Forest Health Monitoring

Program Overview

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National Program Manager

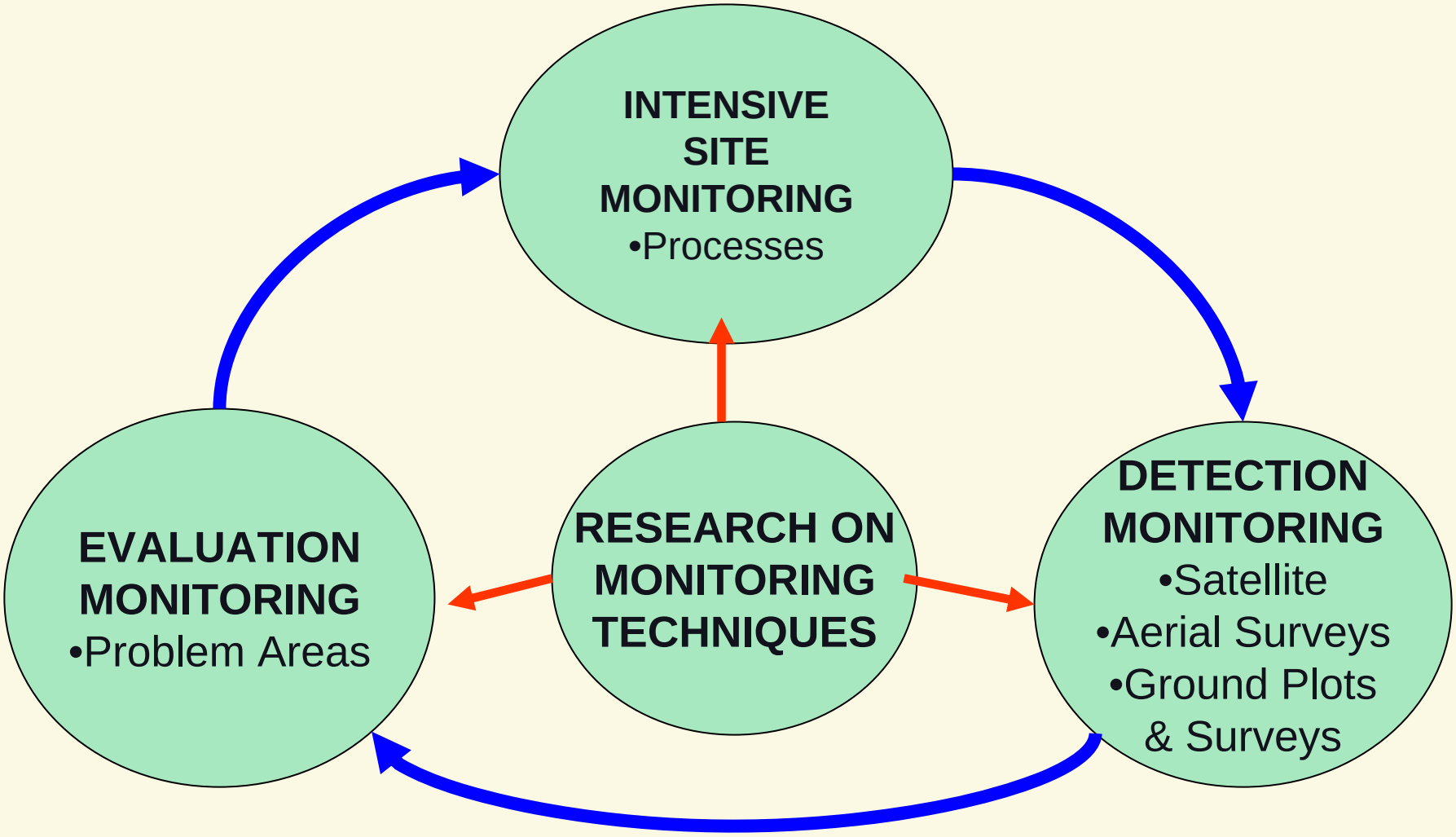
Forest Health Monitoring Program

- Initiated in 1990 to provide information on the status, changes, and trends in forest health and sustainability.
- The FHM program provides information on all forest lands to land-managers and policy makers that affects, directly or indirectly, all Americans.

FHM Objectives:

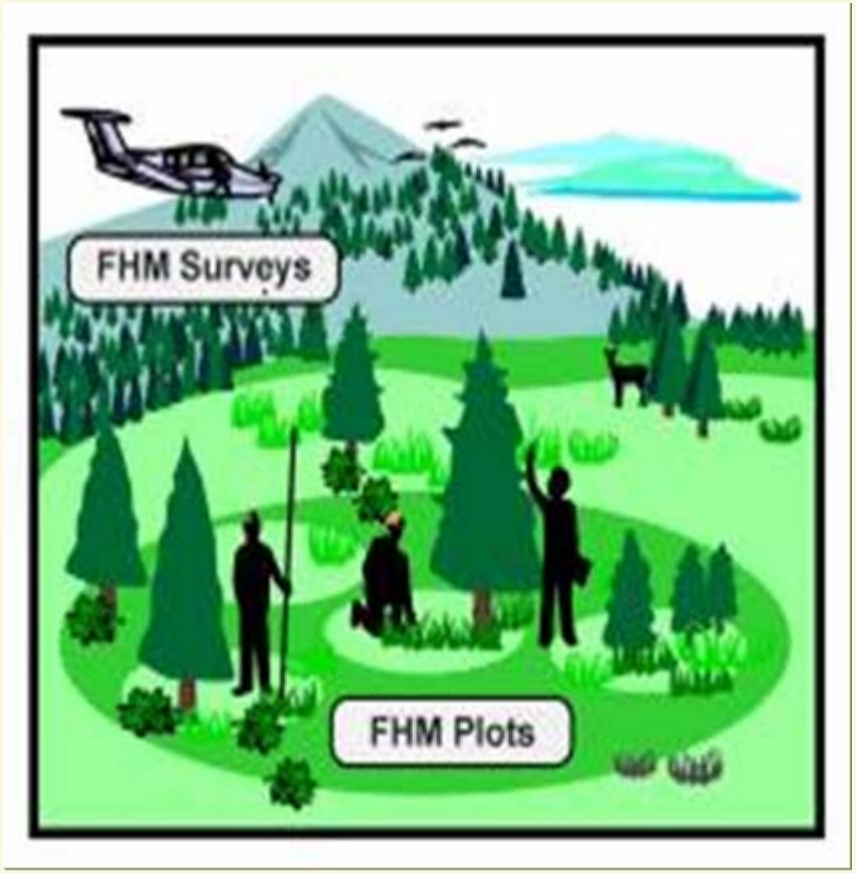
- Establish a monitoring system throughout the forests of the United States to determine detrimental changes or improvements that occur over time.
- Provide baseline and health trend information that is statistically precise and accurate.
- Report annually on status and changes to forest health.

Major Program Components

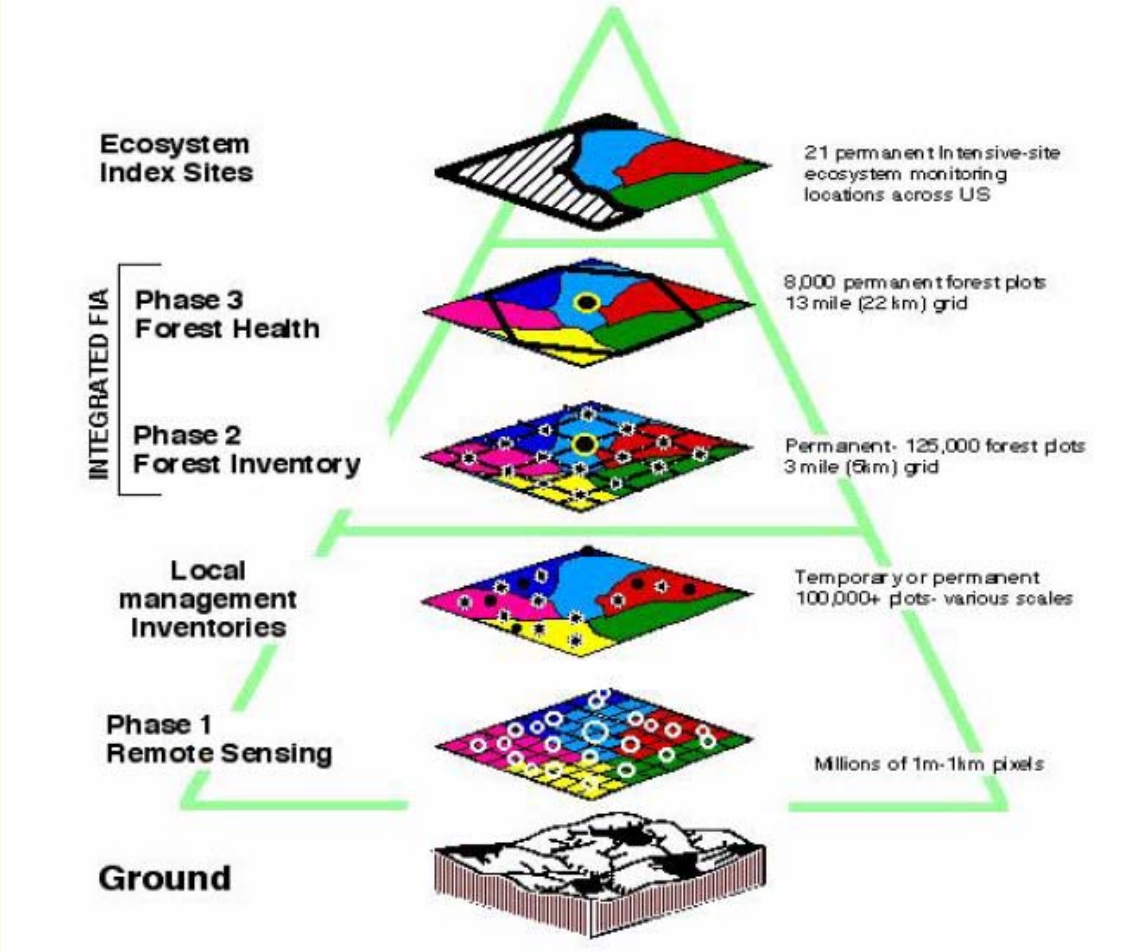


Detection Monitoring

- Nationwide grid of permanent sample points
- Aerial damage detection surveys
- Special ground surveys

