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GEOG 442

Climatic Influences on Coastal Sage Scrub Distribution in Cheseboro Canyon

Introduction

We compared coastal sage scrub (CSS) coverage at Cheseboro Canyon in the Santa Monica Mountains National Recreation Area. Our study compared eight sites of the area with previous surveys conducted in December 2005 and in Spring 2017, Fall 2017, and Spring 2018. Our study had two goals: 1) Compare CSS coverage of the region before the 2018 Woolsey fire and after to observe post-fire succession patterns and 2) Compare CSS coverage of the region during and after the California drought to observe how precipitation played a role in the species mix. Using a chi-squared analyses, we found statistically significant differences in the species mix when comparing aggregated transect data from December 2005 and March 2019, and statistically significant differences in the species mix when comparing aggregated transect data from Spring 2017-Spring 2018 and March 2019. In both comparisons, we observed a large drop in the proportion of native species in March 2019. These results indicate that early post-fire succession and precipitation are major factors in the presence of CSS coverage.

Background

Existing literature on the impacts of drought and fire on CSS

Invasive grasslands in California originate with European arrival and colonization of the region. These exotic forbs and grasses have invaded CSS, and have decreased the coverage of the native shrub community (Cox and Allen 2011). The conversion of shrublands to non-native grasslands can be attributed to many factors, including drought and increased fire frequency. (Kimball et al. 2014).

Post-fire succession of CSS has been well-documented in previous literature. In the first few years after a fire, nonnative grasses and forbs dominate. At this time, some shrubs whose roots were preserved may start sprouting (Kimball et al. 2014; Eckardt 2006). During the second year, seedlings produced by sprouting shrubs start to establish in the community. As CSS establishes, grasslands and forbs decrease. Eventually, the area becomes dominated by shrubs again. While fire is a natural part of shrub communities, fires that are too frequent can harm the recovery of CSS. This is because as seedlings are just starting to sprout from the first round of post-fire succession, they are destroyed by a second fire (Eckardt 2006). The combination of frequent fires and drought cause permanent loss of CSS in favor of invasive grasslands (Kimball et al. 2014).

While CSS is drought tolerant, the community is more vulnerable compared to chaparral shrubs. (Kimball et al. 2014). Drought can negatively impact CSS coverage. This was documented in a study of the Santa Monica Mountains during drought (2011-2015). The extended and extreme drought greatly decreased the coverage of shrubs. This was partly

attributed to increased nitrogen deposition, which can decrease the drought tolerance of CSS. (Valliere 2016).

Study site-Cheseboro Canyon

Cheseboro Canyon is located in the northernmost section of the Santa Monica Mountains National Recreation Area, just east of Agoura Hills, California. Today it is managed by the National Park Service. For thousands of years the Chumash people lived in the canyons and surrounding areas. In the early 1800's, ranchers settled in the canyons and brought with them cattle and other livestock. The native plants of Southern California were not adapted for heavy grazing, and instead the ranchers replaced them with European plants like mustard and thistle (National Parks Service 2017). Years of grazing, fires, fragmentation, and invasive species have created a loss of Coastal Sage Scrub in the canyons, but there are some areas where CSS still thrives.

In December 2005, Scott Eckardt, a graduate candidate at California State University, Long Beach, conducted extensive research of the Cheseboro and Palo Comado Canyons. After analyzing aerial photos of the area, Mr. Eckardt found several areas where CSS was expanding without active restoration efforts in the area. He surveyed eight of these CSS stands using a method of transecting each stand with "eight contiguous 2 by 3 meter quadrats." Despite previous disturbances from invasive grasses, fires, and grazing, these transects had a species mix of 95% native species. Mr. Eckardt's comparison of these transects found that fire intensity (measured by heat) and fire return interval (the time between fires in a site) were factors in CSS loss. Other factors included previous grazing in site and presence of invasives, which altered

environmental conditions for native shrubs, such as soil moisture and light availability (Eckardt 2006).

