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Long-term data suggest a severe decline in recruitment of the American pika on Niwot Ridge, Boulder County, Colorado

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ABSTRACT

Climate-mediated range shifts have been documented for many species, but details of the demographic response to climate—useful for inferring causation—are often lacking. We used data from the Niwot Ridge Long Term Ecological Research site (NWT LTER, Boulder County, Colorado) to explore demographic trends in the American pika, a species that has disappeared from portions of its range. Pikas were captured, weighed, and classified by stage from 1981 to 1990, in 2004, and from 2008 to 2020. Parturition dates were estimated for each juvenile, using a growth curve developed for this population. Trends in pika recruitment were estimated using generalized linear models to test for a decline in recruitment with year and with a metric of warm-season temperature (growing degree-days) calculated from NWT LTER sensor data. Our metric of recruitment (the annual number of juveniles per capture) fell by over 50 percent during the study, declining inversely with year and with growing degree-days. This decline was not confounded by changes in the phenology of pika parturition or trapping dates, both of which remained stable throughout the study. Together, these results suggest that recruitment is in decline with warming temperatures on Niwot Ridge, providing the first evidence of support for recent projections of climate-mediated pika losses in nearby Rocky Mountain National Park.

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Introduction

The distributions of many species are expected to contract or collapse as the rate of climate change exceeds the potential for adaptive evolution (Visser 2008; Schiffers et al. 2013; Martin et al. 2023). Formal range projections are often based on a species distribution model (SDM), using a species' current or past climate associations to project its range under future climate scenarios (Guisan and Thuiller 2005; Wiens and Zelinka 2024). Such correlative models can work well when fitted to data that represent key features in the projected climate, but predicting a species' response to novel climatic conditions can require a more mechanistic approach (Araújo and Guisan 2006; Buckley 2008; Charney et al. 2021), such as estimating climate-mediated demographic rates (Holt et al. 2005; Pagel and Schurr 2012). Relating a species' demographic rates to climate requires either long-term study or a space-for-time substitution in which demographic rates are measured across different climates. However, space-for-time substitutions necessarily introduce myriad changes in variables other than climate. Here, we present evidence in support of a recent SDM by analyzing results from a long-term demographic study in a location known to have experienced a change in climate during the study period.

The American pika (*Ochotona princeps*; hereafter "pika") is a small, cold-adapted mammal related to rabbits and hares that has long been the subject of distributional studies, perhaps most notably as one of the "mammals on mountaintops" isolated in the Western United States as relics of the last ice age (Brown 1971; Grayson 2005). This species inhabits rocky debris and especially rock-ice features in montane settings (Hafner 1993, 1994; Millar and Westfall 2010). Although still broadly distributed throughout its former range (Galbreath, Hafner, and Zamudio 2009; A. B. Smith et al. 2019), the pika has been lost from many warmer and lower-elevation habitats (Beever, Brussard, and

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Berger 2003; Nichols, Klingler, and Peacock 2016; Billman et al. 2021; Beever et al. 2025) and has been selected as a climate change indicator species (Garrett et al. 2011) due to its apparent dependence on the disappearing cryosphere (Fountain et al. 2012). Across most of its range, the pika requires snow cover for insulation during the cold season, as well as warm-season access to cool subsurface spaces—like those found in rock glaciers (Barsch 1996; Leopold et al. 2011, 2015; Millar, Westfall, and Delany 2013, 2014)—where it can shed heat passively (Millar, Westfall, and Delany 2016). These requirements derive from the pika's high metabolic rate and low thermal conductance, which combine to maintain a very high resting body temperature (MacArthur and Wang 1973). Though these adaptations allow pikas to survive long winters without hibernation, they also limit pika surface activity during the warm season (MacArthur and Wang 1974).

Recent pika range dynamics appear to be driven by both temperature and precipitation, in a pattern expected or observed for many montane species (McCain and Colwell 2011; McCain, King, and Szewczyk 2021). Local pika extinctions have occurred mainly at sites with warmer summer temperatures or where winter snowpack appears to be insufficient for insulating pikas from extreme cold (Beever et al. 2010, 2011; Ray, Beever, and Loarie 2012; Johnston et al. 2019; Billman et al. 2021; Beever et al. 2025). Pikas are also more commonly detected in relatively mesic sites such as where taluses are surrounded by forbs rather than xeric-adapted grasses, providing indirect evidence that precipitation limits their distribution (Rodhouse et al. 2010; Erb, Ray, and Guralnick 2011; Wilkening et al. 2011; J. A. Smith and Erb 2013; Ray, Beever, and Rodhouse 2016; Johnston et al. 2019).

