Chapter 1. Introduction

Mark J. Ambrose

This annual technical report is a product of the Forest Health Monitoring (FHM) Program. The report provides information about a variety of issues relating to forest health at a national scale. FHM national reports have the dual focus of presenting analyses of the latest available data and showcasing innovative techniques for analyzing forest health data. The report is organized using the Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests (Anon. 1995) as a general reporting framework.

While FHM is committed to reporting annually on the state of U.S. forests, there are not always enough new data available to warrant reporting on each indicator every year. In this report, indicators are included if a substantial amount of new data has become available since they were last reported by FHM, or if progress in the development and application of analytical techniques has enabled FHM to use the data to provide new insights into the health of U.S. forests. Earlier reports have strongly focused on indicators of forest condition and on levels of stressors that may be affecting forest health. In this report we also examine some of the mechanisms behind the stressors that affect U.S. forests, including the relationship of lightning to forest fires and pathways by which exotic insect pests can be introduced.

The Forest Health Monitoring Program

The FHM Program is a national effort to determine on an annual basis the status of, and changes and trends in, indicators of forest condition. The Forest Service, U.S. Department of Agriculture cooperates with State forestry and agricultural agencies to conduct FHM activities. Other Federal Agencies and universities also participate. The FHM Program has five major activities (Tkacz 2003):

- Detection monitoring—nationally standardized aerial and ground surveys to evaluate status and change in condition of forest ecosystems
- Evaluation monitoring—projects to determine extent, severity, and causes of undesirable changes in forest health identified through detection monitoring
- Intensive site monitoring—to enhance understanding of cause and effect relationships by linking detection monitoring to ecosystem process studies and to assess specific issues, such as calcium depletion and carbon sequestration, at multiple spatial scales

- Research on monitoring techniques—to develop or improve indicators, monitoring systems, and analytical techniques, such as urban and riparian forest health monitoring, early detection of invasive species, multivariate analyses of forest health indicators, and spatial scan statistics
- Analysis and reporting—synthesis of information from various data sources within and external to the Forest Service to produce issue-driven reports on the status of and change in forest health at national, regional, and State levels

In addition to FHM's national reporting, each of the five FHM regions, as well as FHM's partners both within the Forest Service and in State forestry departments, also produce reports. The regions, in cooperation with their respective States, produce "Forest Health Highlights" (available on the FHM Web site at www.fhm.fs.fed.us); State reports such as Keyes and others (2003), Laustsen and others (2003), Neitlich and others (2003), Steinman (2004), and Snyder (2006); and other forest health reports, such as Morin and others (2006) and Cumming and others (2006). FHM and its partners also produce reports on monitoring techniques and analytical methods, such as Smith and Conkling (2004) and O'Neill and others (2005).

Data Sources

The FHM Program strives to use a variety of data collected by the various branches of the Forest Service as well as data from other sources. A major data source is the Forest Service's Forest Inventory and Analysis (FIA) Program. The FIA Program's phase 2 consists of plots measured at regular intervals to collect data associated with traditional forest inventories. FIA's phase 3 plots are a subset of the phase 2 plots. On phase 3 plots additional data are collected on many of the forest health indicators that were previously measured as part of the FHM detection monitoring ground plot system (Palmer and others 1991).[1]

For this report, Forest Service data sources were: FIA periodic inventory and annualized phase 2 survey data (1990–2003)[2]; FIA phase 3 data—crown condition (2000–04), lichens (1998–2003); and Forest Health Protection (FHP) aerial survey data

[1] U.S. Department of Agriculture Forest Service. 1998. Forest health monitoring 1998 field methods guide. Research Triangle Park, NC: U.S. Department of Agriculture Forest Service, National Forest Health Monitoring Program, 473 p. On file with: Forest Health Monitoring Program National Office, 3041 Cornwallis Road, Research Triangle Park, NC 27709.

[2] U.S. Department of Agriculture Forest Service, Forest Inventory and Analysis National Office,1601 North Kent Street, Suite 400, Arlington, VA 22209. http://fia.fs.fed.us/tools-data/data/. [Date accessed: September 1, 2005].