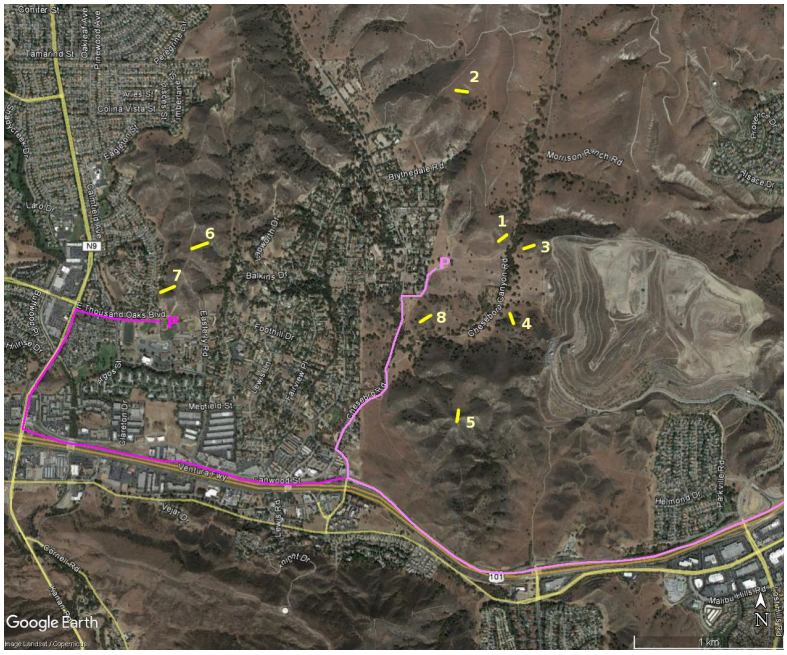
During the Spring 2017, Fall 2017, and Spring 2018 terms, undergraduate students from Dr. Rodrigue's California Ecosystems course at California State University, Long Beach, revisited Mr. Eckardt's eight selected sites in Cheseboro Canyon. From 10-meter and 20-meter transects respectively and observed a species mix of about 70% native species averaged out during this time period. The drop in CSS coverage is not surprising, considering that the region was in an intense drought during this time.

In the past 14 years since Mr. Eckardt's research, the site has faced major disturbances. The California drought, which started in December 2011 and was not declared over until March of this year, likely had negative impacts on CSS in the region (Gorman 2019). In November 2018, the Woolsey fire burned an estimated 88% of the Santa Monica National Recreation Area, including Cheseboro Canyon, making it the most destructive fire ever recorded in the area (National Park Service 2019). These disturbances very likely impacted the coverage of native vegetation in our study site.

Our Project Objectives

Our project had two main goals. The first is to compare early post-fire CSS succession with the data collected before both the fire and the drought. To do this, we compared our data (taken in March 2019) with Mr. Eckardt's data, which was collected in December 2005. Our null hypothesis was that there is no significant difference in the species mix observed before and after the Woolsey fire. The second objective is to compare the species mix found during the last years of the California drought with the species mix found after the drought. To do this, we compared

our data with the data collected by previous students from Spring 2017-Spring 2018. Our null hypothesis was that there is no significant difference in the species mix of the transects during and after the drought. For both analyses, we used an alpha statistic of 0.10 because this was an exploratory study.



Above: Cheseboro Canyon Study area with transects labeled. Source: http://web.csulb.edu/~rodrigue/geog330/maps/CheseboroCanyon2016.png

Methods and Data

We collected data from four of Mr. Eckardt's 2005 transects: 1,3,4 and 8. We replicated his original methods as well, using 8 continuous 1x1 meter quadrats for each transect. In addition, we documented species richness and percent cover of natives and non-native species.

