

Managing climate change refugia to protect wildlife

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The study, by a group of resource managers and scientists, sets out for the first time specific steps to help researchers and managers identify and manage these more resilient, climate-stable havens for plants, animals and fish. Details appear in the current issue of the journal *PLOS ONE*.

Morelli says, "These are places that will be protected from climate change, at least relative to the land around them. Management actions can then reduce other stressors, like disturbance or invasive species, so these areas can act as short-term sanctuaries for species of conservation concern and other important natural and cultural resources."

She adds, "Natural resource managers are trying to help species adapt to climate change, looking for places where they can make a difference within the constraints of funding and staff time. They can't act on everything, everywhere, so our idea was to highlight areas that are more resistant to climate change that could help populations remain in place despite warming and changing precipitation."

The authors distinguish refugia from smaller, more transient micro-environmental "refuges" that offer plants and animals protection from exposure and disturbance. By contrast, the refugia concept is an old one with roots in paleontology, used to describe areas where plants and animals were isolated and saved from glacial destruction during past ice ages, Morelli points out.

The authors offer specific steps and opportunities for managing refugia. For example, protecting climate change refugia for wolverines may seem daunting as individuals can range over hundreds of kilometers. However, these predators might benefit from protecting snow refugia because the minimum snowpack they need for den sites can potentially be managed.

Another example they cite is freshwater refugia for cold-water-

dependent species such as salmon. Cold groundwater that flows into streams and rivers via deep aquifers buffered from regional air temperatures can support cold, sustained streamflows in regions where water temperatures might become too warm or stream flows too low otherwise. They note that "such large, cold, connected river networks are recognized as regional strongholds for imperiled fish populations facing increasing pressures from climate warming and other stressors."

In addition to discussing historical and contemporary refugia and how they fit into planning, the researchers present seven detailed steps for managing refugia, with challenges and opportunities accompanying each. They note that "species already limited to extreme environments, such as alpine species restricted to mountain summits, might not be candidates for management with refugia," but others such as wolverines might benefit from climate change refugia because they require "minimum levels of snowpack for den sites that could potentially be managed."

Morelli and colleagues point out that unlike historical climate fluctuations, current global greenhouse gas levels are likely to exceed any seen in the past, so [climate change](#) refugia identified today will probably not offer long-term solutions for stressed species. But when coupled with management strategies they could serve as reservoirs of genetic material, for example.

"There is a great need for such a strategy, even based only on changes in climate that have already occurred. Over 80 percent of U.S. national parks are already at the extreme warm end of their historical temperature distributions, indicating that ongoing and future changes in the same direction will transcend temperatures that they experienced over the last century," they add.

"Ultimately, a mix of strategies, including distributing management actions across areas with a range of climate vulnerabilities, might be the

most effective path," Morelli and colleagues write.

More information: Morelli TL, Daly C, Dobrowski SZ, Dulen DM, Ebersole JL, Jackson ST, et al. (2016) Managing Climate Change Refugia for Climate Adaptation. *PLoS ONE* 11(8): e0159909. [DOI: 10.1371/journal.pone.0159909](https://doi.org/10.1371/journal.pone.0159909)

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