San Diego River Park Foundation Critter Cam Project

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ENVS 498B Environmental Sciences Senior Project Report

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Abstract

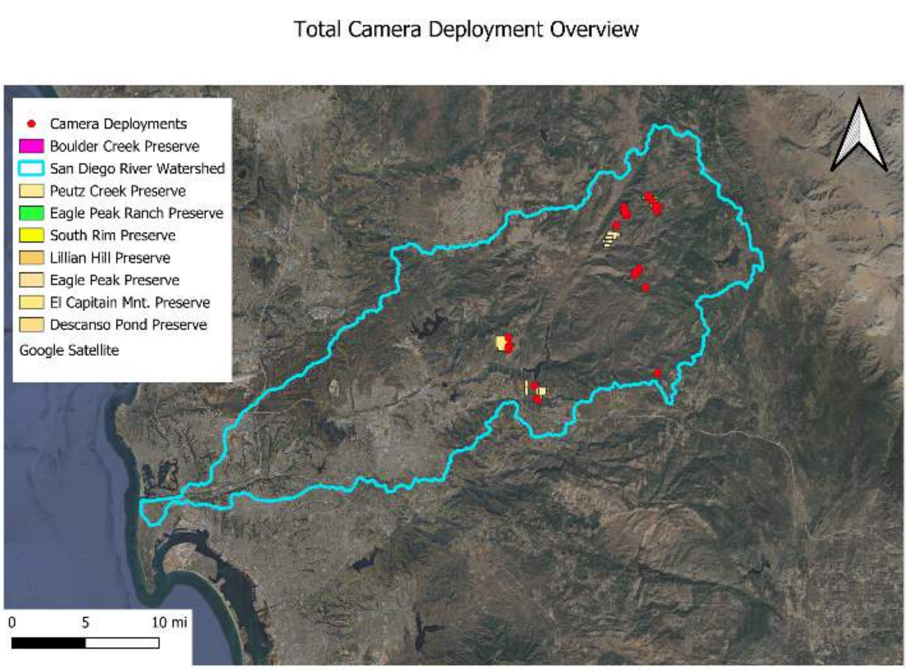
Wildlife camera trap projects provide long-term monitoring of species presence and ecological patterns. This study utilized data from the San Diego River Park Foundation's Critter Cam Project to examine relationships between habitat and climate variables for three main mammals. This study is to help aid management and conservation for the Foundation within their preserves. The puma (*Puma concolor*), coyote (*Canis latrans*), and grey fox (*Urocyon cinereoargenteus*) are the three main predators present in north San Diego County. The habitat composition was analyzed using QGIS and non-metric multidimensional scaling (NMDS), while species distributions were evaluated with chi-squared residual tests. Climate variables of drought, temperature, and precipitation were assessed through scaled comparisons and Spearman's rank correlation analysis. Results indicated that habitat differences partially explained species distributions, with coyotes more abundant in varying habitat types, while pumas prefer woodland preserves. Climate analysis had varying results, especially in relation to species population and precipitation. However, significant negative relationships were observed for pumas in one preserve and grey foxes in lagged analysis. Visual trends suggested that all three species may increase during drought periods, potentially due to shifts in prey vulnerability and availability. Despite limited statistical significance, patterns align with broader ecological theory linking climate variability to predator-prey dynamics. These findings highlight the complex and indirect ways climate variability influences predator dynamics. The results can influence strategies for habitat protection, and provide future direction.

Introduction

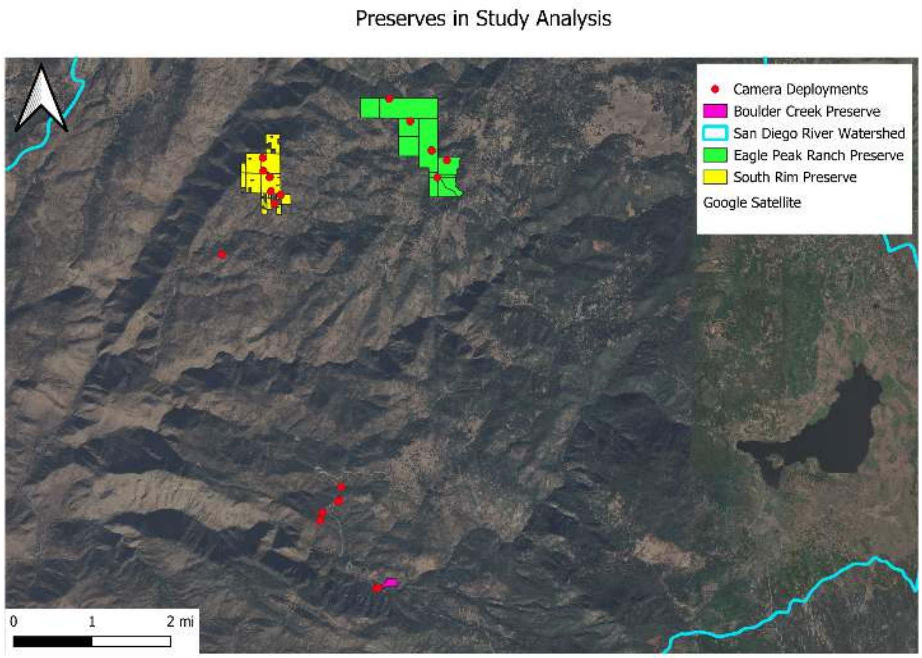
Wildlife camera projects have been growing in popularity throughout the environmental science community. They are a less time consuming way to gather long-term data on wildlife in a given area. Motion sensor activated cameras can detect when an animal is passing by, take a photo, and then that photo can be used to gather information such as what species are in the area, how frequently a species occurs, and time and date of the species. The San Diego River Park Foundation, a nonprofit organization dedicated to protecting, restoring, and enhancing the health of the San Diego River watershed, is the organization this study is run through. The Foundation works with volunteers, doing a wide range of community based science projects along the river. One of these projects is their Critter Cam Project. This project utilizes wildlife cameras in a range of different locations. The Foundation owns nine preserves spanning in the more rural areas of the San Diego River, stretching up to Julian, California. The goal of the project is to assist with wildlife research that can help identify key preserve conservation and management strategies.

