INFORMATION SYNTHESIS FOR PREDICTING CLIMATE CHANGE IMPACTS ON INVASIVE SPECIES

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ABSTRACT

The objective of this work is to develop strategies to incorporate aspects of climate change into analytical tools and products, so that they can be used for longer term planning and management decisions. Issues to consider include the direct change in insect and pathogen biology, the direct changes in host plant biology, the changes in agent-host interactions, and the changes in interactions with other disturbance agents (fire, storms, etc). Issues specific to invasive species include impacts on the speed of spread, the biological range of habitats, and the eventual geographic extent of the invader.

The institutional tools and products we want to make "climate smart" include operational risk and hazard models and rating systems; the strategic National Insect and Disease Risk Map (NIDRM); species-specific non-native invasive risk analyses; and insect and pathogen management impact models for the Forest Vegetation Simulator (FVS). Various analytical relationships are used in existing tools and products. Existing models of relationships range from simple correlations to complex process models; the simple ones often reflect our incomplete state of knowledge and understanding of these biological systems. When climate relationships are represented by correlated, non-climatic variables, direct modeling of future climate scenarios is not possible. For non-native organisms, "incomplete knowledge" is usually a gross understatement.

Modeled descriptions of risk relationships between agents and hosts may use physiographic site descriptors, climate, or calculated variables such as moisture stress, which represent biological processes. In a changing climate, correlates and indices of climate (elevation, latitude, and site index) are not stable, requiring further analysis. Our analytical process considers the following questions: what are the known agent/host/climate relationships; how might climate change modify these relationships; how might climate change create new problems; and where, when, and how much might these changes impact forest resources. Our specific projects include construction of a Risk and Hazard Rating System Database; a Pest and Host Range Mapping System; and a Pest, Host, and Climate mechanism publication summary.

The Risk and Hazard Rating System Database was developed as a Microsoft Access database. It includes details on about 520 citations, about 190 available within the product as PDFs or online with URL links. Entries include agent and host, independent and dependent variables, model type, geographic range, and bibliographic citations. The assembled variables found to be significant in risk assessments and empirical evaluations will help indicate how projected climate change for an area may modify risk conditions. Even through direct climate information may not have been included in the original studies or models, correlates such as aspect, elevation, habitat type, site index, and latitude should be useful in projecting at least the impact of changes in temperature and precipitation.

Our Pest and Host Range Mapping system links an Access database and an ArcGIS geographic database to store information about host-pest relationships and spatial information for host and pest distributions and observed and predicted damage locations. We currently have entries for about 800 tree species and 3,500 pest species. This system has the potential to extract climatic and related physiographic factors limiting host and pest range and for use with climate scenario vegetation range change projections.

We are also reviewing climate change literature to assemble a comprehensive list of climate factors that have been documented as mechanisms impacting pest biology, host biology, or pest x host interactions. This information is being summarized in a simple database linking mechanisms, pest groups, and citations.

The National Insect and Disease Risk Map is a national Forest Service product to project potential future forest damage. FHTET has been asked to build functionality into the NIDRM, which could include longer term climate change impacts. We are currently building procedures to integrate external research results on the impact of climate change scenarios on forest stresses and species distributions, modifications of existing risk models, and the other broad, potential impacts of climate change on forest health not at issue under current conditions.

At the fine spatial scale project level, we are investigating the use of our FVS-BGC model as a practical means not only for incorporating climate change scenarios into growth and yield models, but also for estimating stress and other forest health-related hazards to potential insect and disease risks.