The Recent California Population Decline of the American Pika (*Ochotona princeps*) and Conservation Proposals

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Abstract

American Pikas are lagomorphs that collect plant material in the summer in order to build their haypiles that will sustain them throughout winter, since they do not hibernate. Pikas expire when they overheat, which is why they burrow in talus at high elevations in order to avoid overheating. The American Pika population is currently at risk of local extirpations due to various stressors, such as increase in global temperatures, human impact and temperature sensitivity. They are important to protect because they are an indicator species for rising temperatures in their habitat as well as ecosystem engineers for impacting the diversity gradient of plants within meadows. They are currently a Species of Concern and have not been able to be listed under the Endangered Species Act. Adaptive management is the best way to support the American Pika with persistent monitoring on their population as well as meadow vegetation. There needs to be more research, monitoring and awareness of the recent population decline of American Pika in order to help prevent them from extinction in the future.

Introduction

American Pikas (*Ochotona princeps*) are currently experiencing a significant decrease in their population and are currently at risk of local extirpation. The American Pika is distributed along mountains of the northwestern regions of North America and they live in talus and alpine habitats (Smith and Nagy, 2015). They primarily live within cracked talus rocks and are usually relatively close to alpine meadows for foraging (Ibid). Due to recent increases in fluctuating warmer temperatures that have reduced snowpack in the Pika's habitat, they have been claiming territory toward higher elevations. They are relocating in order to maintain their body temperature, since they cannot survive temperatures above seventy-eight degrees Fahrenheit (Smith and Nagy, 2015). As a result, the current habitat of the American Pika is shrinking into isolated islands at elevations above two thousand meters and they will eventually struggle to compete for territory and resources (Holtcamp, 2010). Their population is not sustainable with their dwindling habitat and this may result in their extirpation in the future (Ibid). There have been several studies indicating a declining trajectory in their population within the past sixty years and previous attempts to enlist them under the CA and U.S. Endangered Species Act has failed. Even though the American Pika population is still considered healthy, they are experiencing declining populations and a general declining trajectory in their habitat that could extirpate American Pika populations in California.

Background of the American Pika

Taxonomy

The American Pika is a small mammal that is a part of Order Lagomorpha, family Ochotonidae along with rabbits (Smith and Weston, 1990). Key characteristics in the Pika's skull includes oval interorbitals that are flatter than other mammals, slender rostrum, and they don't have postorbital processes in their frontals (Ibid). They have a distinct dental formula that helps identify their fossils with two over one incisors, zero canines, and three over two premolars. The oldest fossil remains of the Pika dates back over five hundred thousand years ago and they were not always found in talus habitats. After various cataclysmic events and temperature changes throughout geographic history, Pikas were predicted to retreat up mountains and began to recolonize in talus habitats (Smith and Weston, 1990)

Life History

Unlike rabbits, Pikas have short and round ears that are dark in color. Pikas grow up to six to eight inches long, have a lifespan of four to seven years and adults weigh between one hundred and twenty grams to one hundred and seventy grams (Smith and Weston, 1990). They have digitigrade short legs and a long tail that is hidden within their pelts. Both males and females have the same brown pelts, but females molt their pelts two weeks later than males because of lactation or pregnancy (Ibid). Females also molt differently with scattered patches while males molt from head to toe. They are general herbivores, forage by immediate consumption and they also collect plants to stockpile for winter because they do not hibernate. Non hibernation is common in the lagomorph family and Pikas do not hibernate due to their successful adaptation of collecting plant material in

their insulated talus burrows. Their diet consists of various grasses, lichens and forbs; they prefer short alpine grasses. Pikas are generally active about thirty percent of the day, they will collect their food or patrol their territory. American Pikas are territorial and they mark their territory with scents from their apocrine gland complex located within their cheeks. Pika's are typically vocal with specific calls to various individuals, such as short calls to scare away other pikas or to warn potential predators to stay away. Long calls are typically heard from adult males to attract females during their breeding season. American pikas prefer to give birth between March through May for favorable feeding conditions and they prefer to give birth early in the year so their young can be fully-grown and independent before winter. The gestation period lasts for about thirty days and females usually have two litters a year with about two to five pups per litter. The young are reliant on their mother for about four weeks until they become adults at about three months old (Smith and Weston, 1990).