Every preserve shows different counts and types of species. The first data began to be collected back in 2012, where volunteers hike into the preserves to set up the cameras and consistently check on the memory cards, then uploading the data. Map 1 references the camera deployment from the San Diego River Park Foundation (SDRPF) that have been active throughout the years. The uses of what species occur on the preserves are utilized to answer many different types of questions. As the analysis of the data is primarily reported to the public and consistency is needed, large mammals in San Diego County are the primary focus. The main mammals include pumas (*Puma concolor*), coyotes (*Canis latrans*), and grey foxes (*Urocyon cinereoargenteus*). The primary report of this paper is an analysis on these mammals' presence through the years in the preserves in comparison to precipitation and temperature values through the years, searching to discover if these environmental factors have any impact on San Diego's primary mammal species.

The study area consists of three different preserves, South Rim, Boulder Creek, and Eagle Peak Ranch, all containing consistent sightings of these three mammals throughout the years (Map 2). A multistep process occurred for understanding if precipitation and temperature patterns affect mammals in North San Diego County. The first part of the study began by analysing the habitat differences among the preserves, and the total count of animals per preserve. The second part moved into the analysis of coyote, grey fox, and puma correlation to drought and temperature, followed by precipitation. The following paper discusses the impacts of these factors on each individual species, as well as future directions of where this data would be beneficial, and where there is still data lacking.



Map 1: The total current camera deployment by SDRPF within the San Diego River watershed (QGIS, 2024)



Map 2: The focus preserves for this study, showing South Rim, Boulder Creek, and Eagle Peak Ranch. Location of current camera deployments still shown (QGIS, 2024)

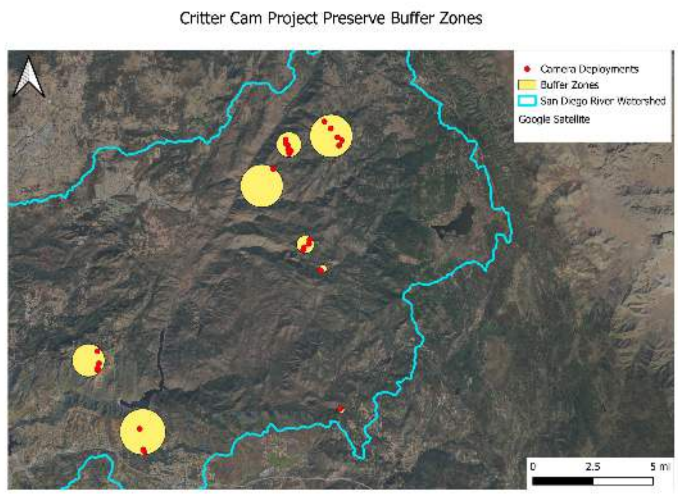
Methods

2.1 Data Collection

Multiple different types of motion sensor activation cameras were deployed to the location spots for the given preserves (Map 2). All but two cameras, which are cell-ready, require the exchange of memory cards every 1-2 months. These images were uploaded to Wildlife Insights, an organization allowing quick identification and organization of camera trap photos. Wildlife Insights then organizes the images into useful spreadsheets, ready for analysis by the SDRPF team. Camera locations are typically changed every couple of years, shifting between different locations on individual preserves and to other preserves based on perceived patterns of animals. The goal with the movement of cameras is to capture the best available location within preserves and the most amount of images.

2.2 Preserve Comparison

Using the QGIS platform, the original analysis was performed. Buffer zones were created to have a consistent surface area for identification. The buffer areas chosen were based on circles that enclosed the entirety of each individual preserve. Size was not standardized across the properties, due to varying size, and some buffer zones reaching out of the watershed study area. Map 3 refers to the extent of each of these buffer zones, calculated using QGIS.



Map 3: Buffer zones for Critter Cam Project preserve comparison (QGIS, 2024)

Using vegetation habitat data provided by the San Diego Regional Data Warehouse by SanDag and SanGIS, the vegetation data for each property was extracted through QGIS, allowing for a usable comparison to the major mammals. Using RStudio, a non-metric multidimensional scaling (NMDS) test was run for full vegetation comparison (Chart 1). A second test on RStudio was then run for results of each mammal per preserve. This test was a chi-squared residual test and utilized an edited CSV created from wildlife insights.

2.3 Precipitation and Temperature

Precipitation data for the study zone was used through the San Diego City Water Authority webpage, from their collection site at Lake Cuyamaca (Rainfall, 2026). Drought comparison data found through the USGS drought database chart for San Diego County (USGS, 2026). Temperature data gathered through graph comparison from the San Diego Climate Station, provided by Climate Stations. Due to differences in data format, including non-numeric graphical representations for temperature and drought, a standardized scaling approach was applied. Drought, temperature, and mammal abundance were converted to a common 0–3 scale to allow for direct comparison across variables. This approach facilitated visual and statistical analysis of relationships between climate conditions and species presence despite inconsistencies in the original data formats. Table 1 provides the scale information.

