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Distribution and Climatic Relationships of the American Pika (*Ochotona princeps*) in the Sierra Nevada and Western Great Basin, U.S.A.; Periglacial Landforms as Refugia in Warming Climates. Comment

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Millar and Westfall (2010) surveyed for the presence of American pikas in study regions in the Sierra Nevada (SN), southwest Great Basin (swGB), and central Great Basin (cGB) in 2007–2009, and they added valuable information on site locations with recent pika occupancy, pika use of rock-ice geomorphic features, and surface temperature and precipitation conditions near pika-occupied sites. However, Millar and Westfall (2010) overreached their data in making the unsupported conclusion that "[i]n contrast to studies that document species vulnerability elsewhere, pikas in the SN and swGB appear to be *thriving* and *tolerating* a wide range of thermal environments" (p. 76, emphasis added). Millar and Westfall's (2010) one-time surveys do not permit an assessment of whether pikas are thriving, stable, or declining in their study regions, which would require an examination of population status over time. Further, Millar and Westfall's (2010) study does not adequately characterize the range of thermal environments that pikas are experiencing, nor do they show that pikas are tolerating these temperatures.

Millar and Westfall's (2010) conclusions have already had direct bearing on pika management and conservation decisions. The American pika has been identified as a species that appears particularly vulnerable to climate change, especially in the SN and GB where climate-mediated extirpations have been documented (Beever et al., 2003; Grayson, 2005; Moritz et al., 2008; Galbreath et al., 2009; Beever et al., 2010; Wilkening et al., 2010), and has been considered for protection under the U.S. Endangered Species Act based on threats from climate change (U.S. Fish and Wildlife Service, 2010). Millar and Westfall's (2010) conclusions that pikas are "thriving" and "tolerating a wide range of thermal environments" were cited prominently by the U.S. Fish and Wildlife Service to support its decision not to designate the pika as a threatened or endangered species based on climate change threats (U.S. Fish and Wildlife Service [2010]: 6442, 6443, 6453, 6456, 6463). Because of their conservation and management relevance, Millar and Westfall's (2010) conclusions merit reexamination.

Conclusion 1: "Pikas in the SN and swGB appear to be thriving"

Millar and Westfall's (2010) one-time surveys provide a snapshot of where pikas are distributed currently in their SN and swGB study regions. However, these surveys do not provide sufficient information to assess whether pikas in these regions are "thriving." Thriving is defined as "growing well or vigorously"[1] and connotes population status over time. Determining whether pikas are thriving, as opposed to stable or decreasing, entails an assessment of pika population status over time that should be based on appropriate population data, such as temporal changes in site occupancy (*see* Beever et al., 2003; Moritz et al., 2008), demographic rates (*see* Ray, 2010), or density and/or population size. However, Millar and Westfall's (2010) rapid assessment simply surveyed for the presence of individual pikas or their sign in haphazardly selected (i.e., selected in a non-probabilistic manner) habitat patches, and these patches were not revisited over time. The one-time detection of a single pika or its sign does not provide information on the viability or persistence of pikas in those patches (van Horne, 1983). For example, an occupied site with a pika or pika sign could be acting as a source or sink (i.e., colonization followed by rapid extinction).

Although Millar and Westfall (2010) never discussed why they concluded that pikas are "thriving" in the SN and swGB, they might point to their finding of high recent occupancy in pika sites. Millar and Westfall (2010) classified 94% of pika site occurrences (i.e., sites with a pika or pika sign) as recently occupied. However, almost one-third of these positive occurrences had only indirect evidence of pika occupancy (i.e., pika sign such as brown fecal pellets considered to be recent) rather than the definitive evidence of pika occupancy (i.e., pika sighting, vocalization, or fresh haypile) used in other studies. Because indirect sign like pika pellets persist over time, especially in semi-arid climates, and because pellet-color changes (used as an indication of age by Millar and Westfall, 2010) may vary over regions and conditions (Nichols, 2009), the presence of brown pellets does not necessarily indicate that pikas occupied the site recently. Indeed, pellets have persisted for decades in the swGB (Nichols, 2009) and for millennia in the GB (Grayson, 2005). If pika site occupancy were to be based only on definitive evidence of pikas following other published studies (*see* Beever et al., 2003, 2010; Moritz et al., 2008), occupancy of pika sites in Millar and Westfall's (2010) study regions would fall to 77% for the SN, 35% for the swGB, and 6% for the cGB. This interpretation provides a much less optimistic picture of pika occupancy in the SN and GB.