For our first analysis, we compared the aggregated data from transects 1, 3, 4 and 8 of our survey in March 2019 with Scott Eckardt's aggregated data collected in late 2005 of all eight

transects. We compared the 3 most dominant species found in the data: *Salvia leucophylla, Artemisia californica*, and *Isocoma menziesii.* We compared the species mix using a chi-squared analysis, which we calculated using 2X3 worksheet from Dr. Rodrigue's Chi-Squared spreadsheet.

For our second analysis, we compared our aggregated data of transects 1, 3, 4 and 8 from the March 2019 survey to the aggregated data from Spring 2017, Fall 2017, and Spring 2018 of all eight transects. We compared 6 dominant species that had the highest summarized count in the data. These were: *Avena fatua, Artemisia californica, Elymus glaucus, Eriogonum cinereum, Melica imperfecta, and Salvia leucophylla.* We compared the species with a chi-squared analysis, using Dr. Rodrigue's 2X6 worksheet in the chi-squared spreadsheet.

Results

Post-fire: Comparing 2019 and 2005 Species Mix

Table 1: Chi-Squared Calculations

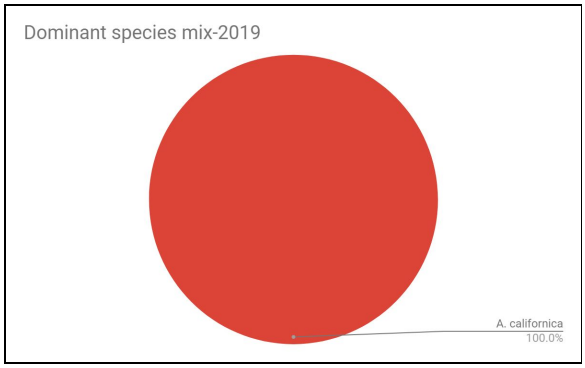
VAR 1 (2019)		VAR 2 (2005)			*
S. Leucophylla	a		b		
Obs	0		25		25
Exp	2.688		22.312		
A. californica	c		d		
Obs	10		35		45
Exp	4.839		40.161		
I. menziesii	e		f		
Obs	0		23		23
Exp	2.473		20.527		
*	10		83		93
r	3				

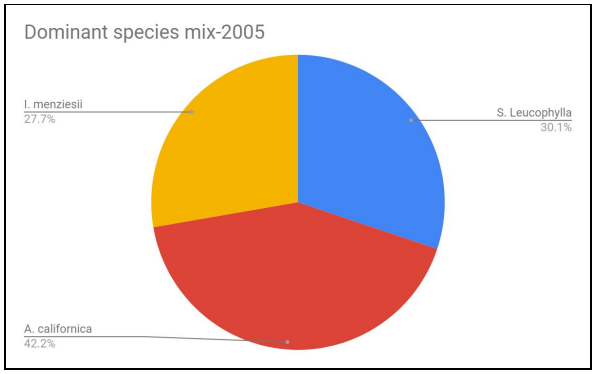
Table 2: Chi-Squared Results

Alpha	0.10
X2 Calc	11.952
X2 Critical	4.605
Probability Value	0.003
Effect size	0.358
Corrected Power	0.935

Our chi-squared calculated value (11.952) is larger than our chi-squared critical value (4.605). In addition, our p-value is smaller than our alpha statistic. Our p-value indicates that there is a 0.3% chance that the null hypothesis is correct. Because of this, we reject the null hypothesis. There is a statistically significant difference between the species mix in 2005 and the species mix in 2019. Our corrected power is quite large, at 0.935. This means that there is a high chance (93.5%) that we avoided a false negative. Our effect size of (0.358), indicating a moderate difference between the species mix data.

