Assessing the Potential Genetic Impacts of Climate Change to North American Forest Tree Species

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Climate change is expected to pose a severe threat to the viability of forest tree species, which will be forced either to adapt to new conditions or to shift their ranges to more favorable environments. Climate change is a priority area identified by the Forest Health Monitoring program of the USDA Forest Service, which is sponsoring a baseline assessment of the risk that climate changes poses of genetic degradation, local extirpation or species-wide extinction to North American tree species. This project has three main objectives: 1) Forecast the location and quality of habitat for at least 100 North American tree species under two climate change scenarios, for the years 2050 and 2100. 2) Measure the minimum required migration distance from each species# current location to the nearest favorable future habitat. Information on the locations of future refuges will be integrated with existing forest fragmentation data to quantify the quality of those refuges and to determine the amount of biotic #resistance# species are likely to encounter as their ranges shift toward those refuges. 3) Assess, with the assistance of other forest geneticists and ecologists, the susceptibility of forest tree populations to genetic degradation and extirpation based on these results and on each species# biological characteristics. Central to this study is the Multivariate Spatio-Temporal Clustering (MSTC) technique, which combines aspects of traditional geographical information systems and statistical clustering tools to statistically model environmental niche envelopes, which can be used to forecast a species# geographic range under climate change. Incorporating more than a dozen spatial environmental variables, it will predict the future location and quality of habitat for tree species and, along with consideration of species# biological attributes, will allow for an assessment of whether migrating species might be able to track the appropriate environmental conditions over time and avoid the loss of extensive genetic variation. The primary products of this work will be a set of large-scale, 4-km2 resolution maps for each of the tree species included in the study. These will be packaged and available to the public through a new online atlas of climate change genetic risk for North American forest trees. These should be valuable for scientists and policymakers attempting to determine which forest tree species and populations, in the face of climate change, should be targeted 1) for monitoring efforts, 2) for in situ and ex situ conservation actions, and 3) for molecular marker studies that quantify the genetic architecture and diversity of at-risk species. The results also should be useful for land-use planners and conservation organizations interested in identifying geographic locations that could be preserved as important future habitat for at-risk tree species.

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