COMMENT

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The unique Florida Everglades deserve protection, despite being highly vulnerable to climate change.

Climate change must not blow conservation off course

Reconfiguring protection priorities around global warming could be of limited use or even harmful, say **Morgan W. Tingley**, **Lyndon D. Estes** and **David S. Wilcove**.

In March this year, the United States released its national strategy for conservation planning in the face of climate change. The first goal of the National Fish, Wildlife and Plants Climate Adaptation Strategy is to "conserve habitat to support healthy fish, wildlife, and plant populations and ecosystem functions in a changing climate". It warns that by prioritizing certain species and areas over others, there will be winners and losers. Elsewhere in the conservation community, there is increasing acceptance of abandoning protection for many of the species, populations and ecosystems that are most at risk of extinction from climate change[1].

Although climate change seems likely to wreak havoc on biodiversity, as is already happening in some places, its precise effects are difficult to predict. In the meantime, numerous threats that are better understood and more immediate — notably, the direct destruction of habitats — continue to drive species towards extinction.

The best conservation response to global warming is not to beat an orderly retreat while saving the strongest, but to consider climate change as one of a suite of maladies, all of which must be addressed to protect biodiversity. In some cases climate change may be the most urgent threat; in most cases it is not[2].

MOUNTAIN BIAS

In the growing literature on conservation and climate change, the golden word is 'resilience'. Conservationists hope to take actions that help organisms and ecosystems to survive in a warmer and more volatile world. ▶

Because the resilience of individual species to climate change is difficult to predict, researchers have suggested prioritizing regions that are expected to be climatically stable for at least the next 100 years[3]. In the past five years, scientists have undertaken global and regional mapping of climate-change velocity to identify these 'refugia'[4].

Climate-change velocity indicates how fast (for instance, in kilometres per year) and in what direction temperatures are shifting across a landscape. Velocity calculations suggest that in a changing climate, topographically diverse areas such as mountain chains will be more climatically stable than less-complex terrain such as flatlands. In mountainous areas, a wide range of temperatures occurs in a relatively small area. Thus, the distance an organism must migrate to remain at a constant temperature in a changing climate is much shorter in rugged country than in flat terrain.

Our concern is that using metrics such as climate velocity to guide conservation prioritization may well prove ineffective, or even harmful, given the enormous uncertainty over how species will actually respond to climate change. Meta-reviews assessing the impact of global warming on hundreds of species around the world can give the impression that organisms are uniformly marching uphill or to higher latitudes in step with changes in mean temperature[5]. But averaging behaviour across diverse species to find overall trends may be of little use in predicting what will actually happen in any one location.

In fact, the closer scientists look at species' ongoing responses to our warming planet, the more surprises they uncover[6]. For instance, the ranges of only 51% of the bird species in California's Sierra Nevada mountains moved to higher elevations between 1911 and 2009, despite a 1–2 °C mean temperature increase over that period[6]. The remaining species either shifted to lower elevations or did not move.

Basing conservation priorities on an area's expected resilience to global warming, and thus biasing protection towards mountainous landscapes, risks potentially losing the diversity of flatlands. On the whole, flatter ecosystems tend to be in greater need of protection than rougher terrain; national parks, for example, more commonly exist in mountainous areas because such regions are less suited to cultivation and pasturing[7].

Prioritizing conservation according to an area's expected resilience at a national or continental scale could mean favouring the Rocky Mountains, the high Andes or Mount Kenya over Florida's fabled Everglades, the *cerrado* of Brazil or Africa's savannahs. Although topographically diverse areas may contain larger numbers of species per unit area than flatlands, many areas of flat terrain are just as important for endemic species. The Brazilian *cerrado*, for example, comprises more than 2 million square kilometres and has one of the richest endemic floras in the world. Yet only around 2% of it is currently protected, and around half the total area has already been cleared for agriculture[8,9].

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Brazil's *cerrado* is a tropical savannah that has one of the richest endemic floras in the world.

THREAT BY THREAT

To move forward, conservationists should consider all threats to biodiversity when deciding which species, habitats or areas to protect, and should not assume that some threats are more important than others. For example, for any conservation area, each potential threat should be evaluated and weighted by the risk it poses, with full consideration of its severity, reversibility, imminence, pace and certainty.

Finding ways to combine these factors into a meaningful metric remains a formidable challenge. Various methods exist to help conservationists to factor climate-change uncertainties into their priority-setting, but as yet there is no consensus on how the future threat of climate change should be compared to ongoing and more certain threats, such as land-use change. Creating a consistent approach for prioritization should be a primary goal. The International Union for Conservation of Nature Red List of Threatened Species could be a good model, because it simultaneously evaluates the risk of multiple threats, from pollution to invasive species.

In the meantime, there are several ways for conservation planners to guard against overcompensating for climate threats. When it is possible to assess the uncertainty associated with a particular threat — a 20% reduction in rainfall by 2050, say — this uncertainty can be factored into prioritization schemes. In other situations, models predicting an optimal prioritization scheme can be run several times, with and without different threats incorporated. Basing prioritization on results obtained from a range of models, each with different parameters, is more likely to result in smart conservation.

Given the sobering picture that has long been emerging from studies and reports such as those produced by the Intergovernmental Panel on Climate Change, it is not surprising that conservationists feel the need to alter course to deal with the threat of climate change. Indeed, some may argue that there is little point in trying to save species from immediate threats when their long-term survival is in question. But if conservation planners don't use resources efficiently to maximize the protection of biodiversity and habitats from today's threats, there may be little left to protect from the effects of global warming 50 to 100 years from now. ■

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