Modeling Future Forests

SYNOPSIS / APRIL 28, 2016 / BY JENNIFER HUSHAW

In recent years, there has been growing interest in anticipating how modern climate change may lead to shifts in tree species abundance and distribution.

While there is uncertainty in model results, two things we can say for sure are: (1) tree species will respond independently, so we may see novel species associations in some locations in the future and (2) there will be significant time lags in forest response.

Vegetation Models: An Overview

Models used to assess potential tree species shifts can be broadly sorted into two categories on either end of a spectrum, from empirical (i.e. statistical) to process-based (i.e. mechanistic) models.

EMPIRICAL MODELS quantify statistical relationships between species occurrence data, such as plot data from the US Forest Service Forest Inventory and Analysis (FIA), and relevant environmental variables, such as soils and climate, then use those correlations to project into the future (often referred to as species distribution, niche, or bioclimatic envelope models).

PROCESS-BASED MODELS are generally more complex because they simulate the actual underlying processes, such as disturbance, growth, and regeneration (e.g. forest gap, ecosystem, forest landscape, and dynamic global vegetation models).

These are not mutually exclusive and an increasing number of hybrid approaches are used in research. Nor is one approach necessarily better than another—each has its strengths and weaknesses depending on scale, data availability, and research question.

Underestimating Adaptability

As noted previously, models that rely on statistical relationships between environmental variables and FIA-based species distributions (i.e. the realized niche) can underestimate adaptability, since this represents only a portion of the possible conditions under which a species *could* grow (i.e. the fundamental niche). This is not to say that forests aren't vulnerable in other ways, such as increasing damage from exotic pests and extreme weather, but they may be more adaptable in terms of temperature tolerance than some results suggest.

Take-Home Message

As an initial step, we recommend CSLN members peruse the results of the modeling efforts listed in Table 2 of the full bulletin, for a sense of the *general* outlook for species that dominate their economic or management concerns. Noting where (and if) the models agree can highlight potential areas of vulnerability (or opportunity) to be explored further. Members with an interest in digging-in on the projections for a particular species can contact the CSLN staff for additional information/assistance.

All the modeling efforts agree on one thing—conditions are going to change. Most tree species will begin to experience novel climate conditions in some portion of their range and, in some cases, that may lead to local extirpation. Ultimately, the uncertainty is in knowing exactly *where* and *when* these species distribution shifts will happen. Generally, we expect species range expansion at the leading edge, in northern and higher elevations, and range contraction at the trailing edge, in southern and low-altitudinal limits. Look for initial forest composition changes at range margins—it is regeneration success or failure there that will determine whether a species persists or migrates.

Note: See the full bulletin for more detail, a comparison of several large-scale modeling efforts, and a short list of "best practices" for utilizing the results.

Click on sub-headings & underlined text to go to the corresponding section of the full bulletin, or read the complete bulletin online: http://climatesmartnetwork.org/2016/04/modeling-future-forests/