Scale Number	Drought Equivalence (A)	Temperature Equivalence (B)	Mammal Count Equivalence (C)

0	No drought year	Coldest/lowest ranging temperatures	No animals detected in year
1	Abnormally Dry (D0)	Average	Low counts
2	Moderate to Severe Drought (D1-D2)	Significant days above, but less intensity	Average counts
3	Extreme Drought - D3	Most intense and highest count	High counts

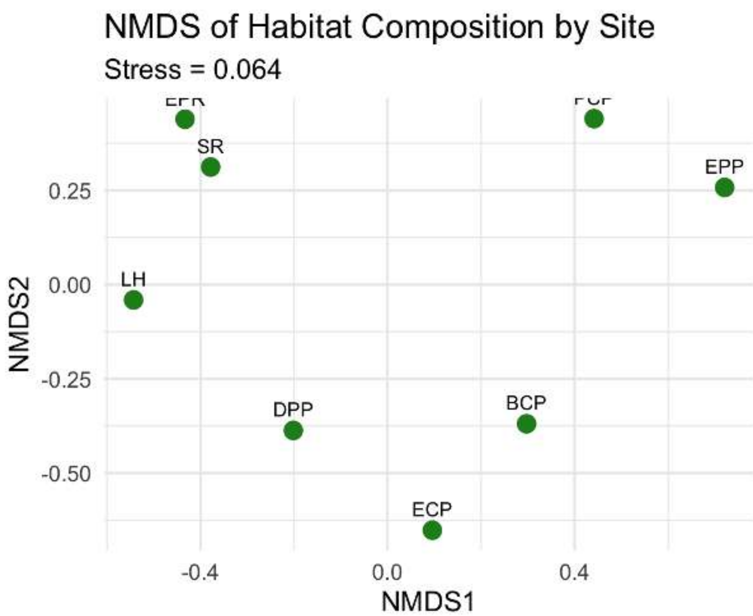
Table 1: Number scale breakdown for analysis. Half values were also used within the chart making to ensure greater accuracy. All are based on the 13 year span of data. Drought equivalence (A); in order to move up a whole number, the majority of the year needed to contain a certain drought ranking. Many years between the 1-2 fell under a 50/50 of the two which allowed them to be in the same category, differing through half value. Temperature equivalence (B); evaluated through graph data. The category reflects on the amount and intensity of days above the median temperature, in comparison to the other years within the study range. Mammal Count Equivalence (C); the average count per mammal from the years of data were taken, and the scale was derived based on the significance of the difference from the average.

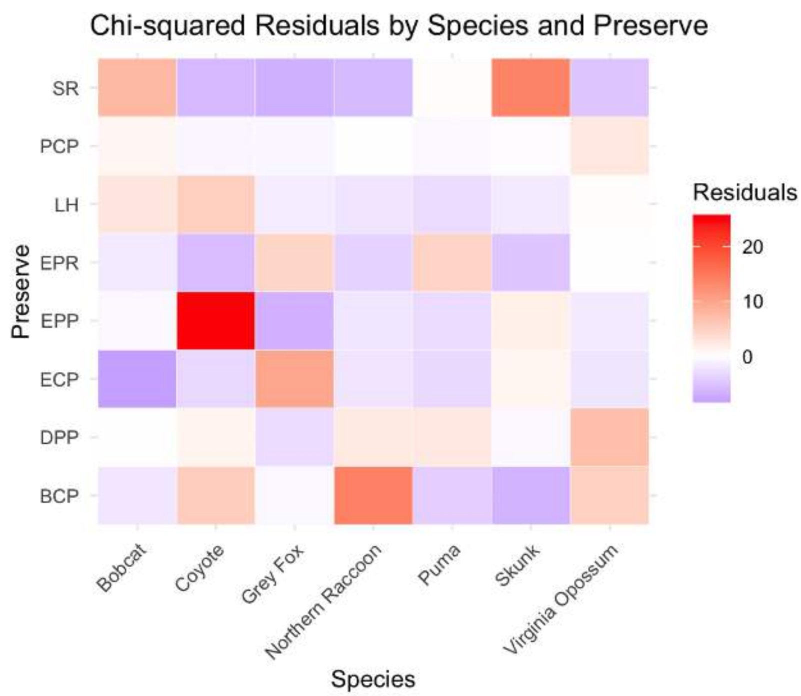
These scale equivalence tables were then placed into graphs, reflecting the amount of Pumas, Coyotes, or Grey Foxes in that year, to visually compare to the drought and temperature.

A second analysis of precipitation was conducted using the San Diego City Water Authority provided CSV on precipitation through the years. Six Spearman's analysis tests were run in RStudio. Three were precipitation versus the same year population of Puma, then Coyote, and then Grey Fox. Three tests were precipitation versus the population of each mammal one year after, creating a lag result to analyze. Graphs created for count analysis are all on the basis of the percentage that the mammal took up of the total proportion of animals in the preserve for that year. The count that is used within the Spearman's test is this same proportion percentage number.

Results

3.1 Habitat and Mammal Count:





(Top Chart) Chart 1: The results of the NMDS test run for vegetation comparison of the eight preserves as of 2024

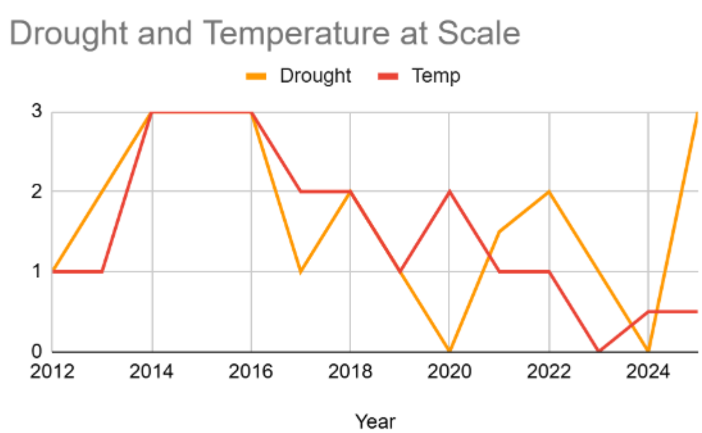
(Bottom Chart) Chart 2: The results of the Chi-squared Residuals test run for species count throughout the eight preserves as of 2024. Red cells = more individuals observed than expected, blue cells = less individuals observed than expected, white cells = about expected.