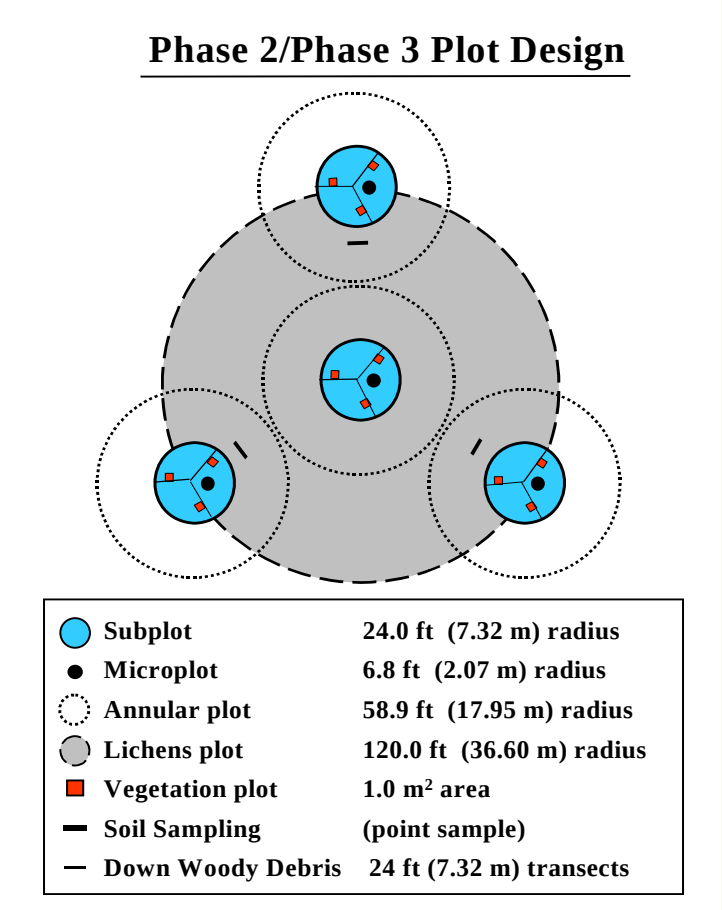


Integrated Monitoring Framework

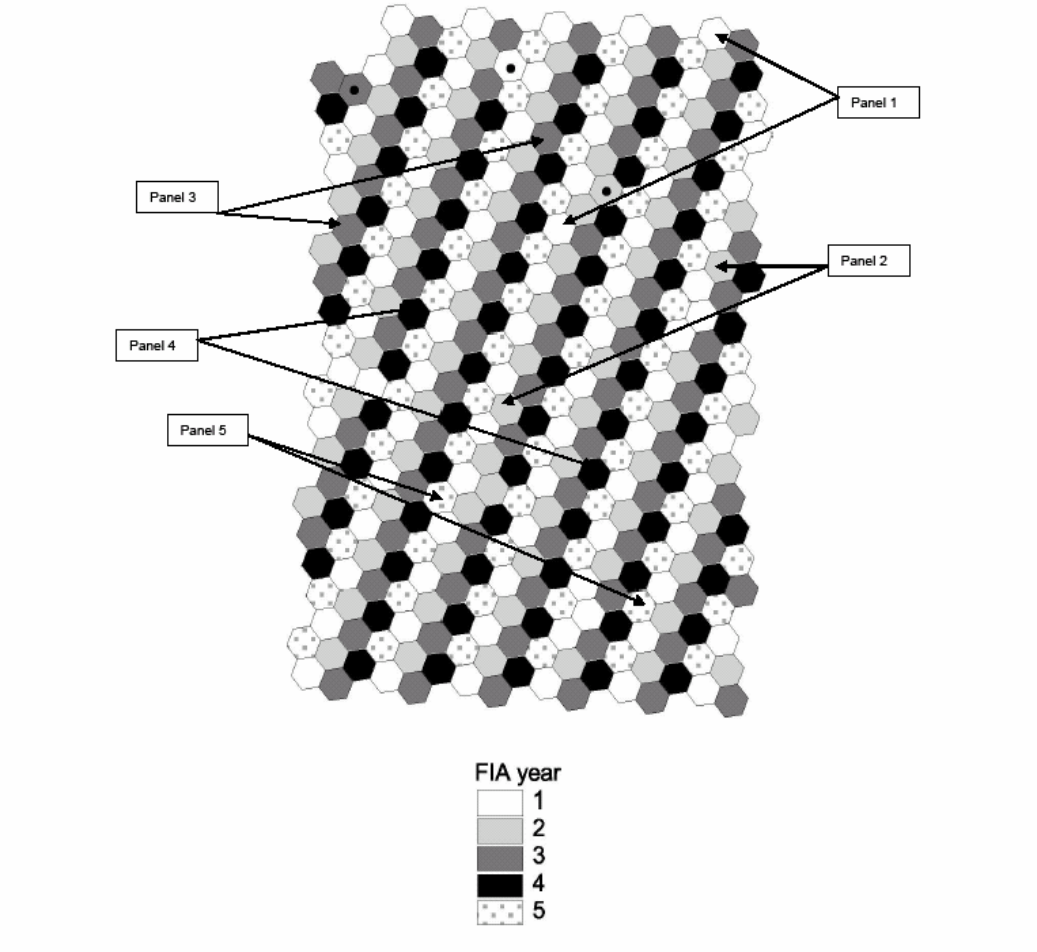


FHM/FIA Plot Integration

- Since 1999 FHM ground plots have been integrated with Forest Inventory and Analysis (FIA) plots
- Phase 2 – Tree Measurements (~125,000 plots, each representing ~6,000 ac.)
- Phase 3 – Health Indicators (~8,000 plots, each representing ~96,000 ac.)
- Each plot measured once every 5 to 10 years

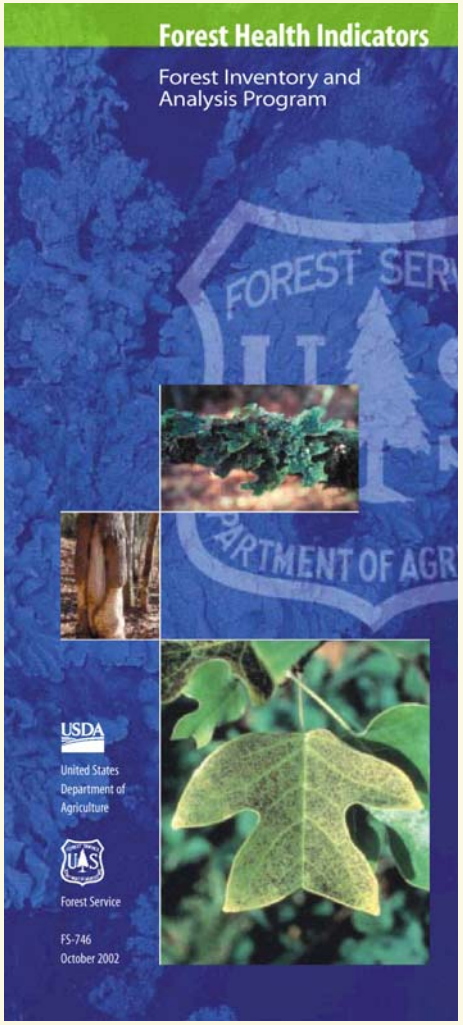


Rotating Panel Design



Forest Health Indicators

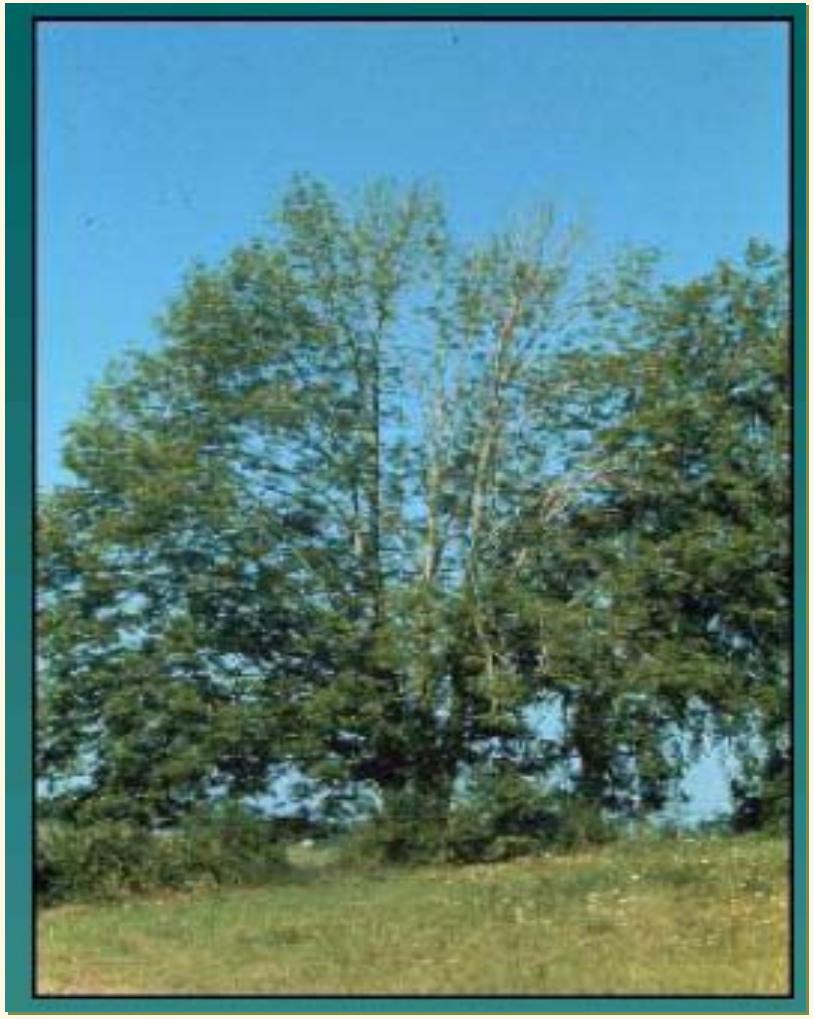
- Tree Growth
- Tree Regeneration
- Tree Crown Condition
- Tree Damage
- Tree Mortality
- Lichen Communities
- Ozone Bioindicator Plants
- Soil Morphology and Chemistry
- Vegetation Structure
- Plant Diversity



