Chapter 9. Summary

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Healthy ecosystems are those that are stable and sustainable, able to maintain their organization and autonomy over time while remaining resilient to stress (Costanza 1992). The National Forest Health Monitoring (FHM) Program of the Forest Service, U.S. Department of Agriculture, with its cooperating partners within and outside the Forest Service, quantifies the health of U.S. forests within the context of the sustainable forest management criteria and indicators outlined in the Santiago Declaration on the conservation and sustainable management of temporal and boreal forests (Anon. 1995). The analyses and results outlined in this report offer a snapshot of the current condition of U.S. forests, incorporating baseline investigations of forest ecosystem health (chapters 2, 3, and 4), examination of change over time in forest health metrics (chapters 5 and 6), and the assessment of developing threats to forest stability and sustainability (chapters 7 and 8).

Understanding the landscape-scale impacts of forest fragmentation requires quantifying the context in which natural landcover exists (chapter 2). A newly developed landcover context model classifies every 0.09-ha parcel of land in the conterminous United States based on the surrounding natural, developed, and agricultural landcover. Using this approach, at least half of the area of the conterminous United States can be characterized as a natural background for scales ranging from several hectares to several hundred hectares. Agricultural and developed landcover backgrounds are important locally but typically occupy < 30 percent of the total area at regional scales. At local scales, forest and grassland tend to occur in contexts dominated by natural landcover types. The same is the case at regional scales in the West but not in the East, where more forest occurs within agricultural and developed contexts.

Lichen species diversity provides a promising metric for quantifying the effects of air pollution and other environmental variables on forest ecosystems (chapter 3). Lichen community data, collected since 1994, are relatively insensitive to local variation in forest structure and more related to large-scale variables in most areas. Specifically, lichen diversity in the East appears to be negatively influenced by deposition of NO_3^- and thus may be a useful indicator of forest response to air pollution and other human impacts, but it may not be a useful indicator for response to changes in climate in the East. In the West, lichen diversity is correlated with environmental variables, such as precipitation, latitude, and elevation. If interpreted carefully, however, lichen diversity may also serve as a useful indicator for pollution and climate response in the West.

Biodiversity is a central component of forest health. Like the lichen community data, data for the vegetation diversity and structure indicator from the Forest Inventory and Analysis (FIA) Program of the Forest Service are collected on phase 3 (P3) plots, providing important baseline information on the composition of forest vascular plants, including the presence of exotic species (chapter 4). In general, forests in cool and moist areas support more plant species than those in hotter and drier climates. Sixty-seven percent of the plots contain at least one introduced plant with multiflora rose, cheatgrass, and Japanese honeysuckle being the most common exotics. The P3 vegetation data will be a powerful tool for assessing change when plots are revisited.

Mortality is a natural process in all forested ecosystems, but high levels of mortality at large scales may indicate that the health of forests is declining. FIA phase 2 data offer tree mortality information at a more spatially intense sample than the P3 data used in past forest health annual technical reports (chapter 5). A test of this approach for six Midwestern States found that the areas of highest mortality relative to growth were in the Loess Hills of Missouri and in northern Minnesota. Much of the mortality in Missouri may be the result of American elm loss to Dutch elm disease, while the high mortality of quaking aspen in northern Minnesota may be attributable to a number of causes.

Several plant species are sensitive to elevated ozone levels, which can injure trees and make them more susceptible to pest and pathogen infestation. The Forest Service national ozone biomonitoring program aims to identify areas where the risk of ozone is high and the forest community is sensitive (chapter 6). Between 2003 and 2005, ozone injury to bioindicator plants was recorded in every FIA region except the Interior West, with injury occurrence relatively constant in the North and Pacific Northwest but decreasing in the South. While statistically significant logistic models were developed for each FIA region where ozone injury occurred on biomonitoring sites, logistic regression provided little improvement, in respect to predictive power, over standard spatial interpolation techniques. However, the results from analysis provide direction for future research.

A developing threat to forest health is laurel wilt, a disease causing widespread mortality in southeastern coastal redbay stands (chapter 7). Laurel wilt is caused by a fungus associated with the exotic redbay ambrosia beetle, which has spread to coastal areas of Georgia, South

Carolina, and Florida after its initial detection in 2002. The climatically suitable area for the beetle is largely constrained to the coastal plain of the southeastern United States. Based on host species distributions, climate matching, and spread modeling, the infestation is likely to expand north and south along the Atlantic coast and west along the gulf coast, with the entire range of redbay at approximately equal risk of infestation.

Sudden oak death, a more established forest tree disease first detected in the mid-1990s, remains limited to northern California and Oregon but may pose a considerable threat to other regions, especially the oak-dominated forests of the Eastern United States (chapter 8). Terrestrial vegetation survey early detection efforts in 39 States between 2003 and 2006 documented only one previously unknown occurrence of *Phytophthora ramorum* in California, suggesting that it is not yet widely established in U.S. forests. However, it is likely that infected landscape plants have been planted in high-risk areas. Stream baiting surveys conducted in 2007 in 152 streams across 28 States detected the pathogen in two streams not previously known to harbor the pathogen, near woody plant nurseries in Washington and Mississippi. Stream baiting for the pathogen appears to be an efficient approach for early detection surveys.

This report presents results from the ongoing national scale detection monitoring efforts from FHM and its cooperators using a wide variety of regional-scale data and analysis techniques. For more information about efforts to determine the status, changes, and trends in indicators of the condition of U.S. forests, please visit the FHM Web site at http://fhm.fs.fed.us. This FHM national technical report is produced by the National Forest Health Monitoring Research Team, which is a part of the Eastern Forest Environmental Threat Assessment Center established under the Healthy Forest Restoration Act as part of a nationwide network of early warning activities about threats to forest health. For more information about the research team and about threats to U.S. forests, please visit www.forestthreats.org/about.

Literature Cited

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