(1998–2004).[3] Other data sources were: National Aeronautics and Space Administration (NASA)—lightning data (Global Hydrology Resource Center 2004); National Oceanic and Atmospheric Administration—Palmer Drought Severity Index (1895 through 2005) (National Climatic Data Center 1994); moderate resolution imaging spectroradiometer (MODIS) fire data for 2001–05 (Forest Service, Remote Sensing Application Center 2006); National Interagency Coordination Center (2004) data on forest area burned in 2005, U.S. Army Corps of Engineers Navigation Data Center (2005)—marine cargo data (1997–2003); and U.S. Department of Transportation, Bureau of Transportation Statistics and U.S. Department of Commerce, U.S. Census Bureau (2005)—commodity flow data.

About the Report

In this report we used the Santiago Declaration and accompanying criteria and indicators (Anon. 1995, Montreal Process Working Group 1999) that were adopted by the Forest Service as a forest sustainability assessment framework (Smith and others 2001, U.S. Department of Agriculture Forest Service 2004). The seven criteria are:

Criterion 1—conservation of biological diversity

Criterion 2—maintenance of productive capacity of forest ecosystems

Criterion 3—maintenance of forest ecosystem health and vitality

Criterion 4—conservation and maintenance of soil and water resources

Criterion 5—maintenance of forest contribution to global carbon cycles

Criterion 6—maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of societies

Criterion 7—legal, institutional, and economic framework for forest conservation and sustainable management

A complete evaluation of all the sustainability criteria is not appropriate here. We focus on criterion 3, which is directly related to issues of forest health.

Bailey's ecoregion sections and provinces (Bailey 1995) as revised (Cleland and others 2005) were used as the assessment units for analysis (fig. 1.1)[4] when the spatial scale of the

[3] U.S. Department of Agriculture Forest Service, Forest Health Technology Enterprise Team. Unpublished database. On file with: FHP/FHTET, 2150 Centre Avenue, Building A, Suite 331, Fort Collins, CO 80526–1891.

[4] Chapter 5, "Baseline Results from the Lichen Community Indicator Program in the Pacific Northwest: Air Quality Patterns and Evidence of a Nitrogen Pollution Problem," is an exception. The analyst used an earlier version of Bailey's ecoregion section delineations (McNab and Avers 1994) to be consistent with the results of earlier lichen analyses referenced.