[1] Definition provided by Merriam-Webster, Cambridge, and Oxford English dictionaries.

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Millar and Westfall (2010) also made the confusing statement that they have found a greater distribution of pikas in the SN and GB than documented in other studies: "This number, diversity of sites, occupancy, and elevational range suggest greater distribution in the SN and GB than has been found in other studies in our region" (p. 86). Although Millar and Westfall (2010) have added to the body of site locations with recent pika occupancy in the SN and GB, pikas have historically been considered widely distributed and abundant in these regions. Early- to mid-20th century natural history accounts described the pika as "widely distributed" in the SN and GB (Howell, 1924: 37), "abundant" in the SN (Howell, 1924: 44), "a common resident" in the SN (Grinnell and Storer, 1924: 218), and relatively dense in the SN: "In one typical rock slide, at the head of Lyell [Canyon], our estimates indicated a population of at least one cony for every 750 square yards. This would mean a population of about six to an acre" (Grinnell and Storer, 1924: 218). Thus, Millar and Westfall's (2010) finding that pikas are widely distributed in the SN across higher elevation habitat (i.e., 90% of all pika sites were above 2500 m) is consistent with previous accounts and museum records indicating pikas are widely distributed and occur generally above 2040 m (Stephens, 1906: 182) or 2134 m (Howell, 1924: 36) in the SN.

Finally, it is important to note that Millar and Westfall (2010) diverged from other recent pika studies (Beever et al., 2008, 2010; Wilkening et al., 2010) in defining their basic unit of analysis—the pika site occurrence. In doing so, Millar and Westfall (2010) increased their sample size but risked confounding their analyses due to pseudo-replication, and hindered comparisons with other studies. As noted by Millar and Westfall (2010) and others, three kilometers represents the approximate upper limit of typical dispersal distances for the American pika, and thus taluses within three kilometers have been considered part of the same site occurrence by other pika researchers (*see* Beever et al., 2008, 2010; Wilkening et al., 2010). In contrast, Millar and Westfall (2010) defined site occurrences as those located more than 50 m from another occurrence. Based on this definition, multiple site occurrences could presumably occur within the same habitat patch that other researchers would have treated as one site. While Millar and Westfall (2010) used 420 sites as the units of analysis, other published studies would have instead considered Millar and Westfall's (2010) 148 "demes" as the independent units of analysis (e.g., Millar and Westfall [2010] defined demes as groups of sites separated from other groups by more than three kilometers). Given that densities of pikas within the study are typically highest at the most climatically favorable sites, Millar and Westfall's (2010) definition of site occurrences may bias results of hypothesis tests regarding pika-climate relationships, although the reader cannot assess to what degree this may be true.

Conclusion 2: Pikas are "tolerating a wide range of thermal environments"

Millar and Westfall (2010) provided data on temporally and spatially averaged surface temperature and precipitation near pika sites from 1971 to 2000 for their analyses of pika-climate relationships. However, these data are not sufficient to support the conclusion that "pikas are tolerating a wide range of thermal environments" (p. 76). Millar and Westfall (2010) did not adequately characterize the range of thermal environments that pikas are experiencing, nor did they show that pikas are tolerating these conditions. Millar and Westfall's (2010) PRISM data modeled at ~800 m horizontal resolution (although the best available for the study regions) are limited in characterizing the surface microclimates experienced by pikas in mountainous, topographically complex SN and GB study regions where conditions can vary markedly over short distances (Lundquist and Cayan, 2007). Additionally, numerous studies have found that sub-talus temperatures are an important component of the pika's thermal environment since pikas retreat to cooler sub-talus environments when ambient conditions are unfavorable as part of behavioral thermoregulation (e.g., Smith, 1974; MacArthur and Wang, 1974). As demonstrated by Beever et al. (2010), sub-talus temperatures are imperfectly correlated with surface temperatures and tend to be cooler. Indeed, one of Millar and Westfall's (2010) most important findings is that most pika sites occurred in rock-ice formations that appear to host cooler-than-expected sub-talus temperatures for their elevation due to internal circulation processes and their topographic locations. However, Millar and Westfall (2010) measured sub-talus temperatures at only 5 of their 420 sites and thus fall far short of adequately characterizing the thermal environments that pikas are experiencing.