The results from the vegetation analysis show that Eagle Peak Ranch and South Rim are closest to each other in habitat from a vegetation analysis. Referring to Chart 1, the two dots are the closest together. Boulder Creek Preserve, the third preserve in this analysis, containing far more agricultural land and less chaparral.

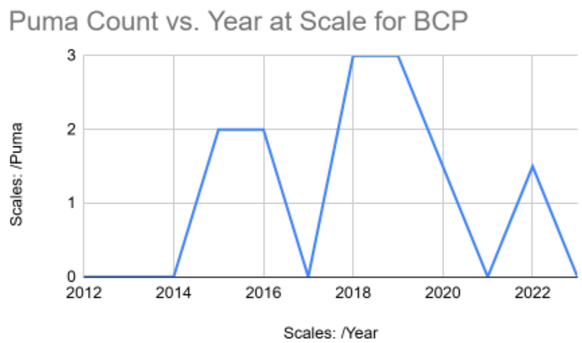
As far as the distribution of individuals within mammal species that extend across the preserves, there was a larger range within the three preserves. The expected value comes from the habitat analysis. South Rim saw less coyotes and grey foxes, but an expected amount of pumas (Chart 2). Eagle Peak Ranch also saw less than expected coyotes, but slightly more than expected grey foxes and pumas. Going down to Boulder Creek Preserve, there were more than expected coyotes, an expected amount of grey foxes, then less than expected pumas.

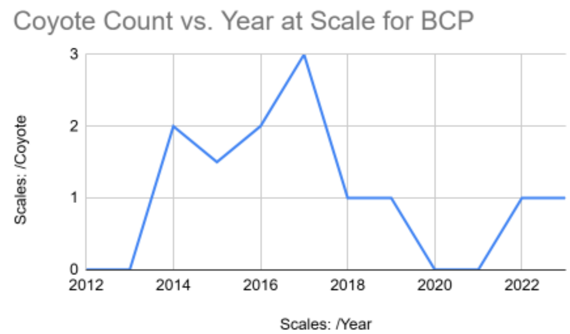
3.2 Drought and Temperature

The following charts 3-12 represent the results for drought and temperature. All of the “count” is not the exact count numbers of the individuals representing the species, it is a calculated proportion of the amount of that species seen compared to the total amount of species seen in the given year at that specific preserve. It represents a percentage that was then average and put on the 0-3 scale.

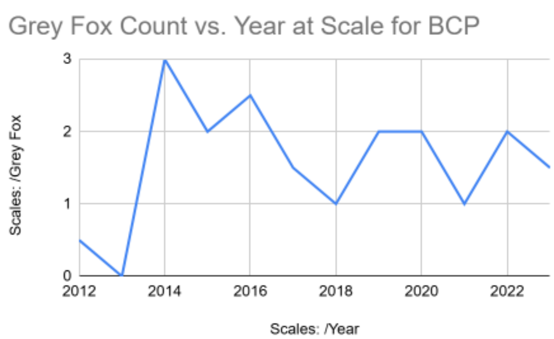


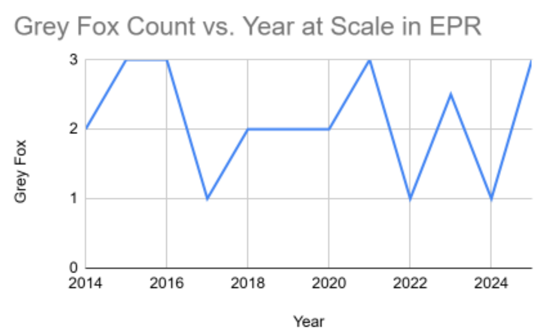
(To the left) Chart 3: The scaled down depiction of drought and temperature on the 0-3 scale. This chart represents the overall trends from year to year. Some significant years include the severe drought and high temperatures from 2014 through 2016.



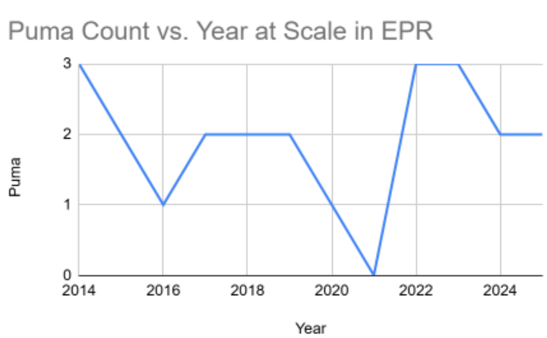


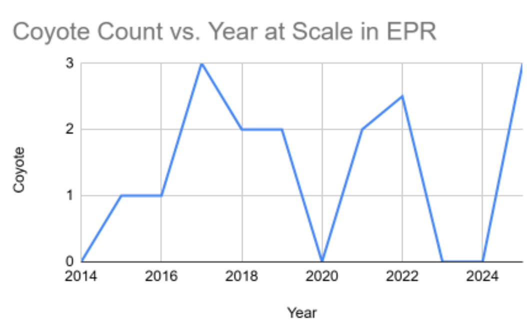
(Left) Chart 4: The Puma proportion per year for Boulder Creek Preserve scaled down to the 0-3 scale for visual correlation.
(Right) Chart 5: The Coyote proportion per year for Boulder Creek Preserve scaled down to the 0-3 scale for visual correlation.



