American Pika Population and Distribution Trends at Niwot Ridge

Summary

This repository was created to facilitate data storage and analysis for a research project analyzing the effects of climate change on the American pika at Niwot Ridge, CO. The goal was to understand pika population changes over the past 10-15 years and examine the connection to a changing alpine climate. The prevalence of pests (mites and fleas) found on pikas was also assessed over time, as an increase in disease is a widely accepted consequence of climate change.

The repository contains raw and processed data files, metadata, information on the data sources, and code used for wrangling, analysis, and visualization.

Investigators

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Keywords

Pika, climate change, temperature, alpine tundra, disease, pests, spatial analysis, population analysis

Database Information

Both climate and pika data was sourced from the Niwot Ridge LTER website on November 27th, 2022. 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 raw pika dataframe contained information for each pika capture, but through the wrangling process additional dataframes were generated to summarize general trends. This included annual pika counts and average annual flea/mite abundance. The raw climate dataframe included daily observations, but had gaps in the average daily temperature measurements. Interpolation was used to create a new "complete" dataframe which was necessary for calculating accurate mean annual temperature values.

Although not used in the formal analysis, approximate elevations for the 3 pika sampling locations were determined by using the USGS TNM Elevation Map. https://apps.nationalmap.gov/elevation/

Folder structure, file formats, and naming conventions

The Data folder contains both raw pika and climate data files (Data/Raw) and an empty processed data folder (Data/Processed) for a future researcher if they wish to fork our repository. The Code folder contains wrangling and analysis code required to generate the visualizations in the final report. The final report is located in the Output folder.

File Folder/Name	File Format
Raw Data	CSV
DataWrangling	R Markdown
DataAnalysis	R Markdown
README	Markdown and PDF
Final Report	R Markdown and PDF

Metadata

Pika Demography Data at Niwot Ridge

File/Column Name	Description
pika_demography.cr.data.csv	Raw Pika Data csv file
LTER_site	Niwot Ridge LTER Site
local_site	WK=west knoll: LL=Long Lake; ML=Mitchell Lake; CG=Cable Gate
date	date
slope_asp	slope-aspect as cardinal direction or FLAT
easting	GPS E-W coordinate as UTM easting
northing	GPS N-S coordinate as UTM northing
tag_type	A = aluminum "rabbit" tag, C = ear-notching code
code_r_ear	color code of right ear
code_l_ear	color code of left ear
num_r_ear	number of right ear, N = Notch, H = Hole, M = Mangled
num_l_ear	number of left ear, N = Notch, H = Hole, M = Mangled
weight	body weight (g)
stage	A = adult; J = juvenile
sex	sex
repro_status	P = pregnant, L = has lactated this year, T = testes detected by feel, U = no evidence
ear-mites_samp	Whether mites were collected (1=collected, 0=not collected)
ear-mite_obs	Ear mite cover: N = none, L = low (0-4 sq mm), M = medium (4-16 sq mm) or H = high (>16 sq mm)
fleas_samp	number of fleas collected
fleas_obs	number of fleas observed
tissue_samp	tissue sample collected: 1 = collected; 0 = not collected
hair_samp	hair sample collected: 1 = collected; 0 = not collected
urine_samp	urine sample collected: 1 = collected; 0 = not collected
feces_samp_dry	dry pellet fecal sample collected: 1 = collected; 0 = not collected
feces_samp_wet	wet pellet fecal sample collected: 1 = collected; 0 = not collected
feces_samp_cae	caecal fecal sample collected: 1 = collected; 0 = not collected
blood_samp_r-o	blood sample collected via retro-orbital bleeding: 1 = collected; 0 = not collected
blood_samp_ear	blood sample collected from ear: 1 = collected; 0 = not collected
smear	slide with blood smear prepared: 1 = collected; 0 = not collected
nobuto	Nobuto strip saturated with blood: 1 = collected; 0 = not collected
saliva_samp	saliva sample collected with cotton swab: 1 = collected; 0 = not collected
rectal_temp	rectal temperature (C)
neck_circ	circumference of neck (cm)
foot_length	foot length (mm)

