Pika Distribution and Trends at Niwot Ridge

https://github.com/ldye16/DyeFreedman_ENV872_EDA_FinalProject

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```r
# Load your datasets
Pika_Raw <- read.csv("./Data/Raw/pika_demography.cr.data.csv",
    stringsAsFactors = TRUE)
Climate_Raw <- read.csv("./Data/Raw/d-1cr23x-cr1000.daily.ml.data.csv",
    stringsAsFactors = TRUE)
```

1 Rationale and Research Questions

The American Pika is a threatened small mammal endemic to alpine tundra habitat in the Rocky Mountains and Sierra Nevadas. Climate change is a growing threat worldwide, and is expected to have a particular impact on high elevation habitats. Pikas are sensitive to both temperature and changes in the water balance (impacted by seasonality of snowmelt), so climate change could undoubtedly threaten their long-term viability. In addition, as Pikas occupy habitat at the tops of mountain ridges, their possible migration either northward or to higher ridges would involve them crossing over lower elevation valleys. Their ability to do so is unknown, which makes their possibility of survival even murkier.

Niwot Ridge is one of the most heavily studied alpine areas in the Rocky Mountains. It is home to multiple research projects, as it is both a NEON and LTER Site. LTER researchers have gathered data on Pika demography and climate over the past 10-20 years. We used multiple public datasets to answer multiple questions regarding trends in climate and Pika populations at Niwot Ridge.

1. Is temperature changing over time at Niwot Ridge?
2. Are Pika populations changing over time and is there a correlation between population changes and temperature changes?
3. Are Pika populations changing spatially over time? Are they seeking higher elevation sites?
4. An increase in zoonotic diseases is a well documented effect of warming temperatures. Is mite and flea prevalence in Pikas changing over time and with temperature?

2 Dataset Information and Wrangling

Both climate and pika data was sourced from the Niwot Ridge LTER website. All datasets are for public use and are available here: https://nwt.lternet.edu/data-catalog Significant wrangling was required to answer the research questions. The general process is explained below for each research question.

Temperature changes over time:

Climate data was available from 2000 to 2021, but we selected for years in which there was an overlap of available temperature data with the Pika data (2008 to 2018). The dataset contained the site and device names, daily min, max, and avg air temperature, relative humidity, barometric pressure, wind speed/direction, solar radiation and soil temperature. We then used the package "zoo" to interpolate NA values in the temperature data.

Pika population changes over time and in relation to temperature:

Pika data was available from 2008 to 2020, but we selected for years in which there was an overlap of available Pika data with the temperature data (2008 to 2018). The dataset contained the site, data, slope aspect, location of capture, identification information, demography data, biological samples collected and pest presence. In order to estimate population over time, we identified annual Pika captures at Niwot Ridge. This required eliminating any possibility of recounts within the same year. We first filtered out any captures that did not have a "tag type", meaning that they were not tagged at all and not enough information is provided to rule it out as a recapture. Second, we filtered out observations where the tag type was recorded, but for an unknown reason none of the tag information (ear tag color or number code) was recorded. Finally, we split the dataset into separate datasets for each year and found the number of unique tag IDs to derive annual counts.

To prepare for our temperature and pika abundance regressions, we needed to calculate mean annual temperature values. We took the interpolated temperature dataset and grouped by year, then summarized by average daily temperature to calculate annual means.

Pika spatial distribution changes:

To assess spatial changes, observations without spatial attributes (easting, northing) were eliminated. Mean annual pika locations were determined by summarizing the easting and northing columns. Both individual and mean annual locations were converted to spatial data frames using the NAD83 Zone 13N projected coordinate system.

Parasite Data:

To determine if there was a change in parasite abundance over time and with changing temperatures, the flea and ear mite data first needed to be isolated from the total pika demography data. The flea and ear mite data within the demography data are flea observations, fleas sampled, ear mite observations, and ear mites sampled. For both flea observations and fleas sampled, the recorded value equates to the number of individual fleas either observed on or sampled from the individual pika. However, for ear mites sampled, the recorded values are binary. A "0" is recorded for individual pikas that did not have ear mites sampled, and a

"1" is recorded for pikas that were sampled. For ear mites observed, the data is represented in categories. The categories are "N" for none observed, "L" for low density, "M" for medium density, "H" for high density, "NA" for individuals whose data was not recorded in the main trapping notebook, and "NS" for Pikas who were not sampled for mites in this way. There are also a few instances of either a "0" or a "1" being recorded and a single recording of "N?".

Once we had isolated the flea and ear mite data from the demography data, we split the dataframe into two, one with only flea data and one with only ear mite data. For the flea data, we grouped by PikaID to isolate individual pikas that were recaptured in a given year. Next, we split the data by year and found the mean value of fleas sampled and fleas observed per pika for each year. We then merged the single-year dataframes to create one dataframe with the average number of fleas observed and sampled per pika per year. We wrangled the mite sampled data the same way. However, since the data was binary, either "0" or "1", the resulting ear mite sampled column represented a proportion of captured pikas sampled for ear mites. Generally, if ear mites were observed on a pika, they were sampled. This means the proportion of pikas sampled for ear mites represents the proportion of total pikas captured in a given year with ear mites present.

For ear mite observed data, we used a different wrangling technique to account for the categorical data. The NA, NS, 0, 1, and N? observations were all dropped. We retained only observations where ear mite observation data was collected. These are N, L, M, and H. Once we had selected the variables we wanted, we grouped them by year and observation type and summed the amount of each observation variable recorded for a year. This gave us a total count for each observation variable for each year. To account for the different number of pika captures each year, we converted the data from a count total to the proportion of each categorical variable represented each year.

In the final step, we joined the wrangled flea and mite dataframes into one final parasite dataframe. The final parasite dataframe was then joined to the climate data, and we had our final merged parasite and climate dataframe.

3 Exploratory Analysis

4 Analysis

4.1 Question 1: Is temperature changing over time at Niwot Ridge?

4.2 Question 2: Are Pika populations changing over time and is there a correlation between population changes and temperature changes?

##Question 3: Are Pika populations changing spatially over time? Are they seeking higher elevation sites?

##Question 4: One well documented effect of warming temperatures is an increase in zoonotic diseases. Is mite and flea prevalence in Pikas changing over time and with temperature?

To analyze this question, linear regressions were ran on flea and mite data over both time and temperature.

5 Summary and Conclusions

6 References

<add references here if relevant, otherwise delete this section>