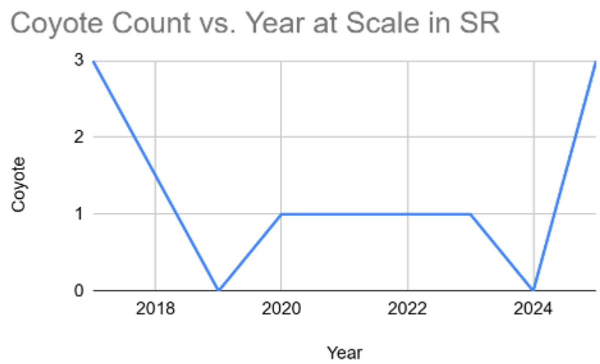


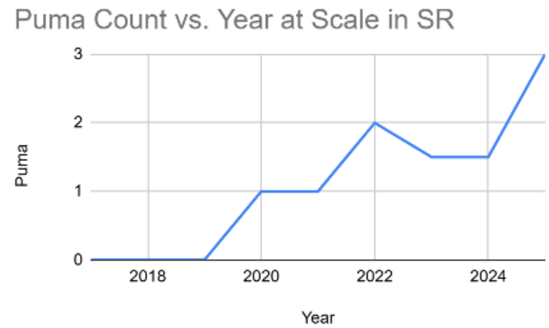
(Left) Chart 6: The Grey Fox proportion per year for Boulder Creek Preserve scaled down to the 0-3 scale for visual correlation.
(Right) Chart 7: The Grey Fox proportion per year for Eagle Peak Ranch Preserve scaled down to the 0-3 scale for visual correlation.



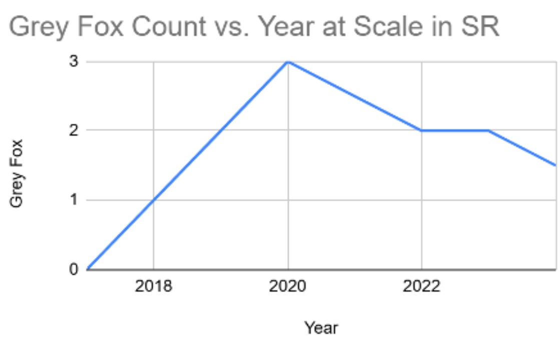


(Left) Chart 8: The Puma proportion per year for Eagle Peak Ranch Preserve scaled down to the 0-3 scale for visual correlation
(Right) Chart 9: The Coyote proportion per year for Eagle Peak Ranch Preserve scaled down to the 0-3 scale for visual correlation





(Left) Chart 10: The Coyote proportion per year for South Rim Preserve scaled down to the 0-3 scale for visual correlation
(Right) Chart 11: The Puma proportion per year for South Rim Preserve scaled down to the 0-3 scale for visual correlation

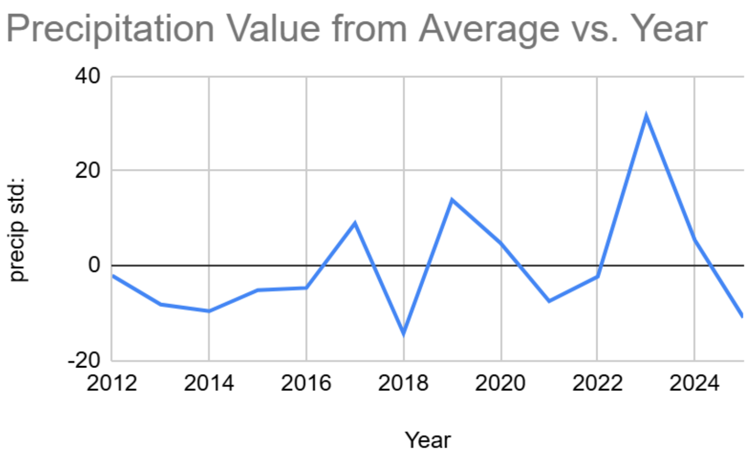


(Left) Chart 12: The Grey Fox proportion per year for South Rim Preserve scaled down to the 0-3 scale for visual correlation

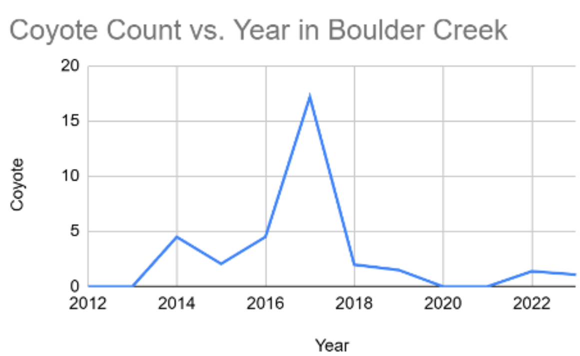
Chart 4 and Chart 5 show pumas and coyotes following a similar pattern to the drought years especially in BCP. In comparison to Chart 3, Chart 4 and Chart 5 both increase to higher levels of count in a positive correlation. Moving to Chart 6 and Chart 7, the grey fox in both preserves follows a similar pattern, seemingly thriving more in direr and hotter years. Stand out years in all four of these charts in 2014-2016 high drought and temperatures, all four populations did well during these years. Pumas and coyotes in EPR follow less of the visual pattern, only decreasing rapidly in the 2020 non-drought year, and increasing again during the 2022 level 2 drought (Chart 8 and Chart 9). The SR charts show more steady populations than the other preserves. Pumas are steadily increasing (Chart 11) and grey foxes are steadily increasing then decreasing (Chart 12). Chart 10 represents coyotes decreasing significantly once the drought years are over, then increasing again when drought starts to increase.

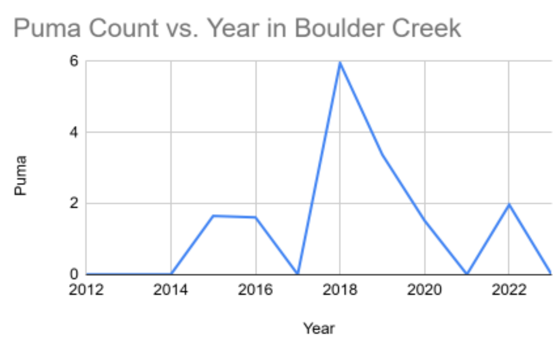
3.3 Precipitation

The following charts 14 through 22 are the unscaled proportion of the mammals in each preserve. Chart 13 is the precipitation difference from the average temperature scaled at zero, found throughout the years. The following mammal charts are not the individual species actual count, but instead their percentage values based on the overall year total count per preserve.