http://fia.fs.fed.us

Crown Condition

- Live crown ratio
- Density
- Foliage transparency
- Dieback
- Diameter



Lichen Communities

- Fungi that live in association with algae
- Sensitive to environmental stresses such as air pollution or climate change
- Indicators of forest biodiversity
- Biotic indexes are developed based on pollution and climate gradients

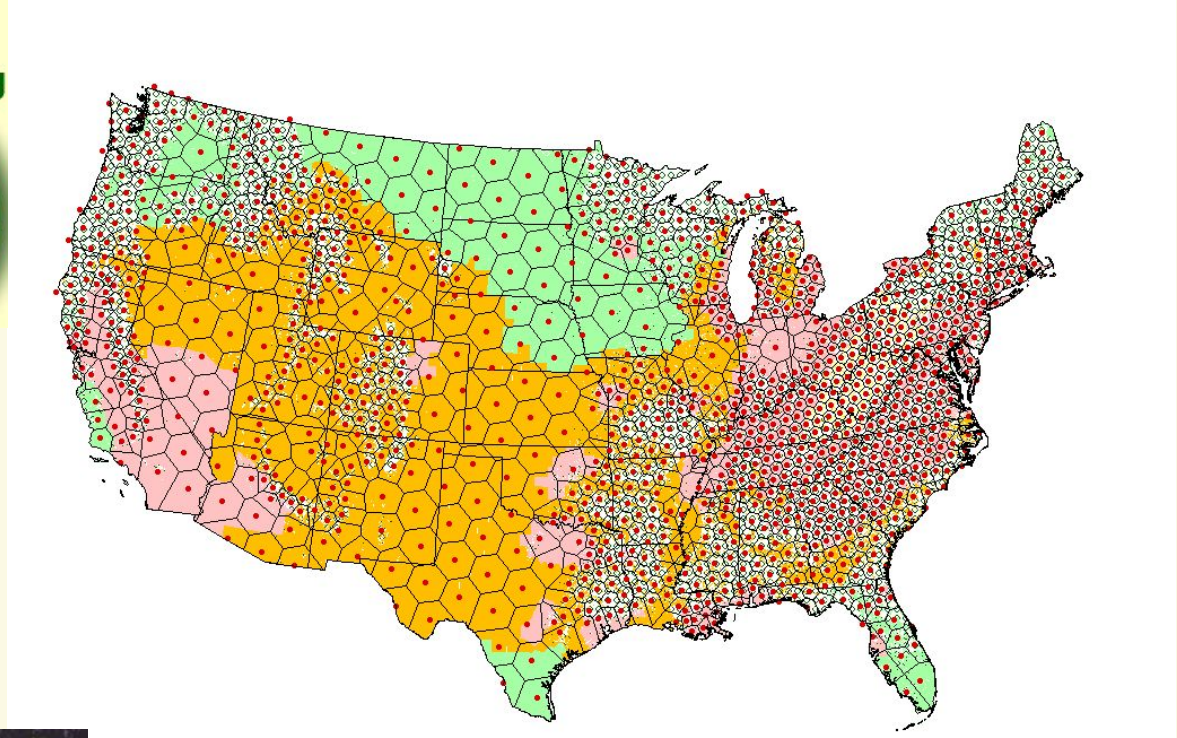
Photo by Stephen Sharnoff

Ozone Injury

- Ozone causes direct foliar injury to many species
- Bio-indicator plants are evaluated for severity of foliar injury
- Sampled on separate plots

Photo by Gretchen Smith

Ozone Biomonitoring



Down Woody Material

- Measurement of fallen trees, dead branches along transects
  - Diameter
  - Length
  - Stage of decay
  - Species
  - Cavities
- Assess fire risk, wildlife habitat, carbon

Photo by Chris Woodall

Vegetation Diversity and Structure

- Type, abundance, and arrangement of plants on plots
- Allows reporting on diversity of native and introduced species
- Monitoring for change over time will be possible by re-measurement

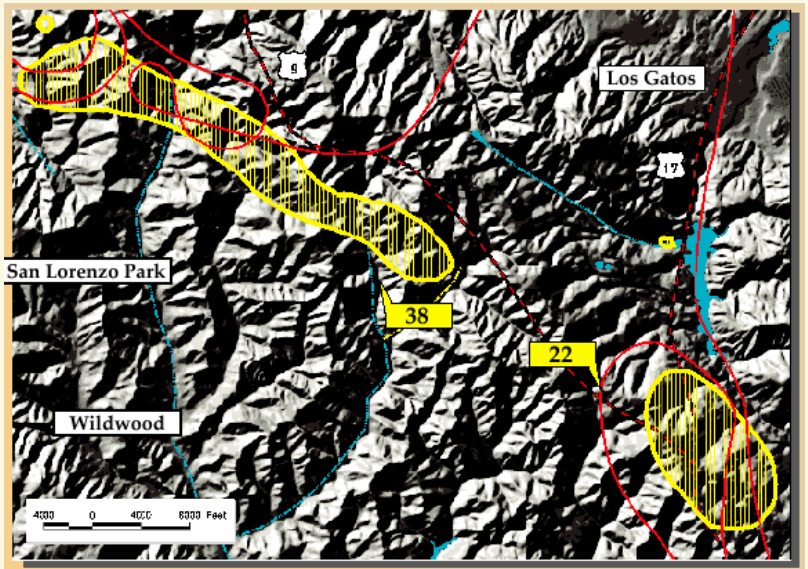
Photo by Will McWilliams

Soil Condition

- Measurement of soil physical properties, compaction, erosion potential
- Soil samples collected for chemical analyses
  - **Acidity**
  - **Exchangeable cations**
  - **Nitrogen and carbon**
  - **Toxics**
  - **Bulk density**

Detection Monitoring

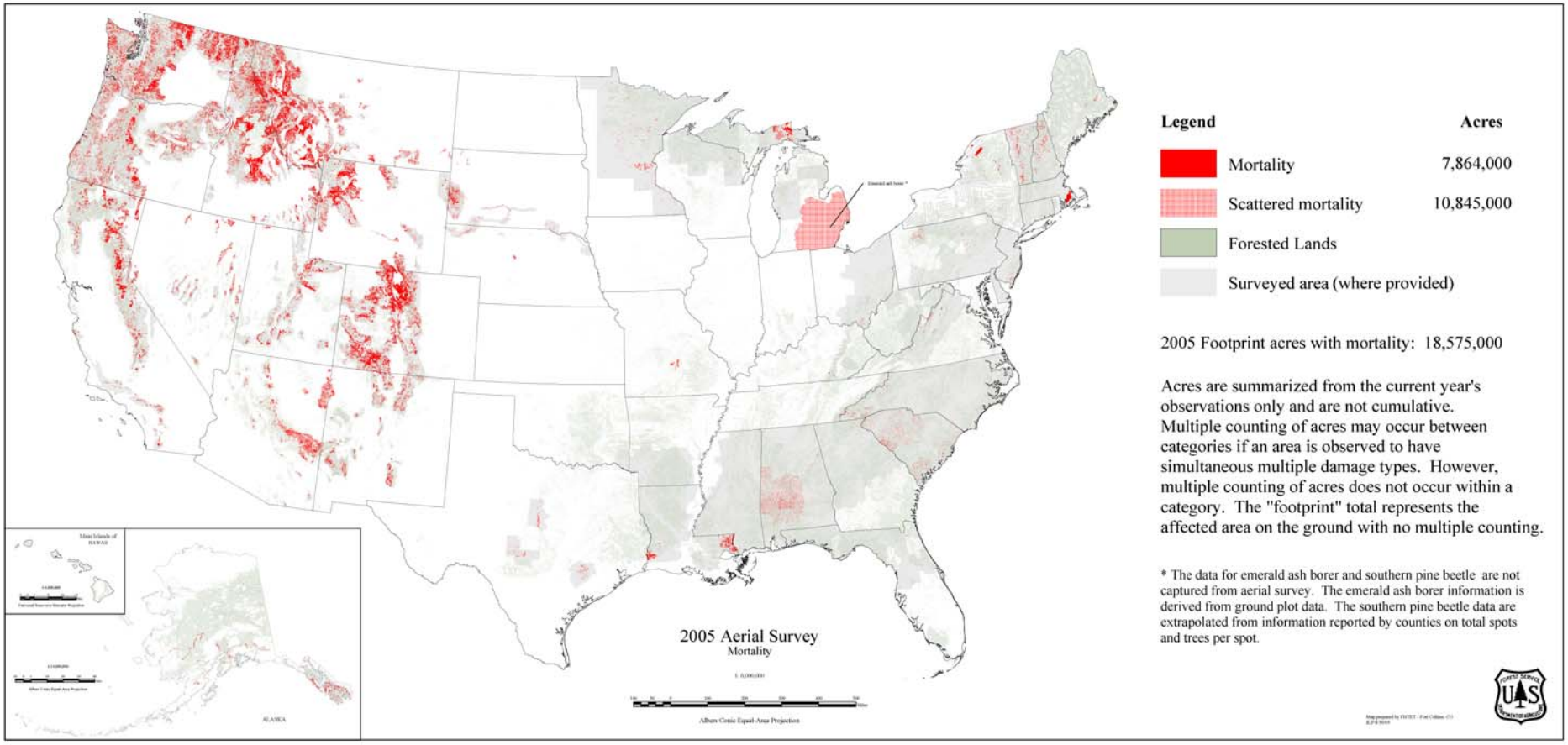
- Aerial Detection Surveys
  - Observers in aircraft at 1,000 to 2,000 ft. elevation
  - Create maps visible damage