SDMs of pika occurrence in talus habitats have forecast widespread declines across the Western United States (Galbreath, Hafner, and Zamudio 2009; Calkins et al. 2012; Ray et al. 2012; Stewart et al. 2015), with remnant populations expected to persist mainly in the Cascade Mountains (spanning the western end of the U.S.–Canada border), and in a portion of the southern Rocky Mountains (Colorado). However, these early forecasts were based solely on habitat suitability, without accounting for pika dispersal and capacity to recolonize habitats after local extirpation. A more recent forecast for Rocky Mountain National Park (RMNP, Colorado) by Schwalm et al. (2016) incorporated genetic estimates of pika dispersal capacity (Castillo et al. 2016) and predicted dramatic declines in pika habitat occupancy during this century, possibly due to climatic changes that should reduce the ability of juvenile pikas to colonize empty habitats. To evaluate this forecast, we analyzed pika demographic data from two studies conducted at the Niwot Ridge Long Term Ecological Research site (NWT LTER; Boulder County, Colorado), which is located less than 20 km south of RMNP. Our study integrates historical (1981–1990) and recent (2004–2020) demographic data spanning forty years to infer regionally relevant trends in juvenile pika recruitment, using generalized linear models to relate the number of juveniles captured to summer temperature and year, while accounting for interannual variation in trapping effort and phenology, including trapping dates and the timing of parturition. Given the rapid and dramatic pika losses predicted for RMNP (Schwalm et al. 2016), our expectation was that pika recruitment on nearby Niwot Ridge has declined with climate warming over the past forty years.

We used demographic data from outside RMNP to evaluate the park-specific forecast of Schwalm et al. (2016) for several reasons. First, no comparable data were available from within the park. Second, using data from an area adjacent to the park could serve as a test of SDM transferability (Araújo and Guisan 2006). A third motivation for this study resulted in part from the NWT LTER mission to provide the knowledge and predictive understanding necessary to conserve, protect, and manage mountain ecosystems, their biodiversity, and the services they provide. Early in his tenure as lead investigator of the NWT LTER, Mark Williams (University of Colorado Boulder, pers. comm.) recognized that extending the historical study of pika demography at NWT was one way to expand the taxonomic breadth of ecological inference contributed by his group. Williams provided opportunities for incorporating this study into NWT LTER proposals to the National Science Foundation and advanced the pika as a likely casualty of the disappearing cryosphere (Fountain et al. 2012).

Methods

Study system

We studied pikas living above treeline within the NWT LTER, where they occupy taluses generated by freeze–thaw processes and glacial activity. Like other lagomorphs, pikas do not hibernate and must continue to feed throughout the winter (Chapman and Flux 1990). However, unlike rabbits and hares that forage widely on growing or dormant vegetation year-round, each pika collects a "haypile" of vegetation cached during the growing season for overwinter consumption (Chapman and Flux 1990). Insulated from subfreezing air temperatures by its fur and a blanket of snow, a pika can survive in situ for nine months or more by feeding

on its haypile (Dearing 1997). These adaptations allow pikas to adopt the relatively sedentary strategy of a central-place forager (Huntly, Smith, and Ivins 1986). Genetic studies suggest that juvenile pikas typically settle in the nearest open territory they can find and rarely disperse more than a few kilometers during their one-time "natal" dispersal event (Peacock and Smith 1997; Castillo et al. 2016). Successful dispersal culminates in the establishment of a permanent territory that will be defended for life, and successful defense of the territory around this haypile likely contributes to a pika's over-winter survival and reproductive success in the following spring (A. T. Smith and Weston 1990). The pika's territorial nature and conspicuous haypiles make it an excellent target for mark–recapture or mark–resight studies of survival. Traps can be set near haypiles to target specific pikas, and marked pikas can be resighted reliably within their territories, which are typically small (~20 m in diameter) and free of tall/dense vegetation (A. T. Smith and Weston 1990).

