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## What are the assumptions and uncertainties of modeling future species distributions?

Traditionally, resource management and conservation have assumed that the distributions of plants and animals and their occurrence in protected areas are static, at least over the time frame of management actions. Yet climate change is already altering species' distributions, and these distributional shifts are likely to increase as the rate and magnitude of climate change accelerate. Understanding how distributions are likely to change in the future is increasingly critical to conservation and management.

Species-distribution models (SDMs) are widely used to project how the distributions of plants and animals may change with climate change. In a paper published in the *Proceedings of the National Academy of Sciences*, we used projections of future climates, combined with future shifts in the distribution of vegetation, to project the future distributions of 60 California landbird species. Most species are projected to decrease in distribution by 2070. Some parts of the state, particularly in the Central Valley and the Mohave Desert, may suffer large losses in overall numbers of species, while other areas, such as the Sierra Nevada, may gain in species richness. Because species may respond to climate change in different ways, groups of species that occur together in the future may be different from those we see now.

Such models offer a glimpse into the future. Like any models, however, they contain assumptions that contribute to the uncertainty of the model projections. If the results are to be useful in conservation and management, these assumptions and uncertainties must be considered. SDMs are built by correlating the present occurrences of a species with the environment of those places and then using models to predict where those conditions

will occur in the future, providing suitable habitat. This assumes that the correlations accurately capture the species' requirements, that these relationships will hold into the future, that the species can move to the places with suitable future conditions, and that interactions with other species will not affect habitat relationships or movements. Additional uncertainties may arise from the climate or distribution model functions, from gaps in the underlying data, or from mismatches between the scale of modeling and the scales at which the species respond to environmental changes.

SDMs can help to incorporate future conditions into conservation and management practices, but the uncertainties of model projections must be balanced with the risks of taking the wrong actions or the costs of inaction.

### Main Points

- Climate change will alter the distributions of many California landbirds.
- Modeling future distributions entails assumptions about the species that contribute uncertainty to model projections, adding to the uncertainties due to the models themselves.
- Conservationists and managers must be willing to act despite the uncertainties. Ignoring the future is not an option.

### Paper citation

Wiens, J.A., D. Stralberg, D. Jongsomjit, C.A. Howell, and M.A. Snyder. 2009. Niches, models, and climate change: Assessing the assumptions and uncertainties. *Proc. Natl. Acad. Sci. USA* 106:19729-19736.