Why They Matter

The American Pika is considered a climate indicator species due to their sensitivity to warm temperatures. Observing a sudden decrease in their population may provide evidence that their habitat is experiencing warmer temperatures than normal and the continued temperature increase may affect other species as well (Smith and Nagy 2015). Since American Pikas do not migrate, their abundance in their small habitat range shows how well they are surviving in recent years (Yandow et. al 2015). Pika's distribution also indicates the overall health of their habitat because they rely heavily on local plant material. Therefore, a healthy Pika population indicates the meadows where they forage are also in good condition (Yandow et. al 2015)

Pikas are also considered to be ecosystem engineers due to their foraging habits. Pikas do not travel far when they forage for current food, but they will travel a few kilometers farther than usual to collect grasses for their haypiles (Roach et. al 2001). This foraging habit resulted in plant species richness with an increased gradient away from their territory (Smith and Weston, 1990). American Pikas are also known as allogenic engineers by altering their habitat with their haypiles. As general herbivores, Pika's haypiles reflect the diversity of plants in their local meadows (Ibid). American Pikas collect an average of six thousand grams of grasses for their haypile each winter and they don't always finish eating their haypile. These haypiles consist of a variety of grasses; the unused plant material decomposes and provides the nutrients to the soil (Aho et. al 1997). Soils within the Pika's burrows are recorded to have higher nutrients than areas not occupied by Pikas (Ibid). Plants growing from old plant material as well as soils under their haypiles have more nitrogen and Carbon. Pikas play a role in plant species richness, soil nutrients; their population health signifies the health and recent temperature changes of their ecosystem.

Caches

Other than being dependent on talus, Pika are dependent on both talus and their caches for survival. They are generalist herbivores that typically build their cache as haypiles during the summer and fall before temperatures become too cold (Smith and Erb, 2013). American Pikas utilize most of their energy to actively search and collect plants in order to stock up for the winter (Dearing, 1997). During the summer, Pikas will make about a hundred trips a day to stock their haypile (IUCN Red List). Once they finish collecting

plant material, they will place their caches within the cracks of the talus (Figure 1) (Holtcamp, 2010). During the summer, American Pikas collect plants by biting through the stem in order to collect an abundance of plants at a time. Since these trips cost energy, American Pikas will pick plants that would provide satisfactory nutrients and will not waste their energy to look for more nutritious plants (Smith and Erb, 2013). They make an average of about twenty-seven trips to fill their caches each hour, but this activity puts them at risk of being exposed to predation (Ibid). However, the amount of vegetation they collect for their cache usually isn't enough to sustain the American Pika through the winter and they will occasionally forage on shrubs or lichens. They will use their cache as an emergency food supply only if the winter weather is too harsh for them to forage in. These caches also function as additional insulation within the talus rocks to protect them from the cold temperatures, which can also be a potential explanation to why haypiles are not always fully consumed during the winter (Dearing, 1997). These caches are selected by water content provided by vegetaiton. American Pikas that live in lower elevations typically forage for plants with higher water content likely due to warmer temperatures and delayed snowfall at lower elevations (Smith and Erb, 2013).

Habitat

Pikas burrow themselves within talus in alpine environments at high elevations and they are usually found above two thousand five hundred meters above elevation (Rodhouse et. al 2010). The Sierra and alpine consists of intense cold seasons with high winds and snow covered or decadent vegetation (Roach et. al 2001). Alpine zone occurs throughout North America in isolated mountains habitat islands. Warming temperatures

have forced the Pika population to relocate up the mountaintops to avoid lethally high temperatures (Rodhouse et. al 2010). They live within talus cracks in order to remain hidden and protected from potential predators (Roach et. al 2001). Talus also provides efficient shelter year round by providing a refuge from predators, keeping American Pikas cool during the summer as well as insulating them from the cold air in the winter (Millar et. al 2016). In the Sierra Nevada, permafrost is commonly found within the talus at high elevations. The permafrost within the talus helps protect the Pikas by providing thermal efficiency (Millar et. al 2014). Talus with permafrost have record low temperatures throughout the year, which is ideal for Pikas (Millar et. al 2014). They are central foragers and they prefer to be in range of meadows for foraging their haypiles. Due to this foraging habit, they alter the plant composition of the meadows that only occur close to talus (Roach et. al 2001).