Pika data

All pika data in this analysis derive from a well-studied pika population inhabiting the West Knoll of Niwot Ridge (40°3′24″ N, 105°35′45″ W; Boulder County, Colorado) at locations averaging 3,612 m.a.s.l. (Ray and NWT LTER 2025). Trapping protocols during the historical (1981–1990) study were drawn from NWT LTER reports (Halfpenny et al. 1984; Auerbach, Halfpenny, and Taylor 1987) and from interviews with James Halfpenny (14 February 2014) and Carron Meaney (23 July 2024). Trapping protocols during the recent (2004–2020) study are summarized in Wilkening and Ray (2016).

During both the first (historical) and second (recent) studies, trapping was conducted in the snow-free season using wire mesh live traps placed selectively on the West Knoll in areas with evidence of pika activity (fresh haypiles or fresh scat in addition to pika detections). Each trap was sheltered under a layer of rocks to enhance trap success and protect trapped pikas from weather and predators. Traps were open only during daylight hours, typically from dawn until early afternoon, and were checked at 2-hour intervals. Each pika captured was tagged using color-coded rabbit ear tags and released after recording its weight, sex, reproductive status, and stage (juvenile or adult; Figure 1). Juveniles were distinguished from adults based on several metrics including size, proportions, pelage, molt characteristics, and pitch of vocalizations, most of which tended to be diagnostic on Niwot Ridge throughout the trapping season (Krear 1965).

Several aspects of the trapping protocol differed somewhat between study periods. Though traps were reportedly baited with slices of fresh apple during the first study, we provisioned traps mainly with fresh native vegetation during the second study. Early in the second study, we experimented with adding apple slices and several other potential baits (other fruits and vegetables, alfalfa, salt licks, mirrors, and playbacks) to selected traps, but we found no clear advantage to any of these baits. Pikas appeared to enter empty traps as readily as baited ones, and apple slices in particular attracted non-target species, so we settled on provisioning traps with forage commonly observed in the summer diet of pikas on the West Knoll (mainly graminoids, such as *Carex* species and *Deschampsia cespitosa*; Dearing 1996), which we harvested primarily from the NWT LTER access road and beyond the reach of any foraging pikas (to avoid depleting pika resources).

Figure 1. American pika juvenile (a) and adult (b) in Rocky Mountain National Park. Photos by Dick Orleans (a) and Neal Zaun (b).

The number of trapping days and the timing of trapping dates also varied between studies and between years within studies. During the first study, trapping generally continued until no new pikas were captured (mean = 17 days, range = 7–28), and mean annual capture dates ranged from 6 July to 16 August (contrary to the originally archived metadata, which reported "a 10-day census period beginning around 15 August"). Less trapping occurred during the second study, when the West Knoll was only one of several pika research sites (Bhattacharyya and Ray 2015; Wilkening et al. 2015; Wilkening and Ray 2016; Wilkening, Ray, and Sweazea 2013; Benedict et al. 2020; Klingler et al. 2021; Whipple et al. 2021, 2022). To accommodate these additional studies, West Knoll trapping occurred on fewer days (mean = 4 days, range = 1–10) and mean annual capture dates ranged from 15 June to 21 September.

Finally, because trapping effort and trap coordinates were not recorded during the first study, we could not replicate these features during the second study. However, traps in both studies were selectively placed where evidence of pikas existed, which included haypile sites with fresh hay and/or fresh pika scat and sites where pikas were detected directly by sight or sound. Although the locations of pika haypile sites appeared to be stable across these studies, based on rusted markers discovered at most hay sites in 2004, we were not certain that each marked position was trapped in each year of the first study. During the second study, we simply conducted the maximum trapping effort possible given our resources and our ability to locate sites with pikas or pika sign. We accounted for these differences between studies using model-based inference as described in the Analyses subsection.

Original data on all species and individuals captured during the first study period, including other small mammals trapped using other methods, are available at https://doi.org/10.6073/pasta/129b75c156d4e825e691b6d5ed401300. An additional, quality-controlled data set (pikas_no_recap.cr.data.csv) is available through the same link, under the title "Pika data cleared of recaptures." This data set, which we derived through examination of the original data, includes only year-unique pika captures from the first study. Original data on year-unique pika captures from the second study are available at https://doi.org/10.6073/pasta/16f051004ae350d029a68c41723fdecf. Our pika trapping, handling, and sampling protocol (#2681) was approved by the University of Colorado Institutional Animal Care and Use Committee, and annual trapping licenses were obtained from Colorado Parks and Wildlife (Control #TR2014).