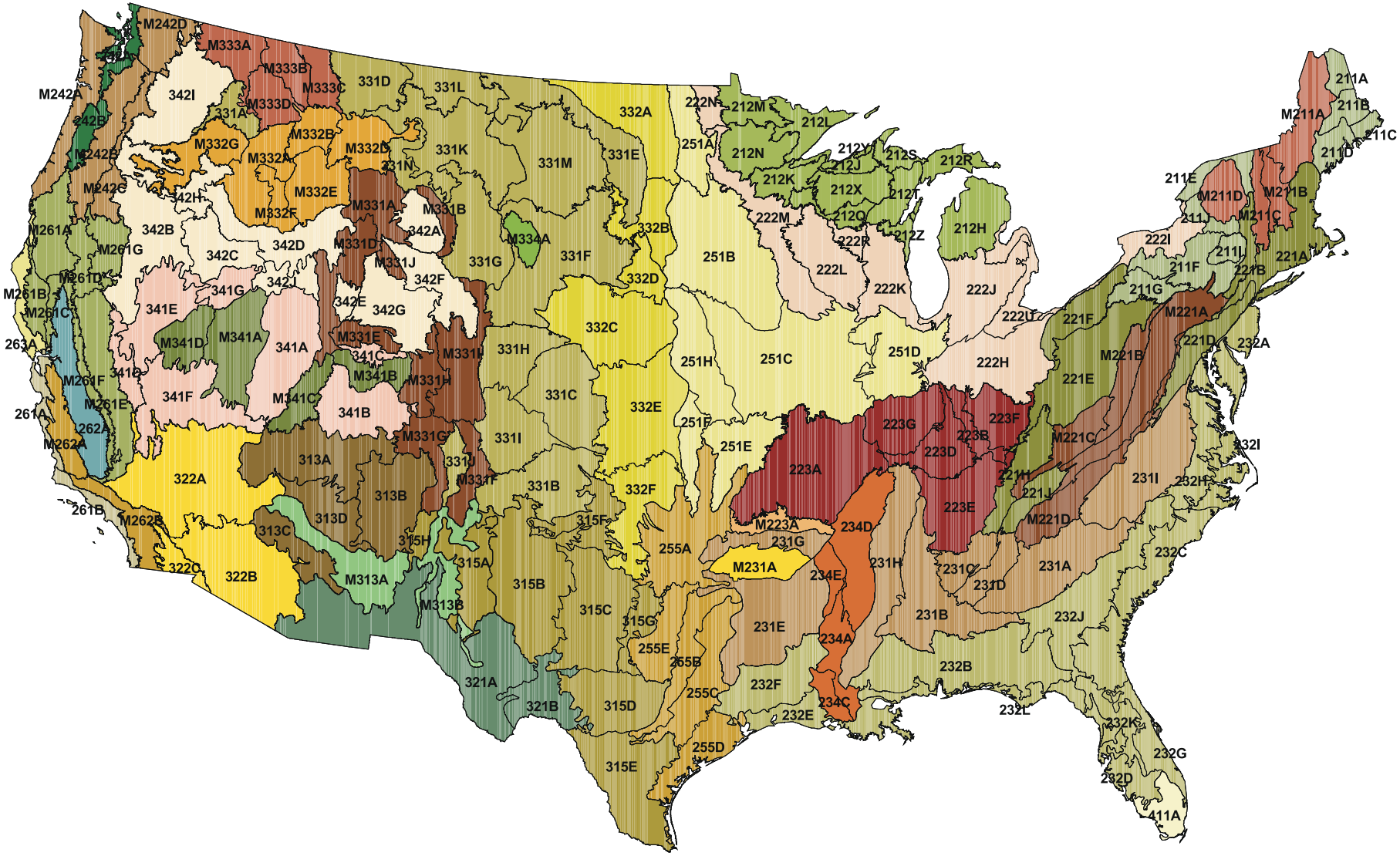

Figure 1.1—Ecoregion provinces and ecoregion sections for the continental United States (Cleland and others 2005). Ecoregion sections within each ecoregion province are shown in the same color.

Eastern ecoregion provinces

- Adirondack—New England Mixed Forest—Coniferous Forest—Alpine Meadow (M211)
- Central Appalachian Broadleaf Forest—Coniferous Forest—Meadow (M221)
- Central Interior Broadleaf Forest (223)
- Eastern Broadleaf Forest (221)
- Everglades (411)
- Laurentian Mixed Forest (212)
- Lower Mississippi Riverine Forest (234)
- Midwest Broadleaf Forest (222)
- Northeastern Mixed Forest (211)
- Ouachita Mixed Forest—Meadow (M231)
- Outer Coastal Plain Mixed Forest (232)
- Ozark Broadleaf Forest (M223)
- Prairie Parkland (Subtropical) (255)
- Prairie Parkland (Temperate) (251)
- Southeastern Mixed Forest (231)

Western ecoregion provinces

- American Semi-Desert and Desert (322)
- Arizona—New Mexico Mountains Semi-Desert—Open Woodland—Coniferous Forest—Alpine Meadow (M313)
- Black Hills Coniferous Forest (M334)
- California Coastal Chapparal Forest and Shrub (261)
- California Coastal Range Open Woodland—Shrub—Coniferous Forest—Meadow (M262)
- California Coastal Steppe, Mixed Forest, and Redwood Forest (263)
- California Dry Steppe (262)
- Cascade Mixed Forest—Coniferous Forest—Alpine Meadow (M242)
- Chihuahuan Semi-Desert (321)
- Colorado Plateau Semi-Desert (313)
- Great Plains—Palouse Dry Steppe (331)
- Great Plains Steppe (332)
- Intermountain Semi-Desert (342)
- Intermountain Semi-Desert and Desert (341)
- Middle Rocky Mountains Steppe—Coniferous Forest—Alpine Meadow (M332)
- Nevada—Utah Mountains—Semi-Desert—Coniferous Forest—Alpine Meadow (M341)
- Northern Rocky Mountains Forest—Steppe—Coniferous Forest—Alpine Meadow (M333)
- Pacific Lowland Mixed Forest (242)
- Sierran Steppe—Mixed Forest—Coniferous Forest—Alpine Meadow (M261)
- Southern Rocky Mountains Steppe—Open Woodland—Coniferous Forest—Alpine Meadow (M331)
- Southwest Plateau and Plains Dry Steppe and Shrub (315)

available data made such analyses appropriate and when the indicator being analyzed could reasonably be expected to show some pattern relating to ecological regions. This is a national, hierarchical system of ecological units that classifies the United States into ecoregion domains, divisions, provinces, sections, subsections, landtype associations, and landtypes (McNab and others 2005). Ecoregion sections typically contain thousands of square miles. Areas within an ecoregion section are expected to be similar in their geology and lithology, regional climate, soils, potential natural vegetation, and potential natural communities (Cleland and others 1997). Ecoregion sections provide a common framework for an ecologically based assessment.