USDA FOREST SERVICE

Caring for the Land and Serving People

National Forest Health Monitoring



Special Detection Surveys

Pine mortality in the Southwest

Piñon pine in New Mexico - 2003

Ponderosa pine in Arizona - 2003

Photos – FHP R3

Special aerial and ground surveys conducted in 2003 covering 15 million acres in AZ, NM, CO, UT, NV

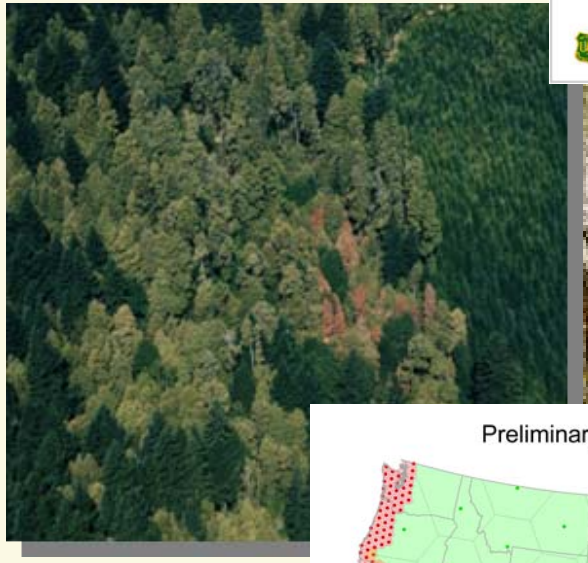
Special Detection Surveys

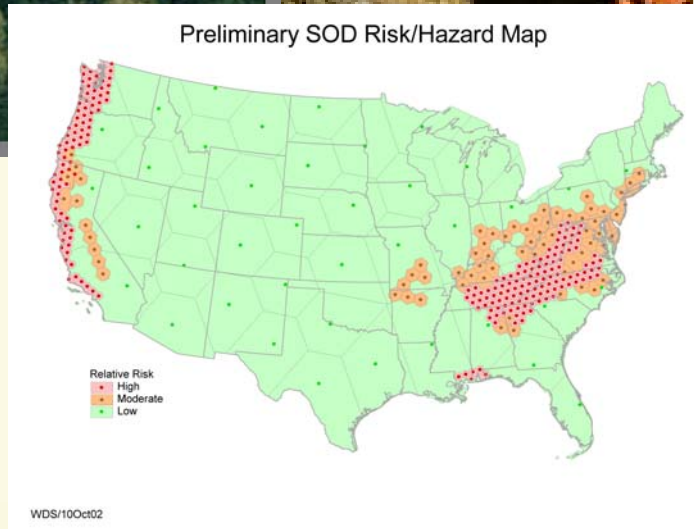
Sudden Oak Death

- Accelerated mortality of tanoak (*Lithocarpus densiflorus*) has been noted in California since 1995
- Extensive mortality of coast live oak (*Quercus agrifolia*) and CA black oak (*Q. kelloggii)* occurs in coastal areas of California
- Causal agent of disease identified as *Phytophthora ramorum* in 2000 by researchers at Univ. of California

Sudden Oak Death Detection and Monitoring

- Objectives:
  - Multi-scale approach to distribution, incidence, and impact of SOD in CA
  - Detection, effectiveness of eradication in OR
  - Detection outside infested areas in CA and OR





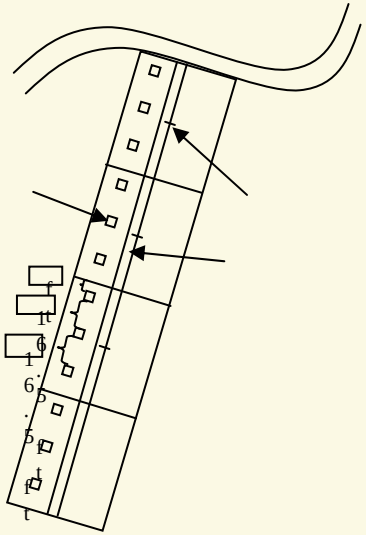
Maps and photos
Courtesy R5, ODF, SRS

Evaluation Monitoring

- Determine the extent, severity, and causes of undesirable forest health changes.
- Address likely cause-and-effect relationships, identify associations between forest health and forest stress indicators.
- Identify management consequences and alternatives for reducing the effects of forest stress.
- Identify research needs.

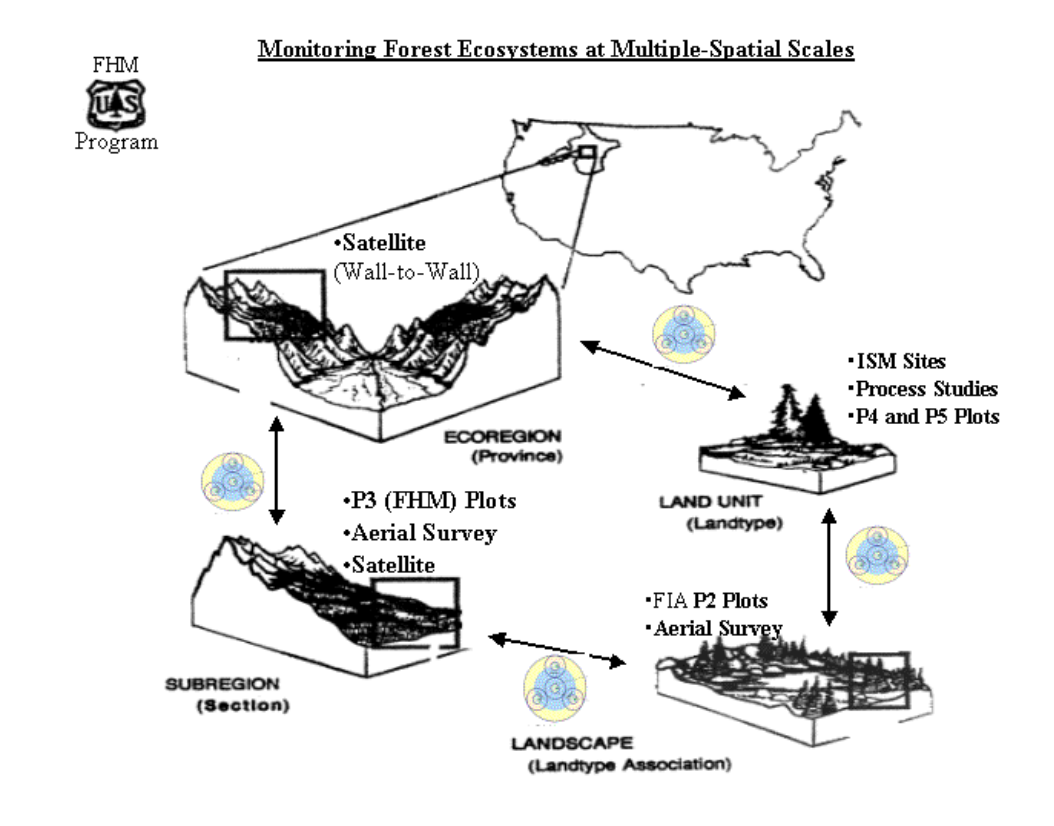
Research on Monitoring Techniques

- Urban Monitoring – design sampling strategies for urban forests and street trees
- Riparian Monitoring – design sampling strategies for riparian forests