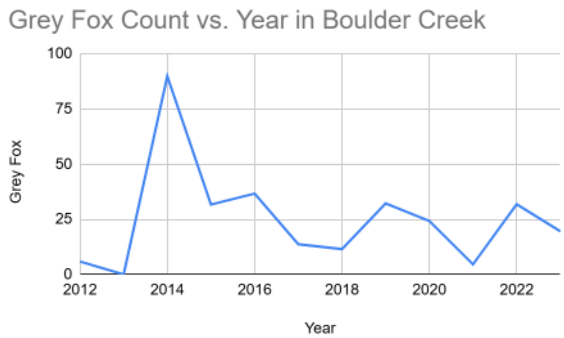


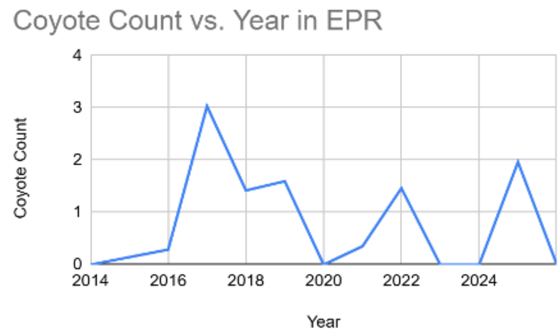
(Left) Chart 13: The trend of precipitation difference from the average precipitation value for the year (Rainfall, 2026)



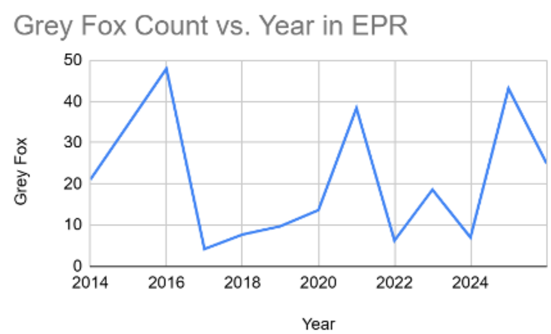


(Left) Chart 14: The Coyote proportion percentage per year for Boulder Creek
(Right) Chart 15: The Puma proportion percentage per year for Boulder Creek

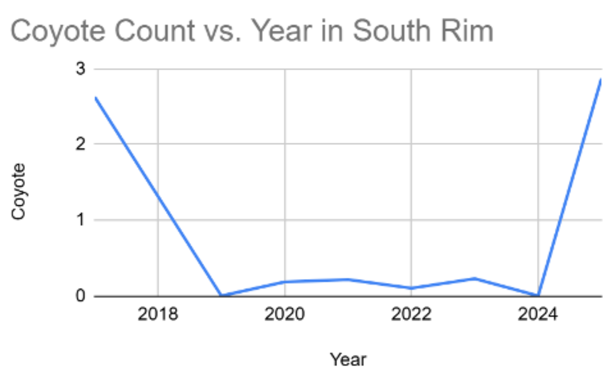


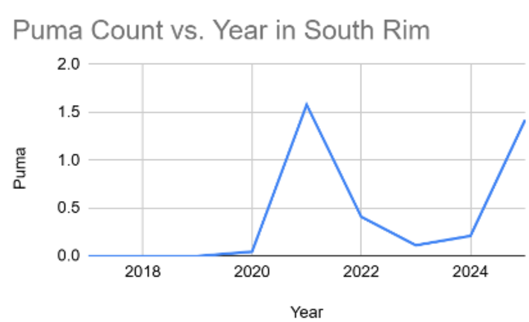


(Left) Chart 16: The Grey Fox proportion percentage per year for Boulder Creek
(Right) Chart 17: The Coyote proportion percentage per year for Eagle Peak Ranch



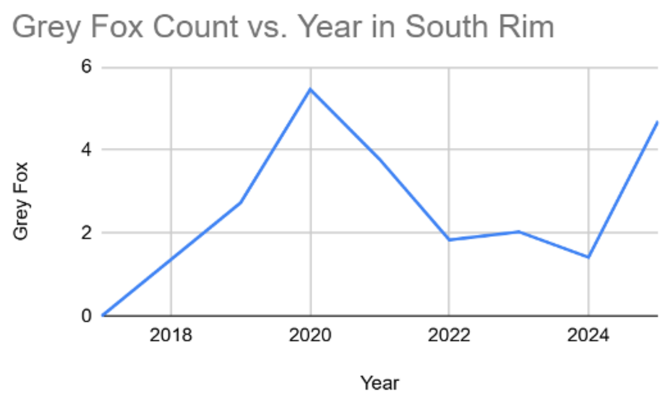
(Left) Chart 18: The Puma proportion percentage per year for Eagle Peak Ranch Preserve
(Right) Chart 19: The Grey Fox proportion percentage per year for Eagle Peak Ranch Preserve





(Left) Chart 20: The Coyote proportion percentage per year in South Rim Preserve

(Right) Chart 21: The Puma proportion percentage per year in South Rim Preserve



(Left) Chart 22: The Grey Fox proportion percentage per year in South Rim Preserve

The visual analysis results are specific for every preserve per mammal. One visual interpretation Chart 16, grey foxes in Boulder Creek follow a negative correlation with precipitation. Their numbers increased as the precipitation decreased and vice versa. Chart 17 however, visually appears as more of a positive correlation between the two, coyotes in Eagle Peak Ranch rise and fall with the precipitation. Coyotes in Chart 14, Boulder Creek, also follow a similar trend, peaking in the same years as those in Eagle Peak Ranch. From Chart 15 and chart 21, the pumas visually have a negative correlation with the precipitation, increasing as precipitation was less than the average. Other charts though like 18 and 19 have no distinguishable visual patterns.

