Potential impacts of climate change on birds and trees of the eastern United States: newest climate scenarios and species abundance modelling techniques

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Introduction

Climate change is affecting an increasing number of species the world over, and evidence is mounting that these changes will continue to accelerate. There have been many studies that use a modelling approach to predict the effects of future climatic change on ecological systems, including by us (Iverson et al. 1999, Matthews et al. 2004); this modelling approach uses a new tool for evaluating multiple species of trees and birds.

Methods

We modelled and mapped current and potential future suitable habitat for 134 tree species and 150 bird species from the eastern United States for potential response to several scenarios of climate change. Each species was modelled individually to show current and potential future distributions according to two emission scenarios (A1fi-high emissions on current trajectory and B1-reasonable conservation of energy implemented) and three climate models: the Parallel Climate Model, the Hadley CM3 model, and the Geophysical Fluid Dynamics Laboratory model. We modelled with Random Forests, a regression tree ensemble method that models better than any other known method as long is there is a sufficient number of samples of presence/absence data (Prasad et al. 2006). We also evaluated both emission scenarios under an "average" future climate from all three models, and evaluated the species for their quality of prediction models.

The primary products of this research are maps (to a resolution of 20x20 km) and tables of potential changes of the species' suitable habitat under the various scenarios of climate change. We also calculated the mean centres and changes of mean centres, under all scenarios, to enable estimation of distance and direction of movement potential by species.

Results and Discussion

We found that species with small ranges, though shown to have more vulnerability to extinction after climate change, also have more uncertainty in predictions of current and potential future habitat distributions because of small sample size and the relatively higher contribution of non-climate variables, like soils or topography, to the models (Schwartz et al. 2006). More local species are relatively more controlled by local environmental conditions and thus may be less endangered by changing climates. These results create a conservation dilemma in that excluding these small-ranged species from climate change analyses underestimates extinction risk, whereas including them may overestimate extinction risk.

We found that the harshest situation and greatest changes in suitable habitat for tree species occur with the high emission scenario (A1fi) under the HadleyCM3 model and the least harsh situation and smaller changes were with the lower emission scenario (B1) under the PCM (Table 1). Most tree species' habitats will move in a north or northeast direction, up to about 800 km with the HadleyCM3-high emissions, and about 400 km with the PCM-low emissions (Fig. 1). All maps, data, and publications, on tree and bird analysis, can be found on our website, www.nrs.fs.fed.us/atlas (Prasad et al. 2007).

Table 1. Potential species changes in area-weighted importance value for habitat suitability for 134 species in the eastern United States. A future : current ratio below 1 indicates a loss, while a value above 1 indicates a gain. (lo and hi refer to emission scenarios, see text).

Scenario	< 0.5	0.5 - 0.9	0.9 - 1.1	1.1 - 2	> 2	Total
PCM lo	14	37	21	54	8	134
PCM hi	25	25	14	40	30	134
Ave lo	15	38	20	48	13	134
Ave hi	23	35	9	37	30	134
GFDL lo	14	40	15	44	21	134
GFDL hi	26	28	12	31	37	134
Had lo	20	34	13	50	17	134
Had hi	25	31	12	36	30	134

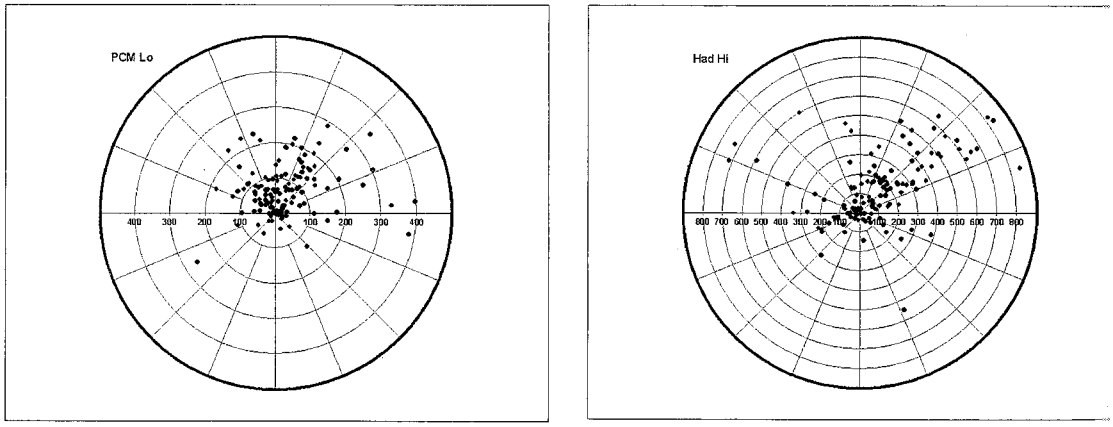

Figure 1. Range of potential mean centre movement for 134 tree species under the least harsh scenario (PCM, low emissions, left) and most harsh scenario (HadleyCM3, high emissions, right).

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