Table 1. Niwot Ridge pika demography metadata. All pika demography data in the raw dataframe is of class "factor", with the exception of easting and northing, which are of class "integer". Adapted from Niwot Ridge LTER Metadata at https://portal.edirepository.org/nis/metadataviewer?packageid=knb-lter-nwt.8.4

Climate Data at Niwot Ridge

File/Column Name	Description	Class
d-1cr23x-cr1000.daily.ml.data.csv	Raw Climate Data csv file	
LTER_site	Niwot Ridge LTER site	Factor
local_site	C1 site	Factor
logger	data logger type (CR23X or CR1000)	Factor
date	date (yyyy-mm-dd)	Factor
year	year (yyyy)	integer
jday	Julian day	integer
airtemp_max	maximum air temperature (C)	numeric
flag_airtemp_max	flag for maximum air temperature: n=no flag; m=missing; q=questionable; e=estimated	Factor
airtemp_min	minimum air temperature (C)	numeric
flag_airtemp_min	flag for minimum air temperature: n=no flag; m=missing; q=questionable; e=estimated	Factor
airtemp_avg	average air temperature (C)	numeric
flag_airtemp_avg	flag for average air temperature: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_max	maximum relative humidity (Percent)	numeric
flag_rh_max	flag for maximum relative humidity: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_min	minimum relative humidity (Percent)	numeric
flag_rh_min	flag for minimum relative humidity: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_avg	average relative humidity (Percent)	numeric
flag_rh_avg	flag for average relative humidity: n=no flag; m=missing; q=questionable; e=estimated	Factor
bp_max	maximum barometric pressure (Millibars)	numeric
flag_bp_max	flag for maximum barometric pressure: n=no flag; m=missing; q=questionable; e=estimated	Factor
bp_min	minimum barometric pressure (Millibars)	numeric
flag_bp_min	flag for minimum barometric pressure: n=no flag; m=missing; q=questionable; e=estimated	Factor
bp_avg	average barometric pressure (Millibars)	numeric

File/Column Name	Description	Class
flag_bp_avg	flag for average barometric pressure: n=no flag; m=missing; q=questionable; e=estimated	Factor
ws_max	maximum wind speed (m/s)	numeric
flag_ws_max	flag for maximum wind speed: n=no flag; m=missing; q=questionable; e=estimated	Factor
ws_min	minimum wind speed (m/s)	numeric
flag_ws_min	flag for minimum wind speed: n=no flag; m=missing; q=questionable; e=estimated	Factor
ws_avg	average wind speed (m/s)	numeric
flag_ws_avg	flag for average wind speed: n=no flag; m=missing; q=questionable; e=estimated	Factor
wd	average wind direction (degree)	numeric
flag_wd	flag for average wind direction: n=no flag; m=missing; q=questionable; e=estimated	Factor
solrad_avg (Watt/mˆ2)		numeric
flag_solrad_avg	flag for average solar radiation: n=no flag; m=missing; q=questionable; e=estimated	Factor
solrad_tot	total solar radiation (Watt/mˆ2)	numeric
flag_solrad_tot	flag for total solar radiation: n=no flag; m=missing; q=questionable; e=estimated	Factor
soiltemp_5cm_avg	average soil temperature at 5cm (C)	numeric
flag_soiltemp_5cm_avg	flag for soil temp at 5cm: n=no flag; m=missing; q=questionable; e=estimated	Factor
soilmoist_5cm_avg	average soil moisture at 5cm	numeric
flag_soilmoist_5cm_avg	flag for soil moisture at 5cm: n=no flag; m=missing; q=questionable; e=estimated	Factor
airtemp_hmp1_max	maximum air temperature sensor 1 (C)	numeric
flag_airtemp_hmp1_max	flag for maximum air temperature sensor 1: n=no flag; m=missing; q=questionable; e=estimated	Factor
airtemp_hmp1_min	q=questionable; e=estimated minimum air temperature sensor 1 (C)	numeric
flag_airtemp_hmp1_min	flag for minimum air temperature sensor 1: n=no flag; m=missing; q=questionable; e=estimated	Factor
airtemp_hmp1_avg	average air temperature sensor 1 (C)	numeric
flag_airtemp_hmp1_avg	flag for average air temperature sensor 1: n=no flag; m=missing; q=questionable; e=estimated	Factor