American pikas are talus dependent and the amount of talus present in their habitat plays a major role in determining their survival. Snowpack decline has been recorded due to increasing temperatures (Rodhouse et. al 2018). Changes in snowpack also change the ecosystem in mountain regions (Mote et. al 2005). As the primary source of water storage, losing the snowpack earlier than expected has lead to changes in local plant species composition (Ibid). Early snowmelt results in plants blooming and drying out earlier. An important variable for snowpack involves forest canopy because a forested canopy can lead to an accumulation of snow. When forest canopy is removed from deforestation, tree mortality or fires, snow accumulation is predicted to increase (Mote et. al 2005). Lack of snowpack has lead to cold stress because the snowpack insulates the American Pikas' talus burrows and the snowpack reduction will reduce insulation (Rodhouse et. al 2018).

Dispersal

American Pikas are separated among isolated island mountaintops due to uninhabitable warmer temperatures at lower elevations. High elevated habitats are distributed across mountains ranges such as Sierra Nevada (Figure 2) (Millar and Westfall, 2010). Pikas usually are independent with only one Pika per territory and the mothers usually force their young out of their territory once she finished weaning (Wolf et. al 2007). They are dispersed throughout their territory with about one Pika per two acres (IUCN Red List). Pikas are limited to these habitats due to their sensitivity to warm temperatures, which minimized their dispersal among their habitats (Beever et. al 2003). They are unable to venture far in the summer when temperatures are too hot because they will expire when they overheat (Ibid). In the winter, it is far too cold for them to leave their talus burrows and they are forced to remain inside their burrows with their caches. Due to their temperature sensitivity, long distance migration is not possible. Once a specific habitat becomes isolated, American Pikas will not make an attempt to recolonize for territory (Galbreath et. al 2009).

Optimal territory is the key for Pikas because there are high risks of predation when they are away from talus refuge. They will also avoid moving to other territories in order to avoid these risks (Peacock and Smith, 1997). Since exposure outside the talus is already risky due to predation, Pikas will remain in their current territory because it is not worth their energy (Ibid). They are philopatric, meaning they normally do not venture far from their familiar habitats. Juveniles will quickly migrate to any available territory nearby (Peacock and Smith, 1997). Once juveniles find their optimal territory, they will remain

there for the remainder of their lives (IUCN Red List). In order to minimize conflicts with other adults, juveniles will forage in different times of the day while the adults are not active (Ibid). Pikas are usually not successful with dispersing long distances and they at most may travel about two miles away. The farther away they are from talus environment, the less successful they are in survival (Beever et. al 2003). Pikas are extremely territorial due to minimal success away from close territory (Ibid). Those that do find a good location with an optimal foraging distance between the talus and meadows will most likely be able to reproduce successfully. Due to the importance of valuable territory locations, adults will not share territories and will also attempt to force other American Pikas from their territory. Some American Pikas may fight to the death in order to retain valuable territory (Peacock and Smith, 1997).

However, in higher elevations they are able to disperse more efficiently since it costs less to travel with cooler temperatures (Beever et. al 2003). It is easier for pikas to claim territory at higher elevations because talus is more abundant (IUCN Red List). The lower the elevation, the less successful Pikas will be (Ibid). Their dispersal is also affected by vegetation dispersal as well. If there is an abundance in forb cover within their habitat, then they will be more successful in cashing and surviving (Rodhouse et. al 2018). Even during hot summer days, mountain temperatures fluctuates enough for American Pikas to disperse or forage during the mornings, evenings or nights to avoid heat (Smith and Nagy 2015). Despite the isolated populations, there is no major lineage differentiation because they are still neighboring populations and not entirely isolated (Galbreath et. al 2009).