Temperature data

The NWT LTER has collected daily air temperature since 1981 at a station adjacent to the West Knoll in a topographic feature known as "the saddle" located at 3,525 m.a.s.l. We used a quality-controlled, gap-filled, daily time series of maximum, average, minimum, and diurnal air temperatures from the saddle station that accounts for instrument turnover, available for 1986 to 2020 temperatures at https://doi.org/10.6073/pasta/49a2171ec028c4ddef298752bc9ebe8d (White, Morse, Chowanski et al. 2025), combined with similar but provisional data from this same station, available for 1981 to 1985 temperatures at https://portal.edirepository.org/nis/mapbrowse?packageid=knb-lter-nwt.315.4.

Growing degree-days (GDD), calculated as the annual sum of daily mean temperatures above 0°C, has been used broadly as a predictor of biotic and abiotic processes across the NWT LTER (U.S. National Science Foundation 2022). In addition to being vetted as a long-term metric of climate at NWT, GDD has been correlated with pika losses elsewhere (Beever et al. 2016) and correlates with other summer temperature metrics previously used to explain pika habitat occupancy and population persistence across the species' range (summarized most recently in Table S1 of Billman et al. 2021). For these reasons, we used GDD to characterize the trend in temperature across our time series. Our purpose was not only to suggest that GDD might have direct effects on pika recruitment (through forage quality or effects of growing season temperature or duration on pika physiology) but to determine whether recruitment can be explained by a predictor variable that is not wholly confounded with study period, to help evaluate the argument that any relationship between recruitment and year might be explained fully by differences in study protocol. Code for calculating GDD from NWT LTER data appears in Online Supplement 1.

Analyses

We used generalized linear models to test the prediction that pika recruitment has declined over time and with local warming. Specifically, we modeled our response variable (the yearly count of juveniles captured) as an overdispersed Poisson function of fixed effects (year or GDD) plus an offset (the yearly count of all captures) to account for variation among years in the number of

opportunities to capture a juvenile. This formulation accounted for the quasi-Poisson distribution of our response variable (an overdispersed count) as well as yearly variation in a metric of trapping effort.

We further accounted for (1) the annual timing of captures, because if capture date trended later in successive years juveniles might be larger when captured and might be mistaken as adults, and (2) parturition date, because if pikas were born earlier in successive years that might also cause them to be larger when captured. We estimated pika parturition dates using a growth curve developed for this population during the first study (Golian and Whitworth 1985), as detailed in Supplement S1. Briefly, this growth curve was based on both captive and wild pikas (all derived from the West Knoll population), allowing the authors to estimate gains in body weight over the entire range of juvenile development, including the period during which juvenile pikas are not yet active (and cannot be sampled) on the surface of their talus habitats.

All analyses and plots were prepared in R (R Core Team 2024).

Results

GDD increased significantly with year in the saddle adjacent to the West Knoll pika population (Figure S1). The expected value of GDD increased by over one-third, from less than 900 in 1982 to more than 1,200 in 2020.

Mean annual capture date did not vary significantly over time (Figure S2; linear model adjusted $R^2 = -0.03$, F-statistic = 0.32 on 1 and 22 degrees of freedom [df], $p = .577$) or between study periods (day-of-year mean ± standard error [SE] = 209.25 ± 2.68 and 214.62 ± 5.71 for the first and second studies, respectively; $p = .054$ by Welch's two-sample t-test, $t = -1.94$, df = 247.70).

The annual number of adult and juvenile pikas captured differed tenfold between study periods and was higher in the first study (gray-shaded rows in Table 1). In contrast, the mean number of trapping days per year was less than fivefold higher in the first study (mean ± SE = 16.80 ± 2.51) than in the second study (mean ± SE = 3.71 ± 0.62).