Literature Cited

Anon. 1995. Sustaining the world's forests: the Santiago agreement. Journal of Forestry. 93: 18–21.

Bailey, R.G. 1995. Descriptions of the ecoregions of the United States. 2d ed. Misc. Publ.1391. Washington, DC: U.S. Department of Agriculture Forest Service. 108 p. [Map scale 1:7,500,000].

Cleland, D.T.; Avers, P.E.; McNab, W.H. [and others]. 1997. National hierarchical framework of ecological units. In: Boyce, M.S.; Haney, A., eds. Ecosystem management applications for sustainable forest and wildlife resources. New Haven, CT: Yale University Press: 181–200.

Cleland, D.T.; Freeouf, J.A.; Keys, J.E. [and others]. 2005. Ecological subregions: sections and subsections for the conterminous United States. Washington, DC: U.S. Department of Agriculture Forest Service. Map, presentation scale 1:3,500,000; colored]. [Also on CD–ROM as a Geographic Information System coverage in ArcINFO format].

Cumming, A.B.; Twardus, D.B.; Smith, W.D. 2006. National forest health monitoring program, Maryland and Massachusetts street tree monitoring pilot projects. NA–FR–01–06. Newtown Square, PA: U.S. Department of Agriculture Forest Service, Northeastern Area, State and Private Forestry. 23 p.

Keyes, C.; Rogers, P.; LaMadeleine, L. [and others]. 2003. Utah forest health report: a baseline assessment, 1999–2001. Salt Lake City: Utah Department of Natural Resources, Division of Forestry, Fire and State Lands. 47 p.

Laustsen, K.M.; Griffith, D.M.; Steinman, J.R. 2003. Fourth annual inventory report on Maine's forests. Augusta, ME: Maine Forest Service; Newtown Square, PA: U.S. Department of Agriculture Forest Service, Northeastern Research Station and Northeastern Area. 49 p. http://mainegov-images.informe.org/doc/mfs/pubs/pdf/anninv/2002invrpt.pdf. [Date accessed: June 22, 2004].

McNab, W.H.; Avers, P.E., comps. 1994. Ecological subregions of the United States: section descriptions. WO–WSA–5. Washington, DC: U.S. Department of Agriculture Forest Service. 267 p.

McNab, W.H.; Cleland, D.T.; Freeouf, J.A. [and others], comps. 2005. Description of ecological subregions: sections of the conterminous United States [CD–ROM]. Washington, DC: U.S. Department of Agriculture Forest Service. 80 p.

Montreal Process Working Group. 1999. Criteria and indicators for the conservation and sustainable management of temperate and boreal forests: Montreal process. 2d ed. Montreal, Canada: Montreal Process Working Group; Ottawa, Canada: Canadian Forest Service. 19 p. http://www.mpci.org/rep-pub/1999/1999santiago_e.pdf and http://www.mpci.org/rep-pub/1999/ci_e.html. [Date accessed: July 18, 2006].

Morin, R.S.; Liebhold, A.M.; Gottschalk, K.W. [and others]. 2006. Analysis of forest health monitoring surveys on the Allegheny National Forest (1998–2001). Gen. Tech. Rep. NE–339. Newtown Square, PA: U.S. Department of Agriculture Forest Service, Northeastern Research Station. 102 p. http://www.fs.fed.us/ne/newtown_square/publications/technical_reports/pdfs/2006/ne_gtr339.pdf. [Date accessed: September 13].

National Aeronautics and Space Administration, Global Hydrology Resource Center. 2004. LIS/OTD 0.5-degree high resolution full climatology. http://ghrc.msfc.nasa.gov/. [Date accessed: March 7, 2006].