The main part of the analysis was the statistical analysis using RStudio to see if there was any statistical correlation between the difference in precipitation from the average and the proportion percentage of the species. The following Tables, 1 and 2, represent the Spearman's correlation test. This test is a non-linear, monotonic test that was the best for this non-linear relationship.

Site	Species	ρ (Spearman)	p-value	Interpretation
BCP	Coyote	-0.06	0.84	No relationship
	Puma	-0.09	0.79	No relationship
	Grey Fox	0.14	0.67	Very weak positive trend, NS
EPR	Coyote	0.15	0.65	Very weak positive trend, NS
	Puma	0.01	0.98	No relationship

	Grey Fox	0.15	0.65	Very weak positive trend, NS
SR	Coyote	-0.26	0.53	Weak negative trend, NS
	Puma	-0.78	**0.02**	Strong negative trend, S
	Grey Fox	-0.45	0.27	Moderate negative trend, NS

Table 2: The results from the first three tests run for precipitation correlation, the Spearman's test. Three preserves, BCP = Boulder Creek Preserve, EPR = Eagle Peak Ranch, SR = South Rim, NS = Not significant, S = significant. Both the rho correlation value (ρ (Spearman)) and the p-value were calculated.

Site	Species	ρ (Lag)	p-value	Interpretation
BCR	Coyote	-0.52	0.10	Moderate negative trend, NS
	Puma	-0.23	0.50	Weak negative trend, NS
	Grey Fox	-0.70	**0.021**	Strong negative trend, S
EPR	Coyote	0.03	0.95	No relationship
	Puma	-0.19	0.60	Very weak negative trend, NS
	Grey Fox	0.54	0.11	Moderate positive trend, NS
SR	Coyote	-0.43	0.33	Moderate negative trend, NS

	Puma	-0.39	0.40	Moderate negative trend, NS
	Grey Fox	-0.14	0.78	Very weak negative trend, NS

Table 3: The results from the second three statistical tests run, Spearman's Lag tests. This test ran each proportion of mammal from t+1, to see if there was any correlation one year after certain precipitation. Three preserves, BCP = Boulder Creek Preserve, EPR = Eagle Peak Ranch, SR = South Rim, NS = Not significant, S = significant. Both the rho correlation value (ρ (Lag)) and the p-value were calculated.

First, the correlation test was run for precipitation within that same year (Table 2). Rho runs on a scale of positive one to negative one, the closer to each end of the spectrum the more of a correlation trend there is seen between precipitation and the mammal. P-value was judged on a scale of significant being <0.05. Based on this, with precipitation in the same year, the most significant result was that South Rim pumas have a strong negative correlation, they increase as precipitation decreases. Grey fox in South Rim also had a more moderate negative correlation, however this result was not significant. The rest of the results were either a very weak correlation or none at all.

For the second test, a lag was added to the Spearman's test (Table 3). This test ran statistics on precipitation and mammal correlation one year after the precipitation year. Slightly more correlation was found within lag (t+1). The only positive correlation found was a moderate positive correlation found with grey fox in Eagle Peak Ranch. Boulder Creek Preserve showed more correlation a year after in all three mammals. Coyotes in BCP had a moderate negative relationship, not significant. Puma in BCP had a weak negative relationship, not significant, while grey fox had a strong negative relationship and was significant. Puma in SR lost their strong negative correlation, but still held a moderate negative correlation, but was no longer significant.

Discussion

4.1 Habitat and Mammal Count

Based on the results of the NMDS test, EPR and SR had the most similarity within habitat coverage. This makes sense based on the relative proximity of the two preserves (Map 2). They both showed high woodland area, while close to zero agriculture. BCP had a much greater variety of habitat displayed, split between shrubland, riparian, and chaparral. Even though SR and EPR had the same habitat coverage, they showed differing expected proportions of the three mammals. SR showed less than expected in both coyotes and grey fox, while EPR showed more than expected in both grey foxes and pumas. BCP had more than expected coyotes, and less than expected pumas.

EPR's grey fox results follow traditional patterns. According to Farrias et al., grey foxes prefer woodlands but adapt to chaparral in the presence of coyote competition. EPR has less than expected coyotes present, which allows for grey foxes to live in their preferred habitat. BCP is the only preserve of the three that have more than expected coyotes. Coyotes in general stick to vegetation where their prey is at, which is more coastal sage scrubs and chaparral, which is present in BCP, but not EPR and SR (Farias, 2012).

Another interesting trend within the preserves is that coyote abundance and puma abundance was always opposite. These two species compete for the same resources and that coyotes often can smell puma on the carcasses and avoid that area (LaBarge et al., 2022). All three of these mammals also share the same prey, so there is competition amongst them. Grey fox however, is the smallest and is usually the first to avoid the area.

Pumas prefer more covered and rugged habitats (Jerkovic, 2025). BCP has the lowest expected puma amount compared to EPR and SR, this is accurate because both EPR and SR are covered woodland areas where there is camouflage and coverage for Pumas.

4.2 Coyotes

Focusing on coyotes, Chart 17 and 14 showed us visually to be more representative of a positive correlation, years where precipitation was low, coyotes were low. Similarly, the year after high precipitation the populations would fall. The year after trend was also represented through the moderate negative trends from the Spearman's results in BCP and SR. Coyotes require three times their biomass in water consumed (Hodge et al., 2022). This is one explanation supporting our data. California water trends show that February followed by January is the wettest month of the year, meaning a majority of the rainfall in San Diego County occurs in the beginning of the year (Weather Watch, 2026). This helps boost water resources and prey for the rest of the year, meaning that the year with raised precipitation would see an increase in water resources and prey compared to the year after.