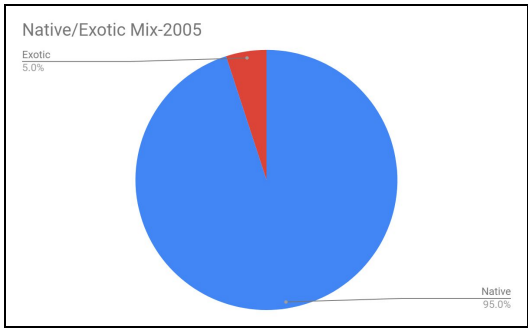
Comparison of dominant species mix

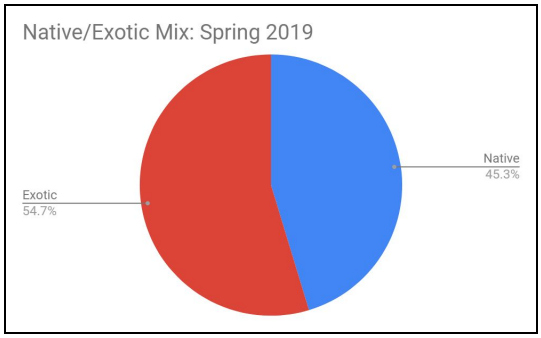




The distribution of these three species very clearly changes between the December 2005 survey and the March 2019 survey. The 2005 survey shows much more biodiversity; with *Artemisia californica, Salvia leucophylla*, and *Isocoma menziesii* all prominent in the mix. On the other hand, of these three species, only *Artemisia californica* is present in the 2019 survey.

Comparison of Native to Exotic Species





The presence of natives versus exotic species also shows a clear difference in the survey years. In December 2005, the cumulative transects showed an overwhelming presence of native species- 95%. In the Spring 2019 survey, the presence of native species had dropped to less than half- 45.3%

Post-Drought: Comparing Spring 2017-Spring 2018 with March 2019 Data

Table 3: Chi-Squared Calculation

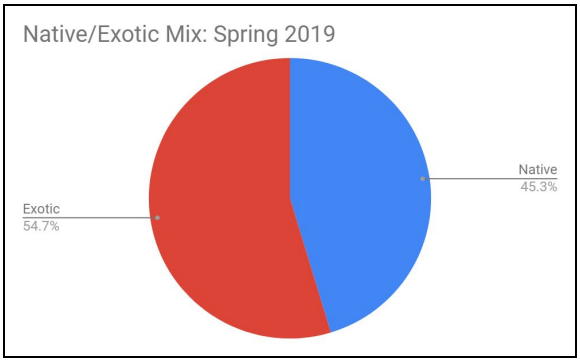
VAR 1 (2019)		VAR 2 (2017-18)			*
A. fatua	a		b		
Obs	0		77		77
Exp	1.782		75.218		
A. californica	c		d		
Obs	10		32		42
Exp	0.972		41.028		
E. glaucus	e		f		
Obs	0		86		86
Exp	1.991		84.009		
E. cinereum	g		h		
Obs	0		59		59
Exp	17		57.634		
M. imperfecta			j		
Obs	0		68		68
Exp	1.574		66.426		
S. leucophylla	k		l		
Obs	0		100		100
Exp	2.315		97.685		
*	10		422		432

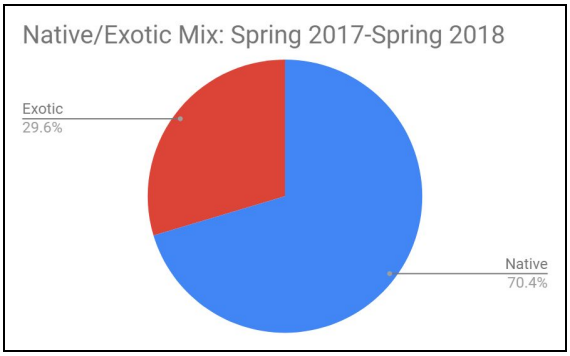
Table 4: Chi-Squared Results

X2 Calc	95.058
X2 Critical	9.236
Alpha	0.1
Probability Value	0.000
Effect Size (Cramer's V)	0.469
Corrected Power	0.999

Our chi-squared calculated value (95.058) is much larger than our chi-squared critical value (9.236). In addition, our probability value (0.000) was much smaller than our alpha standard of 0.1. Our probability value means that there is a 0.000% chance that the null hypothesis is true. This indicates that our results are statistically significant. We have a moderate effect size (0.469), which means that the difference in dominant species mix between these surveys is moderate. In addition, we have a very high corrected power (0.999), meaning that there is a 99.9% chance that we avoided a false negative. Due to these results, we reject the null hypothesis.