Secondly, Millar and Westfall's (2010) rapid assessment was not designed to examine whether pikas are tolerating above-talus or sub-talus thermal environments. "Tolerating" denotes exposure without adverse reaction.[2] Demonstrating thermal tolerance would require correlative or mechanistic studies on individual or population-level pika responses to temperature as exemplified by the long-term research of Wilkening et al. (2010) and Beever et al. (2010). In short, Millar and Westfall's (2010) temperature assessments are too coarse to adequately represent the temperatures that pikas are actually experiencing, and their study methods do not provide sufficient basis to determine whether pikas are tolerating these thermal environments.

Millar and Westfall's (2010) related conclusion that "pikas in our region tolerate *a wider range of temperatures and precipitation than previously interpreted*" (emphasis added, p. 84) is also perplexing. The two studies cited by Millar and Westfall (2010) to support this assertion did not seek to characterize the range of climate conditions experienced by pikas in the SN or swGB and thus do not provide an appropriate basis for comparison. Beever et al. (2008) described sub-talus temperatures for a northwestern Nevada pika site outside of the SN and swGB, while Smith (1974) provided surface temperature data near one SN pika site and one swGB pika site during 1969 to 1972. Moreover, Millar and Westfall's (2010) findings for surface temperature and precipitation at pika sites in the SN and swGB appear to fall within the climatic range reported for the species by Hafner (1993) based on surface conditions in 50 geographically distinct habitat patches. In sum, while Millar and Westfall (2010)'s broad-scale sampling provides additional information on surface-temperature and precipitation conditions near pika-occupied sites in the SN and swGB from 1971 to 2000, their results are consistent with prior studies that have found that pikas inhabit cool, higher-precipitation habitats.

Finally, in contrast to their conclusion that "pikas are tolerating a wide range of thermal environments," Millar and Westfall's (2010) findings suggest that pika distribution is being shaped by recent climate and that pikas may not be tolerating warmer and drier conditions. Millar and Westfall (2010) found a pattern of higher occupancy in (cooler, wetter) SN sites compared to (warmer, drier) GB sites. Only 6% of pika sites were definitively occupied in the cGB and 35% in the swGB, as compared to 77% in

[2] "Tolerate" is defined as "capable of continued exposure to (a drug, toxin, etc.) without adverse reaction" in the Oxford English Dictionary.

the SN. In addition, modeled climate conditions at old pika sites (i.e., those with old pika sign) were significantly warmer and drier than at recently occupied sites (Millar and Westfall 2010). Non-occurrence sites (those with no pika sign) were also significantly warmer and drier than occurrence sites (those with pikas or pika sign) (Millar and Westfall, 2010). Further underscoring the importance of recent climate, Millar and Westfall (2010) suggested that pika distribution in their region has changed over time in relation to climate conditions: ''The truncated and skewed nature of several temperature variables suggests a recent disequilibrium in pikas' range wherein sites at warmer values have been recently abandoned and a new, normally distributed range of occupation sites has not been achieved'' (p. 84).

Overall, a close examination of Millar and Westfall (2010) reveals that their data do not support the conclusion that ''pikas in the SN and swGB appear to be thriving and tolerating a wide range of thermal environments.'' Further research is needed to assess whether pikas are thriving, stable, or declining across the pika sites of Millar and Westfall (2010) and to understand how contemporary climate change may be affecting pika population dynamics at their sites. Additional studies are particularly important given evidence that temperature-mediated pika population extirpations are occurring in the GB (Beever et al., 2010; Wilkening et al., 2010) and given model projections that suggest suitable pika habitat will be largely eliminated in the SN and GB under future climate conditions (Galbreath et al, 2009).

