ADAPTATION

Conservation for any budget

Deciding where and how to allocate scarce funding to conserve plants and animals in a changing and uncertain climate is a thorny issue. Numerical modelling identifies the most effective mix of conservation measures based on the level of expenditure available.

Joshua J. Lawler

Strategies for reducing the impacts of climate change on ecological systems include suppressing fires, installing snow fences, designating preserves, removing dams and moving species to new locations. For many ecosystems under threat, more than one intervention could have positive impacts. However, climate projections are uncertain and ecological responses even more so, and as such there is little guidance on how to decide which effort to prioritize in the face of often limited funds. Writing in *Nature Climate Change*, Wintle and colleagues[1] use model simulations to identify the optimal combination of fire control, land purchase and management for protecting the rich and endangered biota of the South African fynbos.

Recent climatic changes have had significant effects on many plants and animals, and the ecological systems that support them[2]. In response to rising temperatures, many species have shifted their distributions either polewards or upwards in elevation, and key events such as breeding, hatching and flowering are happening earlier in the spring. At the same time, many of the forces that shape ecological systems are also changing. Forest fires have become more frequent in the western United States[3], and projected climatic changes are anticipated to have even greater effects on species and systems in the future[4,5]. Some species will weather the impending changes relatively well, whereas others will face shrinking habitats, changing food resources, new predators and competitors, and even extinction.

A wide range of approaches to reducing the impacts of climate change on species and systems have been proposed[6,7]. Measures such as connecting fragmented landscapes, establishing protected areas, increasing the size of protected areas, and managing processes such as fire and stream flow are based on broad, ecosystem approaches. Other strategies are more tactical, instead targeting particular species or systems. For example, replanting trees along streams has the potential to lower stream temperatures through shading, and removing dams and water diversions can allow fish to move upstream to reach cooler waters. Planting more fire- and drought-tolerant plants may allow an ecosystem to adjust to changing fire regimes, rising temperatures and decreases in precipitation. These strategies may be useful, but they are often expensive, and land managers and conservation practitioners will have to make hard choices to best make use of limited funds.

Wintle and colleagues[1] use numerical modelling of population dynamics, fire, and habitat protection to assess the best use of funds in the fynbos biome of South Africa. This biome is home to over 7,000 plant species, the majority of which are not found anywhere else and many of which are threatened with extinction (Fig. 1). The threat to the ecosystem is twofold: the area is endangered by land clearing for agricultural and urban development, and the projected increase in fire frequency could mean that plants are killed before they can recover and reseed. Wintle and colleagues simulated the responses of populations of 234 plant species in the fynbos to habitat loss and increases in fire frequency. They then assessed the responses of the species to different degrees of fire control and land preservation and management. They used estimates of the costs of land preservation and fire control to determine the optimal mix of the two strategies for a range of annual budgets.

The models indicate that in the absence of fire control, increases in fire frequency may lead to extinction for many fynbos species. If fires will drive species to extinction, preventing development will do little to maintain viable populations. Therefore, when budgets are small, it is optimal to allocate funds solely to fire control efforts. However, when annual budgets are larger — greater than $43 million — a mixture of approaches provides the optimal strategy for conserving the most species. Indeed, the importance of land protection and management increases as budgets rise up to $105 million, at which point additional land purchases add little to the persistence of the plant species.

Figure 1 | Plants of the fynbos. The fynbos biome is home to thousands of plant species that are not found anywhere else. Many of these plants are threatened by the conversion of land to agricultural and urban development, and by anticipated climate-driven changes in the frequency of wildfires. Wintle and colleagues[1] found that the optimal combination of land purchases and fire control for conserving the rich diversity of the fynbos flora depends on the conservation budget available.

The importance of considering monetary costs in setting conservation priorities is not a revelation. It is now well known that merely weighing benefits without estimating costs, particularly of land acquisitions, is inefficient at best, and at worst, ineffective[8,9]. However, Wintle and colleagues provide a clear example of how rigorous, quantitative analyses can assess the results of these actions. Their conclusions are relatively robust to uncertainties in the cost-effectiveness of fire control and land purchases. However, the authors admit that their analyses have not taken uncertainties in the rate of climate change or the responses of individual species to it into account. These uncertainties are not trivial.

Nonetheless, part of the elegance of the approach of Wintle and colleagues[1] is that it can be extended to account for such uncertainties, and used to guide real-world management decisions for complex systems in the face of multiple uncertainties. ❐

Joshua J. Lawler is in the School of Forest Resources, University of Washington, Box 352100, Seattle, Washington 98195, USA.
e-mail: jlawler@u.washington.edu

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