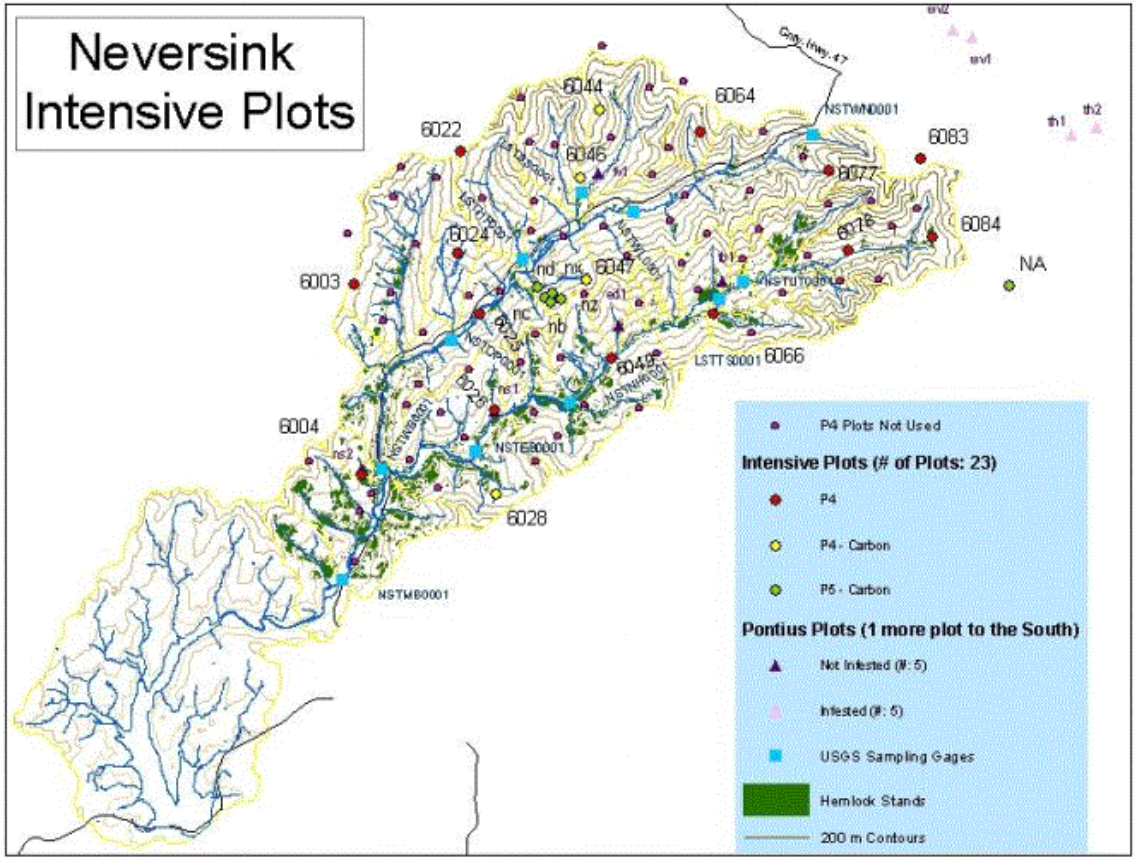
Intensive Site Monitoring
– Linking Multiple Scales

- In depth monitoring of indicators to determine detailed information on key components and processes of selected forest ecosystems



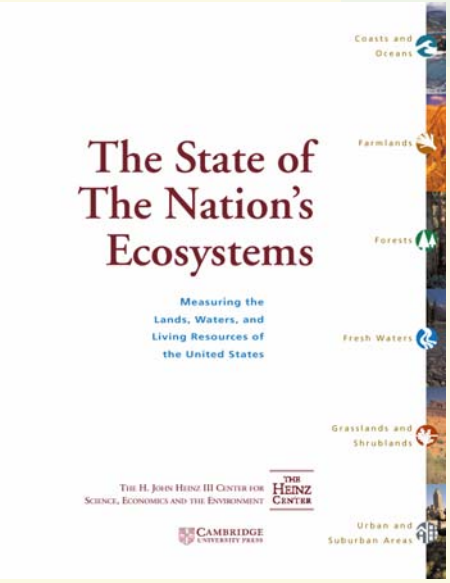
Delaware River Basin Collaborative Environmental Monitoring & Research Initiative CEMRI

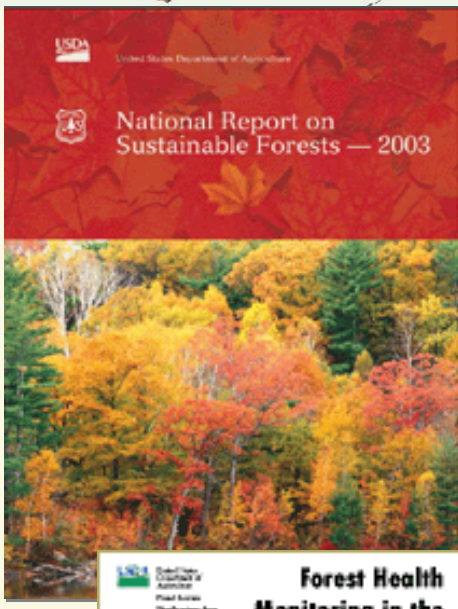
- Water quality
- Total Carbon
- Calcium Depletio
- Invasive Species

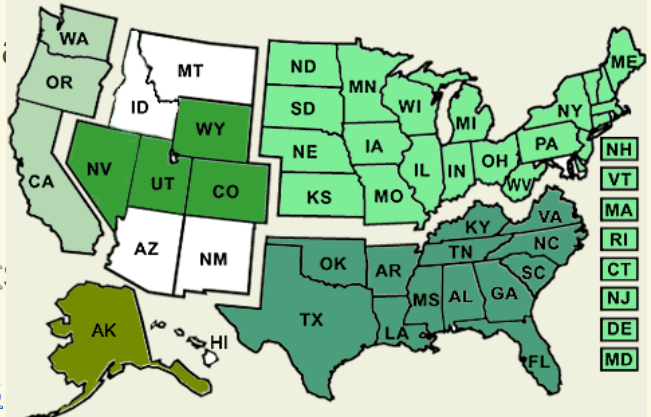


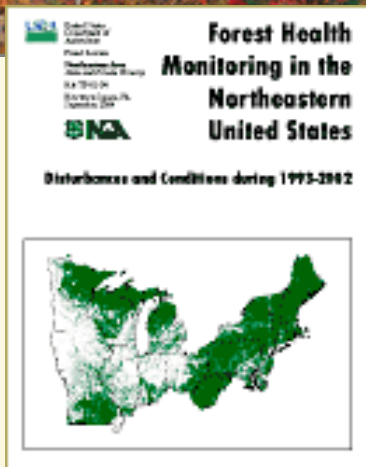
Reporting Highlights

- National Reports
  - FHM National Technical Reports
  - 2003 Sustainability Report – Montreal Process Criteria and Indicators for Sustainable Forests
  - Heinz Center – The State of the Nation's Ecosystems
  - EPA – US/Canada Air Quality Agreement Progress Reports
- Regional Reports
  - Northeast Forest Stressor Report
  - Aspen Forest Cover Ch in Rockies
- State Reports
  - Utah Baseline Report
  - Forest Health Highlight









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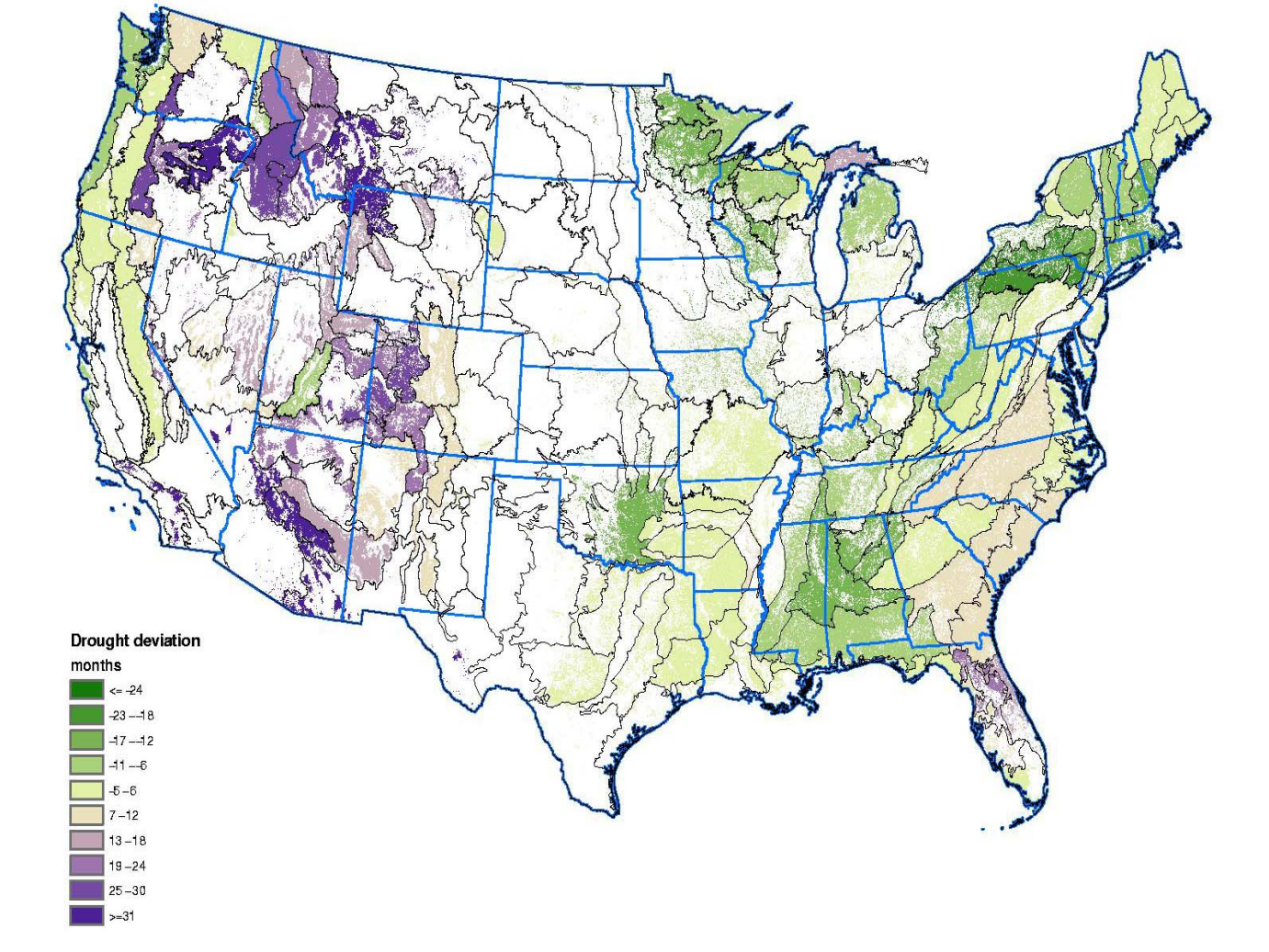
Ecoregion Province