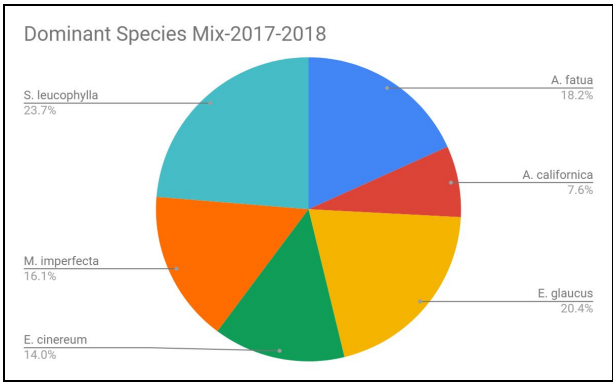
Species Comparison: Native to Exotic

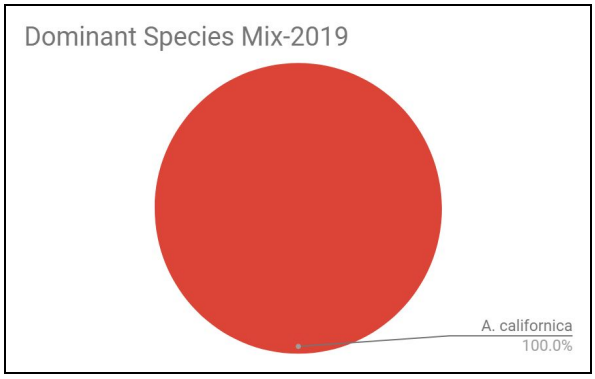




The cumulative data from Spring 2017-Spring 2018 shows a decline in native coverage to 70.4% (down from the Mr. Eckardt's data, which showed a native coverage of 95%). Between the Spring 2019 data and the Spring 2017-Spring 2018 data, there is another drop in native plant coverage from 70.4% to 45.3%.

Dominant Species Comparison





Our comparison of 6 dominant species shows a steep drop in biodiversity from Spring 2017 to Spring 2019. The aggregate data collected from Spring 2017-Spring 2018 shows an almost even distribution of these species. However, the Spring 2019 data, only one of the six species is present (*Artemisia californica).*

Discussion

Post-fire comparison

We reject our null hypothesis at a 90% confidence level. There is a statistically significant difference between the species mix of the December 2005 survey and the March 2019 survey. In addition, the post-fire survey shows a much lower coverage of native shrubs, and is instead dominated by invasive grasses. This result is consistent with previous research, which has observed grass-dominated stands in the first few years after a fire. So, it is possible our survey reflects post-fire succession instead of permanent loss of CSS.

Post-drought comparison

We reject our null hypothesis at the 90% confidence level. Our results show that there is a statistically significant difference between the species mix of the site in data collected in 2017-2018 and data collected in 2019. The change in species mix is likely due to a combination

of early post-fire succession and heavy rains during the winter of 2019; both of these factors would facilitate exotic annuals.

Conclusion

With our results alone, it is difficult to tell whether increased precipitation or post-fire succession play a larger role in the difference in species mix between years. There are many influences that contribute to the dynamic nature of CSS distribution, some of which are discussed here, but many fall outside the scope of this work. For future studies, it would be good to monitor these sites over the next several years to continue observing post-fire succession. Since Mr. Eckardt's data was collected in November or December of 2005, to do a consistent comparison, future students should monitor these sites around the same times of year. In addition, future comparisons should survey all eight transects for a more consistent comparison of aggregate data from previous studies.

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