There was a strong decline in juvenile recruitment over the period spanning both studies (Figure 2). This relationship was highly significant ($p < .001$; residual deviance = 23.52 on 22 df) regardless of whether an identified outlier (open dot) was included in the fit. This outlier in 2018 might be ascribed to sampling error associated with extremely small sample size: Due to logistics, our trapping effort was lower than usual in 2018, resulting in the capture of only five pikas, including only two adults (Table 1), which was much lower than the average number of captures during the second study (mean ± SE = 13.00 ± 1.44). However, all results presented here include the 2018 data.

Pika recruitment also declined significantly with GDD ($p < .001$; residual deviance 26.85 on 21 df; Figure 3). Much of this decline appeared to occur during the first study period (black dots), but a quasi-Poisson regression

Table 1. American pika data from two studies conducted on the West Knoll of Niwot Ridge, Colorado, USA (1981–1990 in gray and 2004–2020).

Year	Mean capture date (day of year)	Adults captured	Juveniles captured	Number of juveniles weighed	Mean juvenile weight (g)	Standard deviation of juvenile weight
1981	198.92	33	29	29	98.38	27.27
1982	212.74	26	38	33	106.82	28.10
1983	205.16	28	39	39	97.17	31.72
1984	201.61	29	63	63	103.38	26.27
1985	187.30	28	36	36	100.81	26.41
1986	203.60	17	13	13	71.54	13.92
1987	224.51	17	23	23	122.09	17.60
1988	226.28	25	11	11	129.00	26.71
1989	222.53	26	32	30	127.08	21.55
1990	227.54	29	16	16	125.88	16.49
2004	254.00	5	3	3	121.67	13.01
2006	220.18	8	3	3	116.67	23.09
2008	209.95	16	6	6	77.17	31.48
2010	202.33	12	6	4	86.75	13.10
2011	198.00	19	2	2	59.00	16.97
2012	166.30	8	2	2	102.00	42.43
2013	189.08	11	1	1	96.00	NA
2014	231.13	10	4	4	96.75	11.44
2015	245.80	4	5	3	122.00	26.46
2016	263.75	4	2	2	116.50	0.71
2017	197.08	9	3	3	94.33	21.08
2018	193.00	2	3	3	107.00	9.54
2019	222.32	13	6	5	112.00	38.84
2020	224.19	11	4	4	136.75	27.04

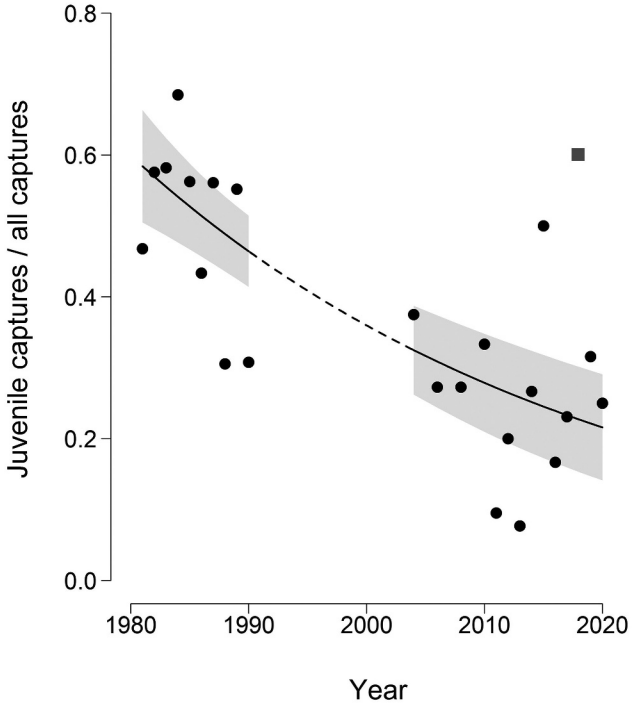

Figure 2. Temporal trend in a measure of American pika recruitment, the proportion of juveniles captures, across two study periods (1980–1990 and 2004–2020) on the West Knoll of Niwot Ridge, Colorado, USA. The curve represents mean recruitment over time according to a quasi-Poisson regression through all points shown, including the point in 2018 (square symbol) when sample size was exceptionally low (see text). Dashes indicate the gap between study periods and shaded areas represent 95 percent confidence bounds.