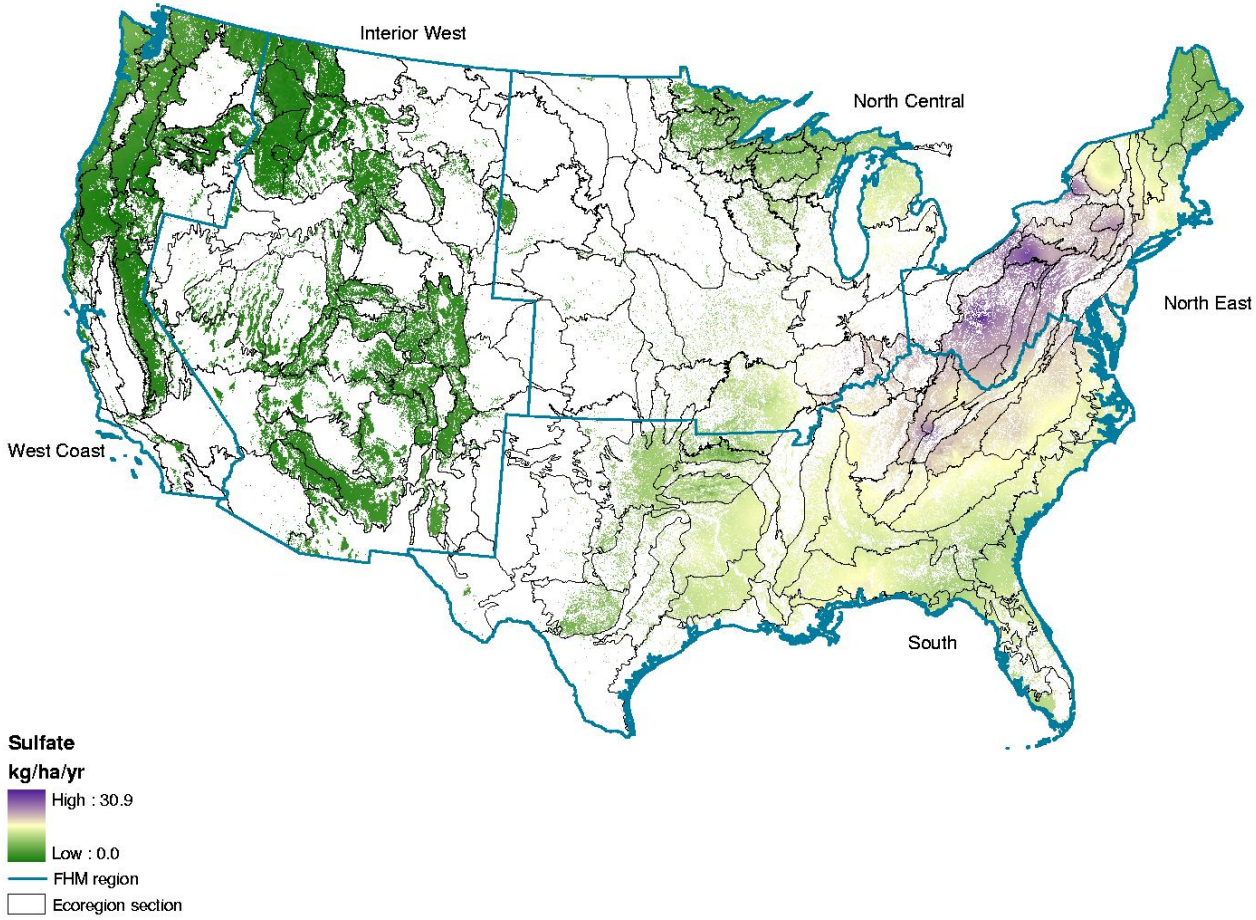
- Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow Province
- American Semi-Desert and Desert Province
- Arizona-New Mexico Mountains Semi-Desert-Open Woodland-Coniferous Forest-Alpine Meadow Province
- Black Hills Coniferous Forest Province
- California Coastal Chapparral Forest and Shrub Province
- California Coastal Range Open Woodland-Shrub-Coniferous Forest-Meadow Province
- California Dry Steppe Province
- Cascade Mixed Forest-Coniferous Forest-Alpine Meadow Province
- Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow Province
- Chihuahuan Semi-Desert Province
- Colorado Plateau Semi-Desert Province
- Eastern Broadleaf Forest (Continental) Province
- Eastern Broadleaf Forest (Oceanic) Province
- Everglades Province
- Great Plains Steppe Province
- Great Plains Steppe and Shrub Province
- Great Plains-Palouse Dry Steppe Province
- Intermountain Semi-Desert Province
- Intermountain Semi-Desert and Desert Province
- Laurentian Mixed Forest Province
- Lower Mississippi Riverine Forest Province
- Middle Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow Province
- Nevada-Utah Mountains-Semi-Desert-Coniferous Forest-Alpine Meadow Province
- Northern Rocky Mountain Forest-Steppe-Coniferous Forest-Alpine Meadow Province
- Ouachita Mixed Forest - Meadow Province
- Outer Coastal Plain Mixed Forest Province
- Ozark Broadleaf Forest - Meadow Province
- Pacific Lowland Mixed Forest Province
- Prairie Parkland (Subtropical) Province
- Prairie Parkland (Temperate) Province
- Sierran Steppe-Mixed Forest-Coniferous Forest-Alpine Meadow Province
- Southeastern Mixed Forest Province
- Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow Province
- Southwest Plateau and Plains Dry Steppe and Shrub Province

Drought

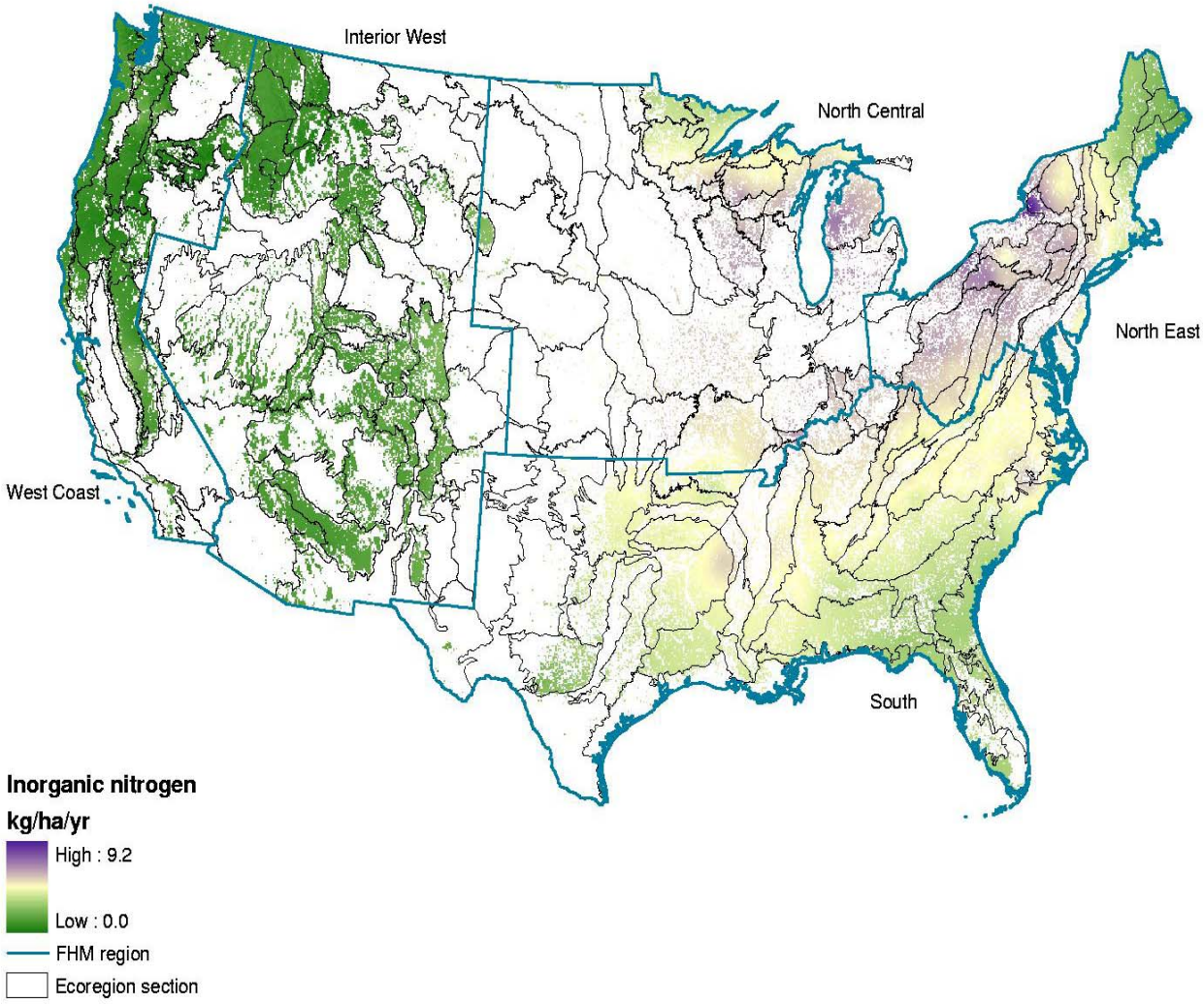


Drought deviation from historic levels (1895 - 2005) for the period from 1996-2005 for forested areas of each ecoregion section