References Cited

Beever, E. A., Brussard, P. E., and Berger, J., 2003: Patterns of apparent extirpation among isolated populations of pikas (*Ochotona princeps*) in the Great Basin. *Journal of Mammalogy*, 84: 37–54.

Beever, E. A., Wilkening, J. L., McIvor, D. E., Weber, S. S., and Brussard, P. F., 2008: American pikas (*Ochotona princeps*) in northwestern Nevada: a newly discovered population at a low-elevation site. *Western North American Naturalist*, 68: 8–14.

Beever, E. A., Ray, C., Mote, P. W., and Wilkening, J. L., 2010: Testing alternative models of climate-mediated extirpations. *Ecological Applications*, 20: 164–178.

Galbreath, K. E., Hafner, D. J., and Zamudio, K. R., 2009: When cold is better: climate-driven elevation shifts yield complex patterns of diversification and demography in an alpine specialist (American pika, *Ochotona princeps*). *Evolution*, 63(11): 2848–2863.

Grayson, D. K., 2005: A brief history of Great Basin pikas. *Journal of Biogeography*, 32: 2103–2111.

Grinnell, J., and Storer, T. I., 1924: *Animal Life in the Yosemite*. Berkeley, California: University of California Press.

Hafner, D. J., 1993: North American pika (*Ochotona princeps*) as a Late Quaternary biogeographic indicator species. *Quaternary Research*, 39: 373–380.

Howell, A. H., 1924: *Revision of the American Pikas. North American Fauna No. 47*. Washington, D.C.: U.S. Department of Agriculture Bureau of Biological Survey.

Lundquist, J. D., and Cayan, D. R., 2007: Surface temperature patterns in complex terrain: daily variations and long-term change in the central Sierra Nevada, California. *Journal of Geophysical Research*, 112: article D11124, doi:10.1029/2006JD007561.

MacArthur, R. A., and Wang, L. C. H., 1974: Behavioral thermoregulation in the pika *Ochotona princeps*: a field study using radiotelemetry. *Canadian Journal of Zoology*, 52: 353–358.

Millar, C. L., and Westfall, R. D., 2010: Distribution and climatic relationships of the American pika (*Ochotona princeps*) in the Sierra Nevada and Western Great Basin, U.S.A.; periglacial landforms as refugia in warming climates. *Arctic, Antarctic, and Alpine Research*, 42: 76–88.

Moritz, C., Patton, J. L., Conroy, C. J., Parra, J. L., White, G. C., and Beissinger, S. R., 2008: Impacts of a century of climate change on small-mammal communities in Yosemite National Park, USA. *Science*, 321: 261–264.

Nichols, L., 2009: Dating Bodie Hills pika extinctions using fecal pellets. Presentation at First Annual Meeting of the California Pika Consortium, Davis, California, 10 November 2009.

Ray, C., 2010: Demographic change and physiological stress in Rocky Mountain pikas. Presentation at First North American Pika Conference, Teton Science Schools, Jackson, Wyoming, 25–27 March 2010.

Smith, A. T., 1974: Distribution and dispersal of pikas—Influences of behavior and climate. *Ecology*, 55: 1368–1376.

Stephens, F., 1906: *California Mammals*. San Diego, California: West Coast Publishing Co.

U.S. Fish and Wildlife Service, 2010: Endangered and threatened wildlife and plants; 12-month finding on a petition to list the American pika as threatened or endangered; Proposed Rule. Federal Register, 74: 6438–6471.

van Horne, B., 1983: Density as a misleading indicator of habitat quality. *Journal of Wildlife Management*, 47: 893–901.

Wilkening, J. L., Ray, C., Beever, E. A., and Brussard, P. F., 2010: Modeling contemporary range retraction in Great Basin pikas (*Ochotona princeps*) using data on microclimate and microhabitat. *Quaternary International*. doi:10.1016/j.quaint.2010.05.004.

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