File/Column Name	Description	Class
airtemp_hmp2_max	maximum air temperature sensor 2 (C)	numeric
flag_airtemp_hmp2_max	flag for maximum air temperature sensor 2: n=no flag; m=missing; q=questionable; e=estimated	Factor
airtemp_hmp2_min	minimum air temperature sensor 2 (C)	numeric
flag_airtemp_hmp2_min	flag for minimum air temperature sensor 2: n=no flag; m=missing; q=questionable; e=estimated	Factor
airtemp_hmp2_avg	average air temperature sensor 2 (C)	numeric
flag_airtemp_hmp2_avg	flag for average air temperature sensor 2: n=no flag; m=missing; q=questionable; e=estimated	Factor
airtemp_hmp3_max	maximum air temperature sensor 3 (C)	numeric
flag_airtemp_hmp3_max	flag for maximum air temperature sensor 3: n=no flag; m=missing; q=questionable; e=estimated	Factor
airtemp_hmp3_min	minimum air temperature sensor 3 (C)	numeric
flag_airtemp_hmp3_min	flag for minimum air temperature sensor 3: n=no flag; m=missing; q=questionable; e=estimated	Factor
airtemp_hmp3_avg	average air temperature sensor 3 (C)	numeric
flag_airtemp_hmp3_avg	flag for average air temperature sensor 3: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_hmp1_max	maximum relative humidity sensor 1 (Percent)	numeric
flag_rh_hmp1_max	flag for maximum relative humidity sensor 1: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_hmp1_min	minimum relative humidity sensor 1 (Percent)	numeric
flag_rh_hmp1_min	flag for minimum relative humidity sensor 1: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_hmp1_avg	average relative humidity sensor 1 (Percent)	numeric
flag_rh_hmp1_avg	flag for average relative humidity sensor 1: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_hmp2_max	maximum relative humidity sensor 2 (Percent)	numeric

File/Column Name	Description	Class
flag_rh_hmp2_max	flag for maximum relative humidity sensor 2: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_hmp2_min	minimum relative humidity sensor 2 (Percent)	numeric
flag_rh_hmp2_min	flag for minimum relative humidity sensor 2: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_hmp2_avg	average relative humidity sensor 2 (Percent)	numeric
flag_rh_hmp2_avg	flag for average relative humidity sensor 2: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_hmp3_max	maximum relative humidity sensor 3 (Percent)	numeric
flag_rh_hmp3_max	flag for maximum relative humidity sensor 3: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_hmp3_min	minimum relative humidity sensor 3 (Percent)	numeric
flag_rh_hmp3_min	flag for minimum relative humidity sensor 3: n=no flag; m=missing; q=questionable; e=estimated	Factor
rh_hmp3_avg	average relative humidity sensor 3 (Percent)	numeric
flag_rh_hmp3_avg	flag for average relative humidity sensor 3: n=no flag; m=missing; q=questionable; e=estimated	Factor

Table 2. Niwot Ridge climate metadata. Adapted from Niwot Ridge LTER Metadata at https://portal.edirepository.org/nis/metadataviewer?packageid=knb-lter-nwt.402.5

Scripts and code

All code required for generating the visualizations in the final report is contained in the Code folder. Code is divided into Data Wrangling and Data Analysis Rmd files.

Quality assurance/quality control

Although no formal QA/QC analysis was conducted, pika demography data was initially examined to account for equal sampling effort between years. Each year contained at least one bout per Niwot Ridge location (West Knoll, Long Lake, Mitchell Lake) and no year contained a large enough number of captures to be considered an outlier. Missing temperature data was replaced using interpolation rather than excluding values outright, because it was clear the timeline of the missing data was not consistent between years. For example, 2012 was missing a large portion of summer temperatures while 2018 contained all temperatures.