Stressors

Adverse Human Impact

Stressors to Pikas from humans include grazing, timber harvesting, road construction and climate change. Extirpation is common in areas that are impacted from livestock-grazed areas. It's essential for them to forage an abundance of various vegetation in order to stock up for the winter. With local vegetation grazed by livestock, the American Pika will not be able to sustain their food supply throughout winter (Beever et. al 2003). Grazing reduces the biomass that will alter plant species composition that will minimize nutrients in the Pikas haypiles (Ibid). Timber harvesting results in the loss of the Pika's alpine plant community and timberlines move up mountains by one hundred to two hundred and fifty meters in various locations (IUCN Red List). There is a positive correlation between American Pika persistence and distance away from human roads, which indicates that the less disturbance from humans the better for the American Pika (Beever et. al 2003). Certain talus locations that used to inhabit American Pika population have now been extirpated due to persistent human construction of roads (Ibid).

Climate change is predicted to be the primary stressor that led to local extirpations of the American Pika. The Pika population at the great basin have experienced reduced dispersal, densities and overall local extirpations (IUCN Red List). Temperatures are expected to rise and they are also predicted to increase at higher elevations that should be considered safe for the American Pikas (Ibid). The loss of snowpack will have devastating effects that will lead to damage of their haypiles as well as increasing stress and mortality rates on the American Pika. The recent reduction of snowpack may be caused by more rain

than snow as well as warmer days. So far, the average temperature has increased by a couple degrees within the past fifty years and the temperature rise is predicted to double in the future(Wolf et. al 2007). This drastic increase will only lead to their natural habitat to become uninhabitable in the distant future (Ibid). The hot summer will be stressful for the American Pika and they will struggle to forage for vegetation that may also be under thermal stress. Even in winter, the American Pika will struggle because of snowpack and permafrost reduction will reduce necessary insulation for their survival.

Temperature Sensitivity

Due to their sensitivity of warm temperatures, their daily activities are based off of current temperatures during the day (Smith, 1974). When comparing Pika populations at high elevations versus lower elevations, Pikas at lower elevations reduced their activity significantly during the day due to warmer temperatures (Ibid). Since Pikas cannot handle activity during the day in lower elevations, they shifted their behavior to be nocturnal. Pikas in higher elevations were more active throughout the day, regardless of the time of day. Pikas that were in higher in altitude were observed to be active at night as well, such as conducting calls, but had far less activities observed at night compared to the Pikas at lower elevations. Pikas have a thick layer of fur to protect their body from decreasing in temperature, which is helpful during the summer as well because nights can drop below freezing temperatures. The Pika population is roughly ten percent more active during the day at high elevations (Smith, 1974). Another way they become stressed is through their haypiles. Snowpack also helps preserve their haypiles to last during winter and snowpack

reduction will decimate the haypiles, which will cause them to struggle to survive the winter (Millar et. al 2016).

Metapopulations

Since Pika populations are separated into islands as metapopulations, their genetic variance puts their population at risk due to the dangers of bottlenecks and extirpations of subpopulations (Hafner and Sullivan, 1995). The severity of bottlenecks can determined by their isolated island size and other drastic changes in their habitat, such as severe drought seasons (Ibid). The larger numbers of metapopulations, the greater the risk of the Pika population experiencing bottlenecks and local extinctions. The Pika population has not experienced a reduction of heterogeneity, which indicates genetic stochasticity within their population. Even though these metapopulations puts the Pikas at risk of local extripations, Pika populations have been resilient to these negative effects.

Why are they not listed as Endangered?

In some studies, there is evidence that their population is rapidly declining and they believe American Pikas are at risk of becoming endangered (Smith and Nagy, 2015). However, there are also various studies that did not find evidence of Pika population decline (Ibid). There are current fluctuations between recolonization and local extinctions, which indicates that they are resilient to population changes (Figure 3). Pikas are still found in their expected habitats frequently and some are found away from historic locations. Despite warmer temperatures in their habitat, American Pika populations appear to be thriving instead of declining (Millar and Westfall, 2010). Even studies that have

occurred after a severe drought observed Pika populations to remain constant, which may indicate adaptation to drought (Rodhouse et. al 2018). Recent data on Pika populations after a drought in 2015, with record low snowpack in Sierra Nevada; the Pika population did not change or decline (Ibid). There was no increase in mortality rates, which indicates that it is possible for the American Pika to survive despite the severity of the recent droughts.

