =	6.79	
df =	2	[P is non-directional]
P =	0.0335	

Citations

Bell, David T., and Muller, Cornelius H. 1973. Dominance of California annual grasslands by Brassica nigra. *American Midland Naturalist* 90, 2: 277- 299

Cox, Robert D., and Allen, Edith B. 2008. Stability of exotic annual grasses following restoration efforts in southern California coastal sage scrub. *Journal of Applied Ecology* 45, 2: 495-504. doi: 10.1111/j.1365-2664.2007.01437.x.

Fleming, Genie M.; Diffendorfer, James E.; Zedler, Paul H. 2009. The relative importance of disturbance and exotic-plant abundance in California coastal sage scrub. *Ecological Applications* 19, 8: 2210-2227

Keeley, Jon E.; Fotheringham, C.J.: and Baer-Keeley, Melanie. 2005. Determinants of postfire recovery and succession in Mediterranean-climate shrublands of California. *Ecological Applications* 15, 5: 1515-1534