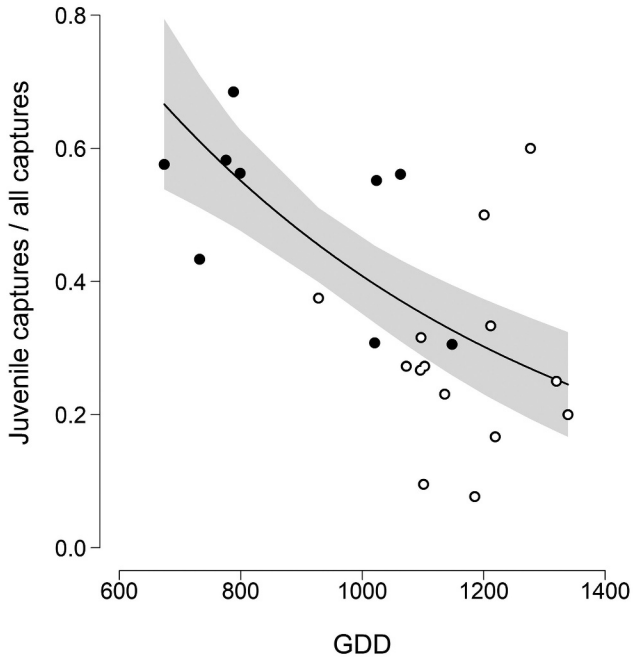

Figure 3. Trend in American pika recruitment with GDD on the West Knoll of Niwot Ridge, Colorado, USA, fitted by quasi-Poisson regression (curve = mean, shaded region = 95 percent confidence bounds) through data from two study periods: 1982–1990 (filled dots) and 2004–2020 (open dots). Pika capture data from 1981 were omitted because GDD was calculated from temperatures measured near the West Knoll since 1982.

of data from 1982 to 1990 did not indicate a significant relationship between recruitment and GDD (p = .111).

We found no evidence for a temporal trend in capture date (p = .577; Figure S2) that might have led to misclassification of juveniles as adults if capture dates trended later in the year. We also found no evidence of a trend in parturition date over time or with GDD (Figure 4) that might have led to larger juveniles in the second study. In addition, juvenile weights did not differ between studies (mean ± SE = 106.80 ± 2.81 g and 103.11 ± 4.80 g for the first and second studies, respectively; p = .432 by Welch's two-sample t-test, t = 0.79, df = 57.70).

Discussion

Over the past forty years, American pika recruitment appears to have plummeted more than 50 percent in at least one study site at a core of the species' distribution. The decline in pika captures between first and second study periods was likely due in large part to the unmeasured decline in trapping effort between periods, but the striking decline in juvenile captures relative to all pika captures at least suggests that recruitment has fallen on the West Knoll of Niwot Ridge.

Our goal in this study was to synthesize data from sequential studies to infer whether there has been a significant decline in recruitment that is congruent with the recent forecast of climate-mediated pika decline in RMNP (Schwalm et al. 2016). We did not aim to discover the precise driver of this decline, given the disparate data available, but rather to determine whether climate change might be a viable hypothesis that should be investigated further by studies more suited for causal inference. Our findings certainly suggest the need to consider that pika populations might soon be lost from some locations in the southern Rockies, in apparent agreement with Schwalm et al.'s (2016) forecast.

Our concern that a decline in recruitment could lead to pika population collapse stems from longstanding evidence that the American pika exhibits "classic" metapopulation dynamics (Peacock and Smith 1997; A. T. Smith and Gilpin 1997; Moilanen, Smith, and Hanski 1998). A classic metapopulation includes many small, extinction-prone populations connected by infrequent dispersal that counters local extinction through