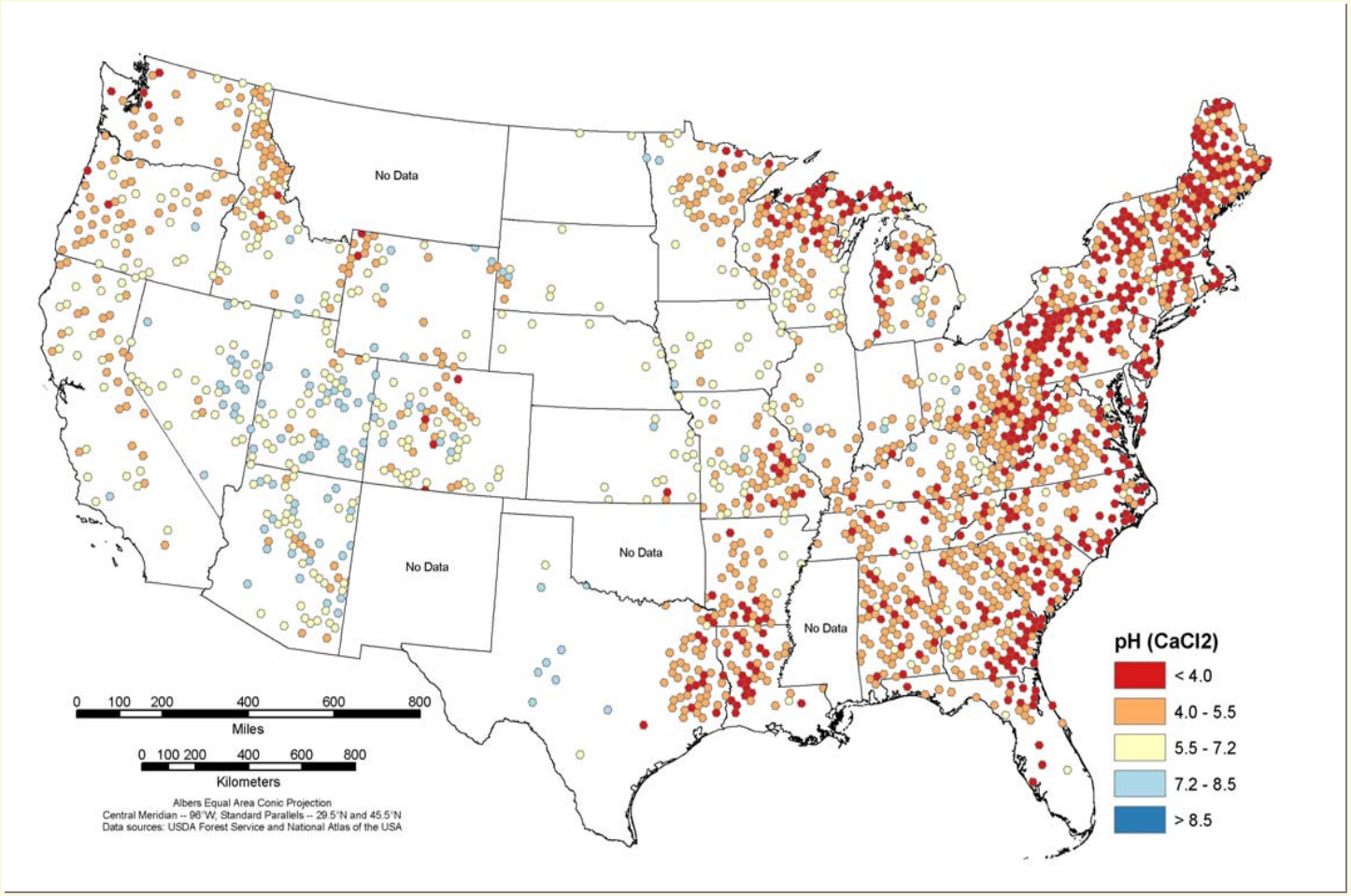
Wet Sulfur Deposition



Wet Nitrogen Deposition



Soil pH

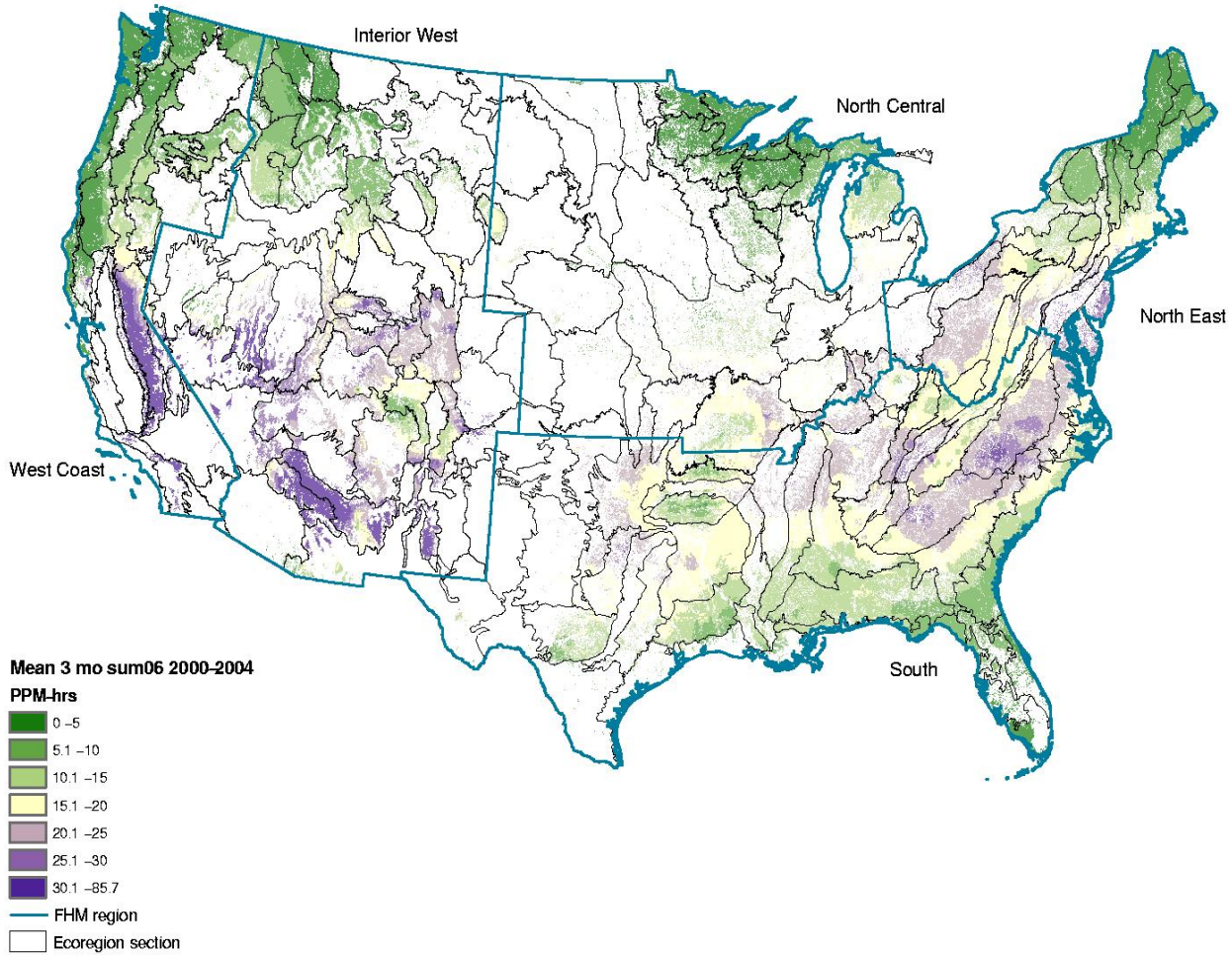


National map of observations of soil pH in the top 10 cm of soil (2001-2003)