A possible explanation for their survival could be from the insulation of the talus rocks (Smith and Millar, 2018). Even with minimal snowpack, talus rocks are still able to insulate pika habitat from temperature changes (Ibid). Talus that were decoupled were able to to maintain cool temperatures in the summer due to snow cover within the cracks. Without snow cover, the talus can still maintain warm temperatures in the winter. Another possible explanation for their success during the drought could be a record high precipitation early in the spring that lead to an abundance of vegetation for American Pikas to utilize for their cashes. It could be possible that the Pikas are adapting to the current temperature changes and they may be resilient enough to maintain reasonable population levels (Smith and Millar, 2018).

Smith wrote a letter to a member of the California Department of Fish and Game discussing his perspective on why the American Pika should not be considered an endangered species (Smith, 2011). There are a few common misconceptions discovered in research papers and the results of his research contradicts various data collected from other studies (Ibid). Many research papers indicate that the American pikas will expire once exposed to lethal temperatures. Research done by Smith has observed American Pikas

behavioral adaptation to temperature sensitive; they actively avoid overheating by taking shelter in talus and forage around the hottest parts of the day. Therefore, it is not entirely accurate to assume American Pikas will automatically expire with lethal temperatures. Recent studies claims extirpation of the Pika population in various sites and his research that was conducted decades ago also did not find American Pika populations in certain sites like Bodie Hills. It should not be surprising that American Pikas are not found in locations where they are not commonly present. Dr. Smith concludes that his current research indicates that the American Pika should not be listed as threatened at this time (Smith, 2011).

Conservation Through Monitoring and Adaptive Management

The most important objective is to keep observing the American Pika. There may not be enough evidence to support the American Pika population as an endangered species yet, but continued observations and research can help determine when they are truly facing a population decline trajectory that may lead to extinction down the road. Adaptive management would be the best option to help the Pika. We can start with monitoring their preferred plants used for their haypiles and monitor the meadow vegetation as a whole (IUCN Red List). We can observe and monitor the plant diversity and determine any disturbances that may be negatively affecting the meadows (Ibid). Ensuring the abundance of local vegetation is available for foraging will have a positive impact on their population. Due to the importance of vegetation abundance to utilize for their haypiles, livestock grazing near their habitats should be minimized. Other objectives in an adaptive management plan can also be to monitor the alpine trees and monitor any timber activity

that may need to be addressed. Luckily, the American Pika distribution is already located within conservation sites. Their population range typically occurs within national parks and protected ranges (IUCN Red List).

Another way to aid the American Pika could be to continuously monitor sites with a history of American Pika populations that were recently extirpated (IUCN Red List). Keeping track of weather and temperature patterns until it returns to favorable conditions and possibly reintroduce them back to their historical habitat (Ibid). We can repair these sites by monitoring and planting meadow vegetation until there is an abundance that may be able to sustain Pikas when they can be reintroduced. Continued awareness, education and research to keep watch of the American Pika should be enough to help protect their population without their listing as an endangered species (IUCN Red List).

Conclusion

After careful consideration and research, I recommend initiating awareness that their population is at risk. They are not a well-known species and their population decline has not received as much attention as it should. The American Pika population is still considered healthy, but they are experiencing a population and habitat-declining trajectory that could extirpate American Pika populations in California. They are an indicator species for their changing mundane habitat through changes in precipitation and increase in temperatures of climate change. The American Pika population shows the overall health of their ecosystem due to their sensitivity to warmer temperature variations. Careful monitoring on the Pika population as well as the vegetation abundance with meadows is essential to determine the direction of their population growth. There needs to be an

adaptive management plan to prevent local extirpations. We need to maintain the plant community health by restoring the meadow vegetation that are negatively affected such as grazing areas. There needs to be an initiative to maintain healthy forests surrounding meadows. We lastly need to continue to investigate other potential factors that may be harming the Pika population, such as invasive species, fracking and mining. Even though there is not enough evidence to support their listing as an endangered species, there needs to be continued research to keep track of their population and conservation efforts can help mitigate their population decline. Unfortunately, it will be difficult for the American Pika to adapt to vast temperature fluctuations and the ultimate consequence may be their extinction in the future.

Figures

Figure 1. Haypiles placed within Talus rocks, which indicates the presence of an American Pika (Holtcamp 2010).