National Climatic Data Center. 1994. Time bias corrected divisional temperature-precipitation-drought index. Documentation for dataset TD–9640. On file with: Database Management Branch, National Climatic Data Center, National Oceanic and Atmospheric Administration, Federal Building, 37 Battery Park Avenue, Asheville, NC 28801–2733. 12 p. http://www.ncdc.noaa.gov/oa/climate/onlineprod/drought/readme.html. [Date accessed: unknown].

National Interagency Coordination Center. 2004. National Interagency Coordination Center 2004 statistics and summary. Boise, ID: National Interagency Fire Center. 10 p. http://www.nifc.gov/news/2004_statssumm/intro_summary.pdf. [Date accessed: May 13, 2005].

Neitlich, P.; Rogers, P.; Rosentretter, R. 2003. Lichen communities indicator results from Idaho: baseline sampling. Gen. Tech. Rep. RMRS–GTR–103. Fort Collins, CO: U.S. Department of Agriculture Forest Service, Rocky Mountain Research Station. 14 p.

O'Neill, K.P.; Amacher, M.C.; Perry, C.H. 2005. Soils as an indicator of forest health: a guide to the collection, analysis, and interpretation of soil indicator data in the forest inventory and analysis program. Gen. Tech. Rep. NC–258. St. Paul, MN: U.S. Department of Agriculture Forest Service, North Central Research Station. 53 p.

Palmer, C.J.; Riitters, K.H.; Strickland, T. [and others]. 1991. Monitoring and research strategy for forests - environmental monitoring and assessment program (EMAP). EPA/600/4–91/012. Washington, DC: U.S. Environmental Protection Agency. 187 p.

Smith, W.B.; Vissage, J.S.; Darr, D.R.; Sheffield, R.M. 2001. Forest resources of the United States, 1997. Gen. Tech. Rep. NC–219. St. Paul, MN: U.S. Department of Agriculture Forest Service, North Central Research Station. 191 p.

Smith, W.D.; Conkling, B.L. 2004. Analyzing forest health data. Gen. Tech. Rep. SRS–077. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 33 p. http://www.srs.fs.usda.gov/pubs/gtr/gtr_srs077.pdf. [Date accessed: July 17, 2006].

Snyder, C., comp. 2006. Forest health conditions in Alaska – 2005. Prot. Rep. R10–PR–5. Anchorage, AK: U.S. Department of Agriculture Forest Service, Alaska Region; State of Alaska, Department of Natural Resources, Forestry Division. 92 p.

Steinman, J. 2004. Forest health monitoring in the Northeastern United States: disturbances and conditions during 1993–2002. NA–Tech. Pap. 01–04. Newtown Square, PA: U.S. Department of Agriculture Forest Service, State and Private Forestry, Northeastern Area. 46 p. http://fhm.fs.fed.us/pubs/tp/dist_cond/dc.shtm. [Date accessed: June 30, 2006].

Tkacz, B.M. 2003. Forest health monitoring program [factsheet]. Washington, DC: U.S. Department of Agriculture Forest Service, State and Private Forestry, Forest Health Protection. 2 p. http://www.fhm.fs.fed.us/fact/03/prog_desc.pdf. [Date accessed: May 18, 2005].

U.S. Army Corps of Engineers, Navigation Data Center. 2005. U.S. waterway data: foreign cargo (inbound and outbound) for 1997–2003. New Orleans, LA: U.S. Army Corps of Engineers, Navigation Data Center, Waterborne Commerce Statistics Center. http://www.iwr.usace.army.mil/ndc/data/dataimex.htm [Date accessed: October 23, 2006]

U.S. Department of Agriculture Forest Service. 2004. National report on sustainable forests—2003. FS–766. Washington, DC. 139 p.

U.S. Department of Agriculture, Forest Service, Remote Sensing Application Center. 2006. MODIS Active Fire Mapping Program: GIS data. Salt Lake City, UT: U.S. Department of Agriculture, Forest Service, Remote Sensing Application Center. http://activefiremaps.fs.fed.us/fireptdata.php [Date accessed: March 21]

U.S. Department of Transportation, Bureau of Transportation Statistics; U.S. Department of Commerce, U.S. Census Bureau. 2005. Commodity flow survey 2002 [CD–ROM]. C1–E02–ECFS–00–US1. Washington, DC.