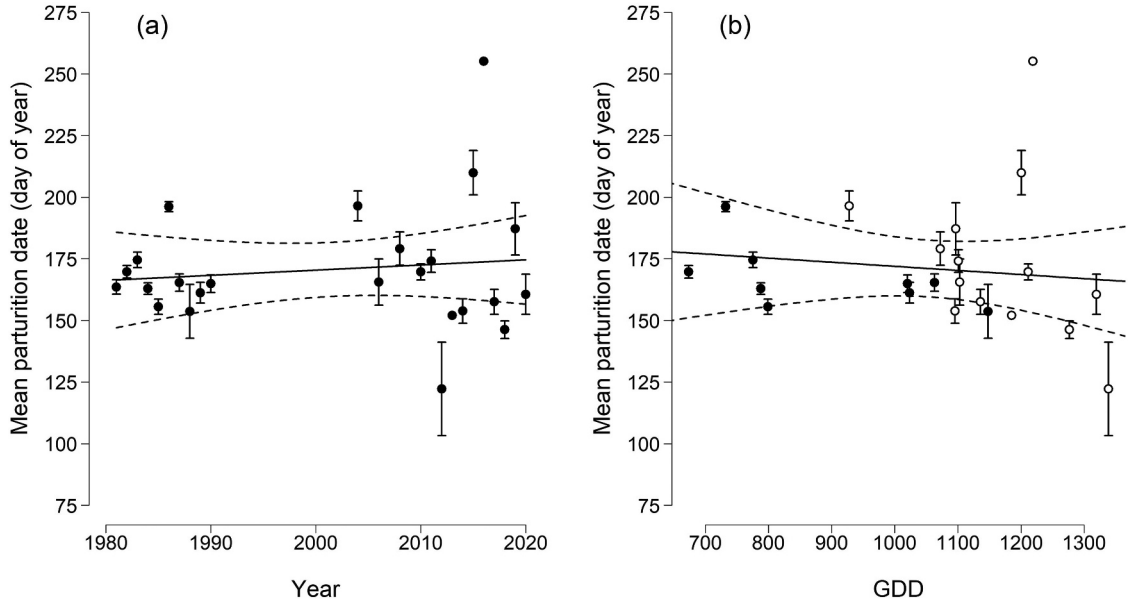

Figure 4. Linear relationships between a mean parturition date estimate and year (a) or GDD (b) for the American pika on Niwot Ridge, Colorado, USA. Data from 1982–1990 (filled circles) and 2004–2020 (open circles) are differentiated in (b) to illustrate any dependence of parturition date or GDD on study period. Because GDD was not available for 1981, sample size was twenty-four in (a) and twenty-three in (b).

colonization of empty patches (Levins 1969). When the metapopulation and its constituent populations are small enough, stochastic events can disrupt the balance between local extinction and colonization, resulting in metapopulation-level extinction (Gilpin 1987). The American pika's territorial behavior, combined with the patchiness of its obligate habitat (taluses), results in small and dispersed populations that are prone to extirpation in the absence of sufficient connectivity. Connectivity between pika populations, which depends solely on the natal dispersal of juveniles, has been shown —using genetic analyses—to decline during interglacial periods of warmer climate (Galbreath, Hafner, and Zamudio 2009).

Castillo et al. (2016) suggested, based on genetic patterns of connectivity in RMNP, that juvenile pikas might be less likely to traverse lower elevations and south-facing slopes in a warmer climate. The relationship we observed between recruitment and GDD suggests that warming and/or earlier summers might limit dispersal, especially if a significant proportion of juveniles on the West Knoll must immigrate from other habitats. Such a constraint on immigration might help explain the large number of unoccupied territories on the West Knoll in recent years (Hill 2021). In any case, recent immigration and local recruitment have not been sufficient to fill these territories.

An alternative hypothesis for the relationship between apparent recruitment and GDD on the West Knoll is that adult survival has increased enough to suppress local recruitment. Estimating survival from these data will be complicated by the lack of data on trapping effort and trap locations during the first study and by small annual sample sizes during the second study, but we can suggest the trend in adult survival from the apparent trend in occupancy of territories at this site. If adult survival were high, the pika's territorial behavior (Krear 1965; A. T. Smith and Ivins 1983, 1984) should result in a lack of open territories, causing more juveniles to emigrate (Southwick et al. 1986) and removing them from the pool of individuals available for capture. Conversely, if adult survival were low, more territories should be available for juveniles to settle, boosting the number of juveniles available for capture. By this argument, the rate of juvenile captures would be expected to decline over time only if the adult survival rate were lower during the first study than during the second study. However, the population on the West Knoll from 1981 to 1983 averaged 7.97 ± 1.01 pikas/ha, which was among the highest reported in the region and across the literature (Southwick et al. 1986). In contrast, we observed many unoccupied territories on the West Knoll during the second study period (Hill 2021), and our impressions of population density—based on behavioral observation of tagged pikas (Benedict et al. 2020) and the low density of suitable trapping sites—was certainly lower than reported by Southwick et al. (1986). If more territories are available for pika settlement today than forty years ago, it seems unlikely that adult survival is higher today or that juveniles are dispersing before we can capture them.