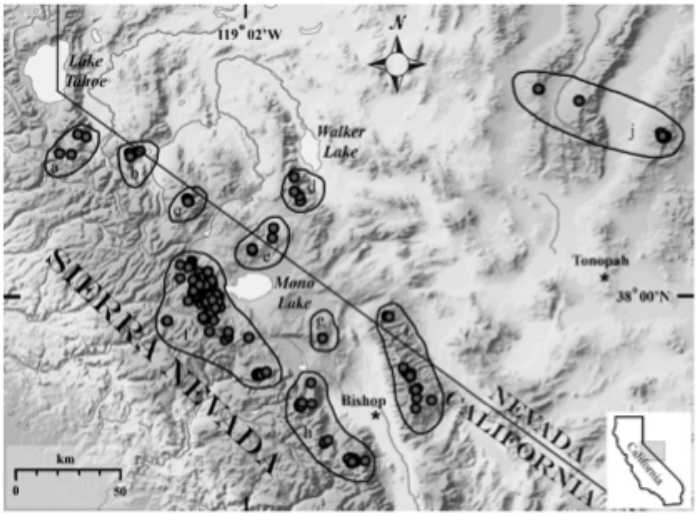

Figure 2. Current distribution of the American Pika population with points indicated as study sites (Millar and Westfall 2010).

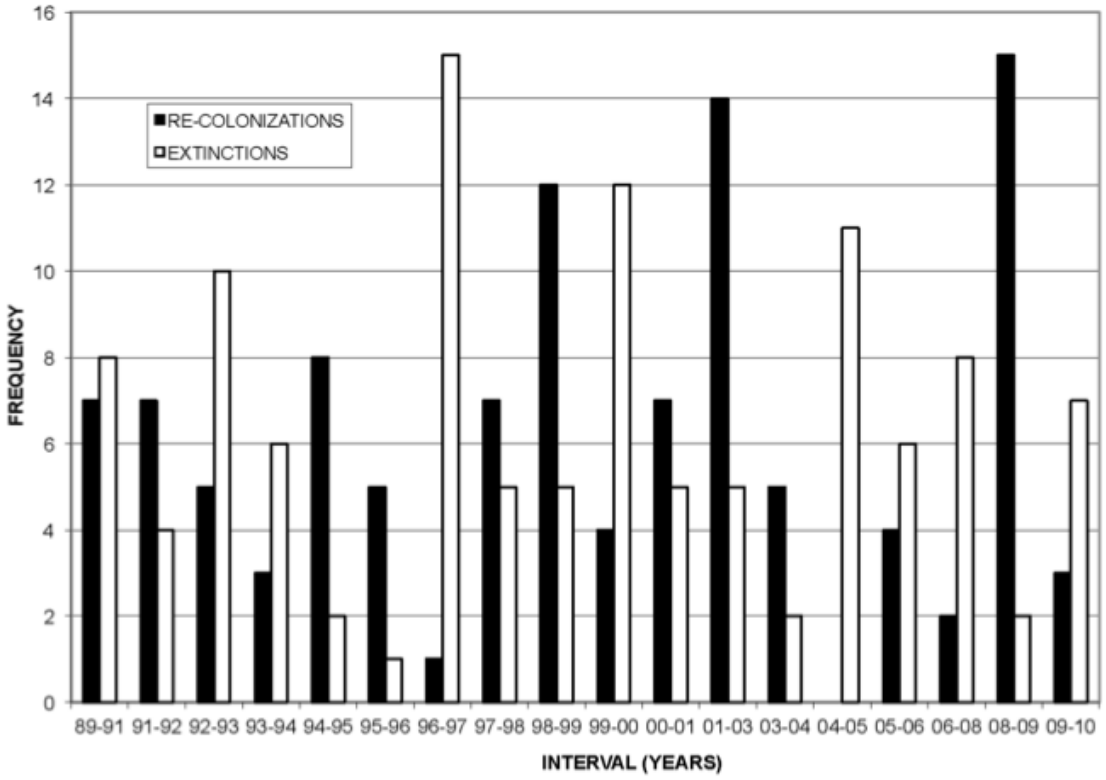

Figure 3. Recent relationship between the recolonizations and extinctions of the American Pika between 1989 and 2010 (Smith and Nagy 2015).

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