The trend of coyotes in all three preserves having peak proportions in 2017 illustrates this further. Following the drought period from 2014 through 2016, there was a rise in precipitation in 2017 (Chart 3,13). Based on a study out of California, coyote's prey of rodents spiked rapidly with the rains in the end of this drought going into 2017 (Parren et al., 2022). If this trend were to occur yearly, with prey peaks in years with increased precipitation following drought, at the beginning of the year this would increase populations. This would also explain any resemblance of a negative trend seen. Years with less precipitation in the beginning have less water for coyotes to consume and less prey abundance in comparison to previous years.

4.3 Pumas

Visually pumas had a negative correlation through both Chart 15 and 21 in BCP and SR. Statistically this was represented in SR as a strong and significant trend. This trend becomes more consistently negative in the lag results, showing moderate negative trends in all three preserves. Pumas and coyotes share similar prey, so there is a possibility for pumas to increase as coyotes decrease. Puma's themselves are not water dependent, unlike coyotes. Pumas primarily just need steady habitat and prey, both of which are dependent on precipitation. Due to a lack of studies in this field, the conclusion is solely based on prey competition and availability in comparison to coyotes, or habitat changes that occur after increased precipitation, like increased flow that cuts off pumas from travelling to the preserves.

As precipitation patterns continue to vary, and drought and temperature increase or decrease due to climate change, there is further room for future studies within this field. While wildlife camera data alone may not be sufficient for puma analysis, this combined with tracking collars for individual pumas and population studies through the years can provide further insight into puma patterns and correlation to precipitation.

4.4 Grey Foxes

Grey foxes were the most numerous mammal based on proportions within the preserves. This being the case, the inclusion of them in the study is for more consistent numbers representing correlation. One main visual result from the grey fox, is that as seen in Chart 16, 19, and 22. The trends of all three populations of grey foxes are similar. The statistical correlation however, suggests that there is in fact differing correlation between the preserves. There is no consistent statistical analysis across the three preserves for the grey fox.

There are some key notes. In BCP, grey foxes hold a strong and significant correlation in the lag analysis. This represents a negative trend with precipitation. A negative trend can be explained through similar findings as to coyotes. Rodriguez-Luna et al., discusses that coyote and grey fox have similar prey species, with grey fox simply focusing on smaller portions and more fruits than coyotes (Rodriguez-Luna et al., 2021). In comparison with the precipitation patterns found for coyotes, this suggests a similar resemblance. The year after precipitation there will be less prey due to less precipitation. The weak positive trends found in BCP and EPR for the current precipitation year concur with these results. Grey fox and coyotes visually have opposing years of abundance, hinting at the overlap and competition for prey.

Similar to pumas, there is a lack of studies focusing on the direct impacts of precipitation on grey foxes. This being said, the primary reasons found through this study for the trends represented by the analysis is prey competition, prey availability, and habitat health due to temperatures and drought that would support or not support grey fox.

4.5 Rebuttal:

The strongest portion of analysis comes from the Spearman's test, which in large was not the most significant test. That is why the visual interpretation, and the outside studies are an important recognition within this data. The data for this project spans at most 13 years, and in preserves like SR, only seven years. When running statistical analysis, this is not always enough data points, more *n* values are important for more accuracy. This project has not collected enough data yet for that. Some of the analysis relies on trends that are not significant, however, these trends have mostly been supported by other studies so they are still referenced. Secondly, this is citizen science, sometimes volunteers forget to upload photos, place cameras in different positions, replace batteries, and more. There are also inconsistencies with the data. Not all the cameras are the same, some of the preserves are larger than others, and the length of the data collection is different. This is an ongoing, continuous project that has room for more analysis in the future. Patterns emerging that represent previous studies are important however, it suggests that SDRPF is on the right path, and that conservation efforts being made are still important.

4.6 Overview

The overarching themes found between the three species is supported by other climatic-predator relationships studied previously, even if not specific to each species. One of the main findings in our study is that lag effects were more informative than same year relationships. Morin et al., discusses the effects of climate changes on predator-prey relationships under four different scenarios. One being the effect of rainfall onto prey health (Morin et al., 2021). Their results were found to also be under t+1, or a lag year as well. In the scenario when rainfall affected the body health of the prey, predators had a negative trend with precipitation the following year. These results are similar to ours. The year after below average rainfall, there was an increase in predators. The theory behind this trend, as reported by Morin et al., 2021, is that the health of the prey declined. Predators were easily able to catch and eat adult prey, and more juvenile prey, due to the decreased health. This represents then the larger picture of predation trends and the importance of climatic changes affecting prey abundance, which in turn ripples up the food chain to predators.

Conclusion

This study found that habitat differences influence predator distribution, while climate variables, particularly precipitation, show weak but consistent lagged relationships with predator abundance. The first thesis question this paper answered was how differing vegetation habitat affects the populations of the main three mammals of coyotes, pumas, and grey foxes. The second thesis question this paper answered is how drought and precipitation patterns are correlated to these three mammal species throughout the range of data collected. Habitat analysis showed that coyotes were more abundant in heterogeneous landscapes, while pumas were associated with woodland preserves. Across all sites, pumas and coyotes exhibited inverse abundance patterns, suggesting competitive interactions.

Although most statistical relationships were not significant, consistent negative lag trends suggest that precipitation may influence predator populations indirectly through delayed effects on prey availability. The strongest significant relationships included a negative correlation between precipitation and puma abundance in South Rim and a lagged negative correlation for gray foxes in Boulder Creek Preserve.

These findings suggest that drought conditions may increase predator pressure on prey populations, particularly in woodland preserves where pumas are more active. This highlights the importance of targeted monitoring and adaptive management strategies during periods of climatic stress. These findings also help support the SDRPF in association with where to focus preservation efforts next, management efforts, and understanding wildlife in our local region more. Climate change continues to shift our local environment. In San Diego, we keep seeing greater variation in drought years, temperature, and precipitation. As climate variability continues to intensify in southern California, understanding these predator–climate relationships will be critical for guiding conservation decisions and maintaining ecosystem balance within the San Diego River watershed.

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