In a broader context, recent re-surveys of pika habitat occupancy throughout the Rocky Mountains also suggest that many formerly occupied sites are now unoccupied (Billman et al. 2021; Beever et al. 2025).

Another hypothesis is that trapping occurred later in the year during the second study, resulting in larger juveniles that might possibly be mistaken for adults. Mean trapping date averaged more than five days later during the recent study, a shift that was nearly significant when the data were grouped for a nonparametric *t*-test. But we found no evidence of a trend in trapping date over time when using linear regression to take advantage of the statistical power available in this long time series. Recall also that determinations of pika stage were often based on several metrics other than size, including physical proportions, pelage, molt characteristics, pitch of vocalizations, and behavior. Depending on dates of parturition, most of these metrics can differ markedly between juveniles and adults well into September on Niwot Ridge (Krear 1965).

Yet another hypothesis is that juveniles were less likely to enter traps during the second study period, perhaps because they were more attracted by baits used in the first study. Although studying the efficacy of trap baits might be warranted for pikas (Johanna Varner, Colorado Mesa University, pers. comm.), we have experimented with many baits at this and other study sites (Chris Ray, University of Colorado Boulder, unpublished data), with little evidence for bait preferences in this generalist herbivore and no evidence of stage-based bait preferences. Related hypotheses, such as juvenile reticence to enter traps due to higher real or perceived risk from predators or humans in the trapping vicinity, should also be considered.

An additional hypothesis raised in review was that traps might have been placed closer to haypiles in the second study, biasing captures toward adult territory owners. Our experience is that juveniles, when present, are likely to occur as close to haypiles as adults, which might preclude this potential bias. Nevertheless, this hypothesis exemplifies the possibilities that can be difficult to reject if the details of a previous—or evolving—research protocol are lost to time. Curating these details will become increasingly important as public repositories accumulate data with potential utility for longitudinal analyses.

In the absence of complete information, a situation familiar to ecologists, we note that we were able to proceed with this analysis due to the statistical power inherent in long-term data, the curation of localized climatic data suitable for longitudinal analyses, and the existence of auxiliary products (growth curves) appropriate for exploring alternative hypotheses. These three elements, and the potential to continue data collection and model development, derive directly from the LTER mission and the researchers who have engaged with it.

Conclusion

Both year and GDD were strong predictors of American pika recruitment on Niwot Ridge over the past forty years. These results are not due to a shift in capture dates or pika parturition dates across years. We conclude that these observations are congruent with a recent forecast of severe, climate-mediated reductions in pika occupancy within nearby Rocky Mountain National Park. Pikas depend on cool microclimates to shed heat during the warm season, which is also the dispersal season for this species. Further research is needed to determine whether these microclimates, linked to the disappearing cryosphere, no longer occur frequently enough in the landscape of the southern Rockies to ensure the successful dispersal of pikas and sufficient connectivity of pika populations to maintain demographic and genetic viability.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The data analyzed for this study are openly available in the Environmental Data Initiative repository at https://portal.edirepository.org/nis/mapbrowse?packageid=knb-lter-nwt.43.5 ((historical pika demography; Halfpenny, Ray, NWT LTER 2025), https://portal.edirepository.org/nis/mapbrowse?packageid=knb-lter-nwt.8.8 (recent pika demography; Ray 2024), https://portal.edirepository.org/nis/mapbrowse?packageid=knb-lter-nwt.413.14 (981–1985 temperatures; Morse and Losleben 2023), and https://portal.edirepository.org/nis/mapbrowse?packageid=knb-lter-nwt.314.4 (-1986–2020 temperatures; White, Morse, Brandes, et al. 2025).

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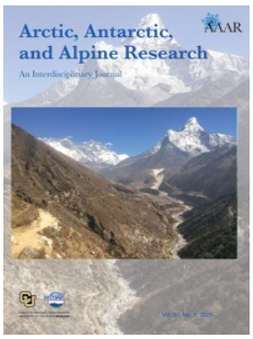

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