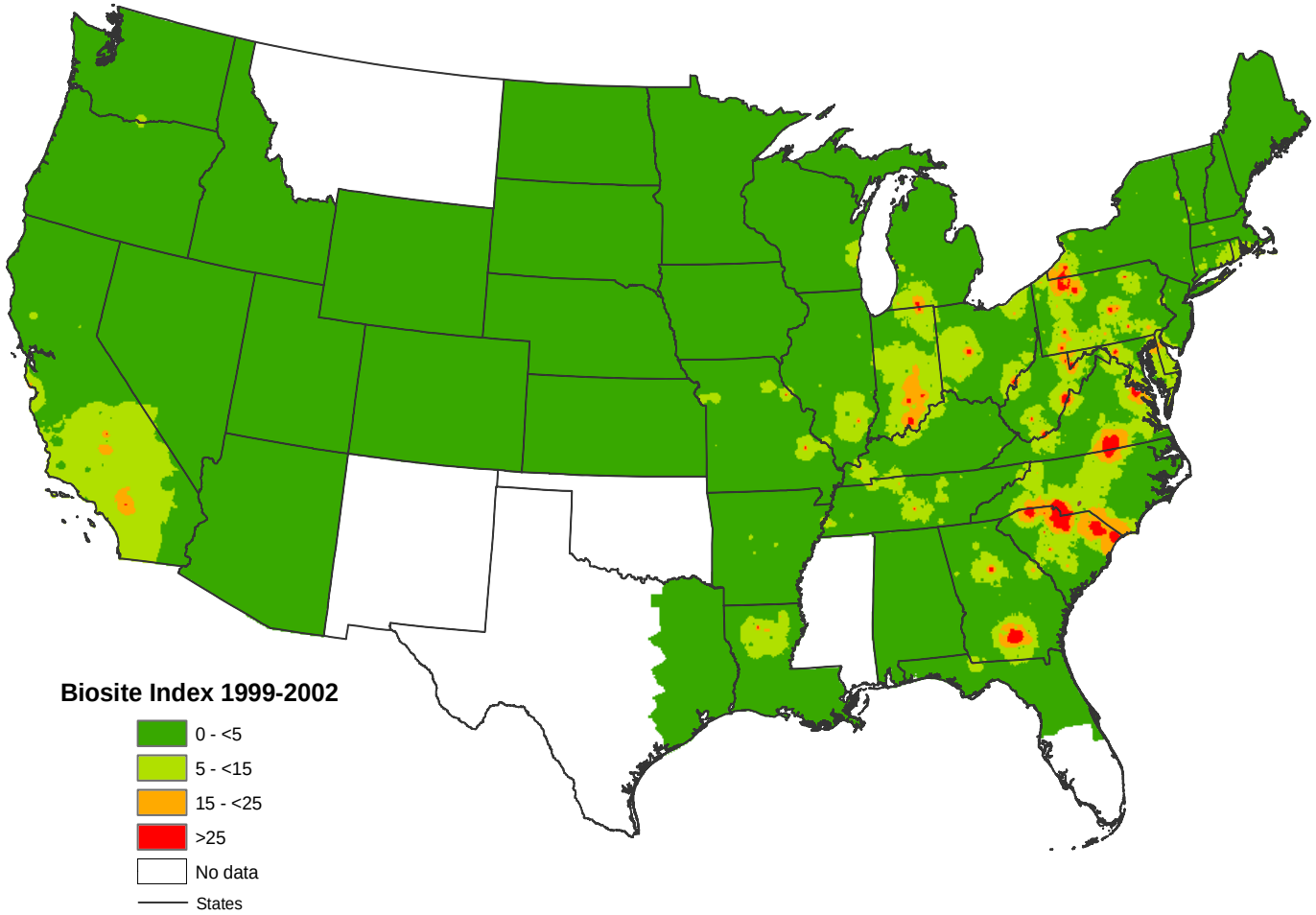
Cation Exchange Capacity

National map of effective cation exchange capacity in the top 10 cm of soil (2001-2003)

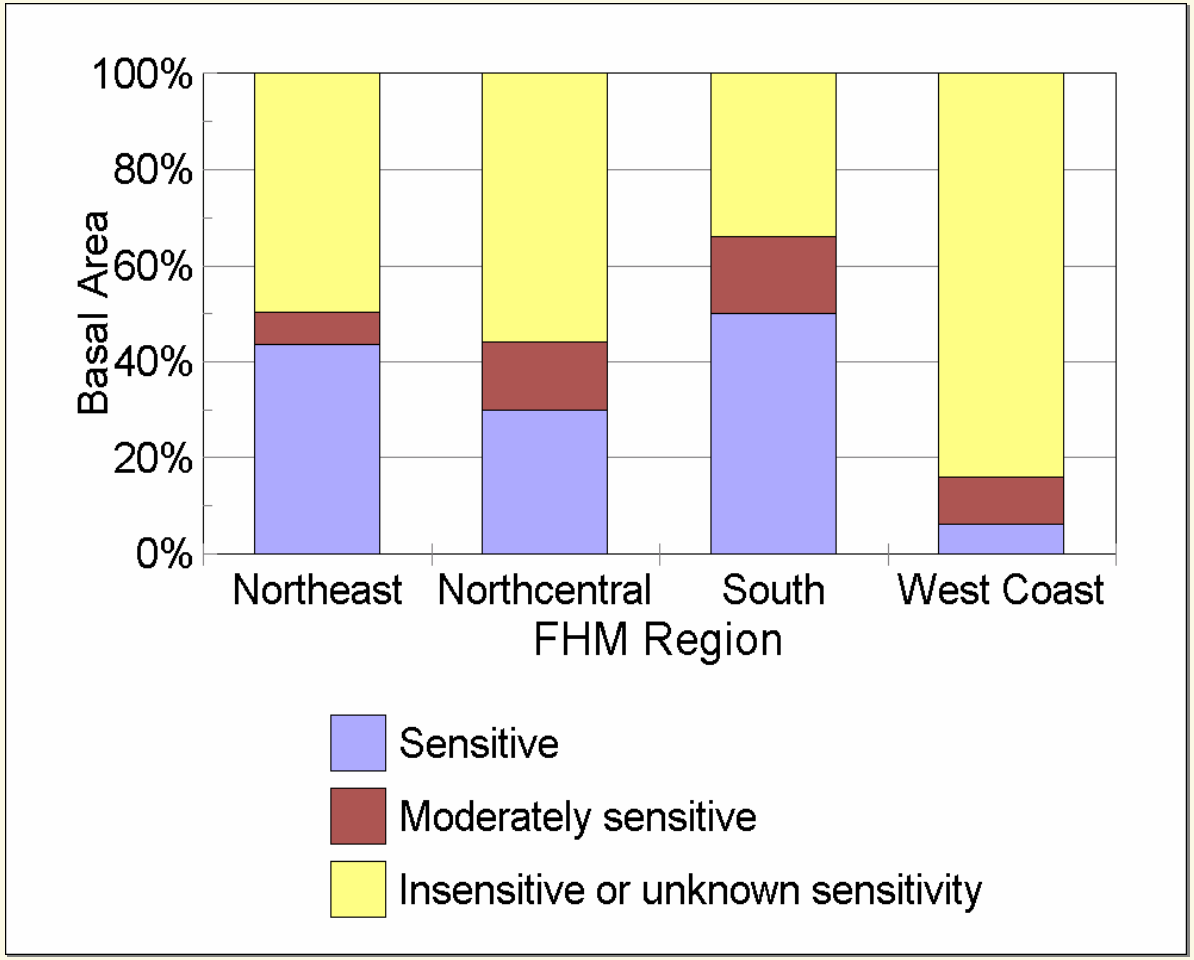
Ozone Exposure



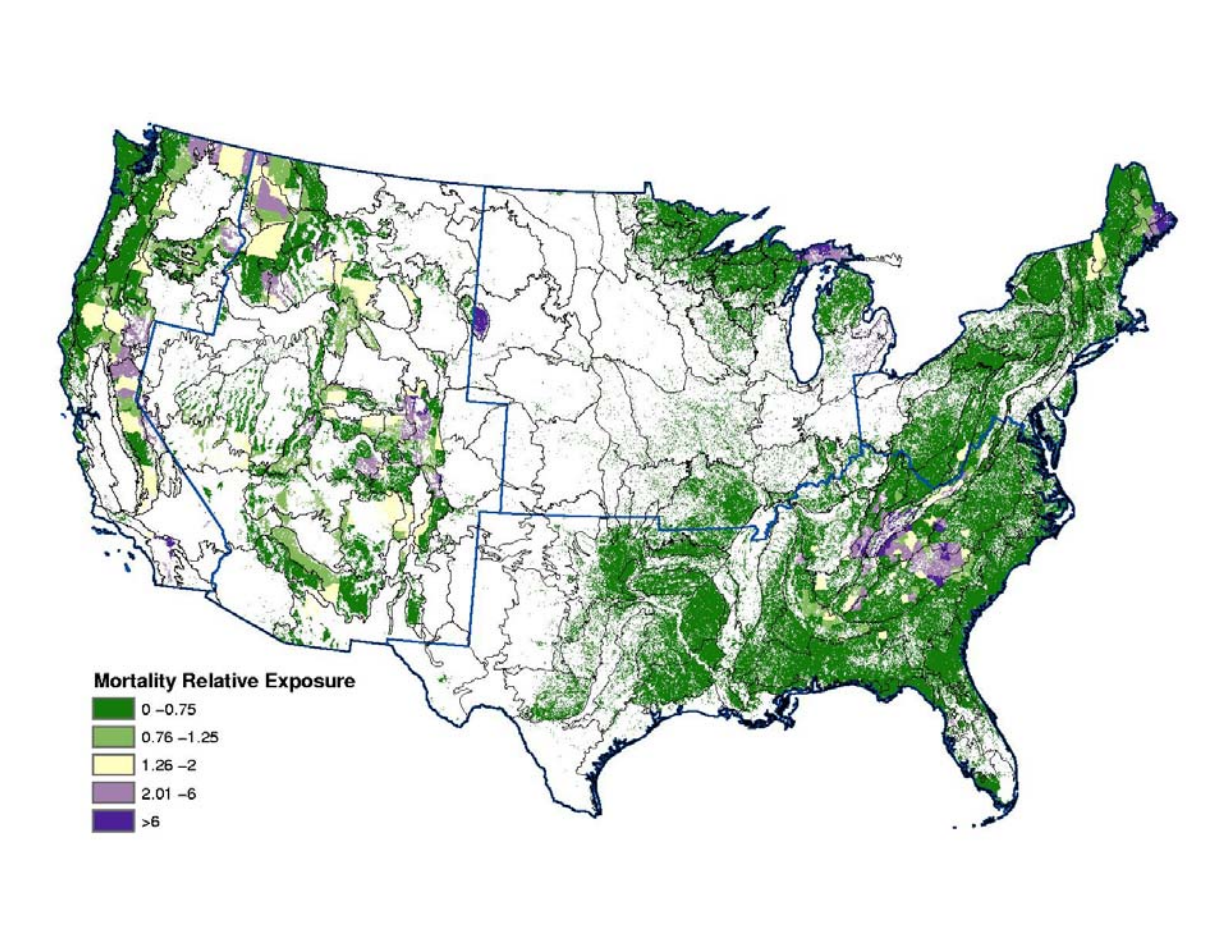
Interpolated ozone biosite index value (1999-2002).



Sensitivity of tree species in the high and moderate ozone risk areas of the US

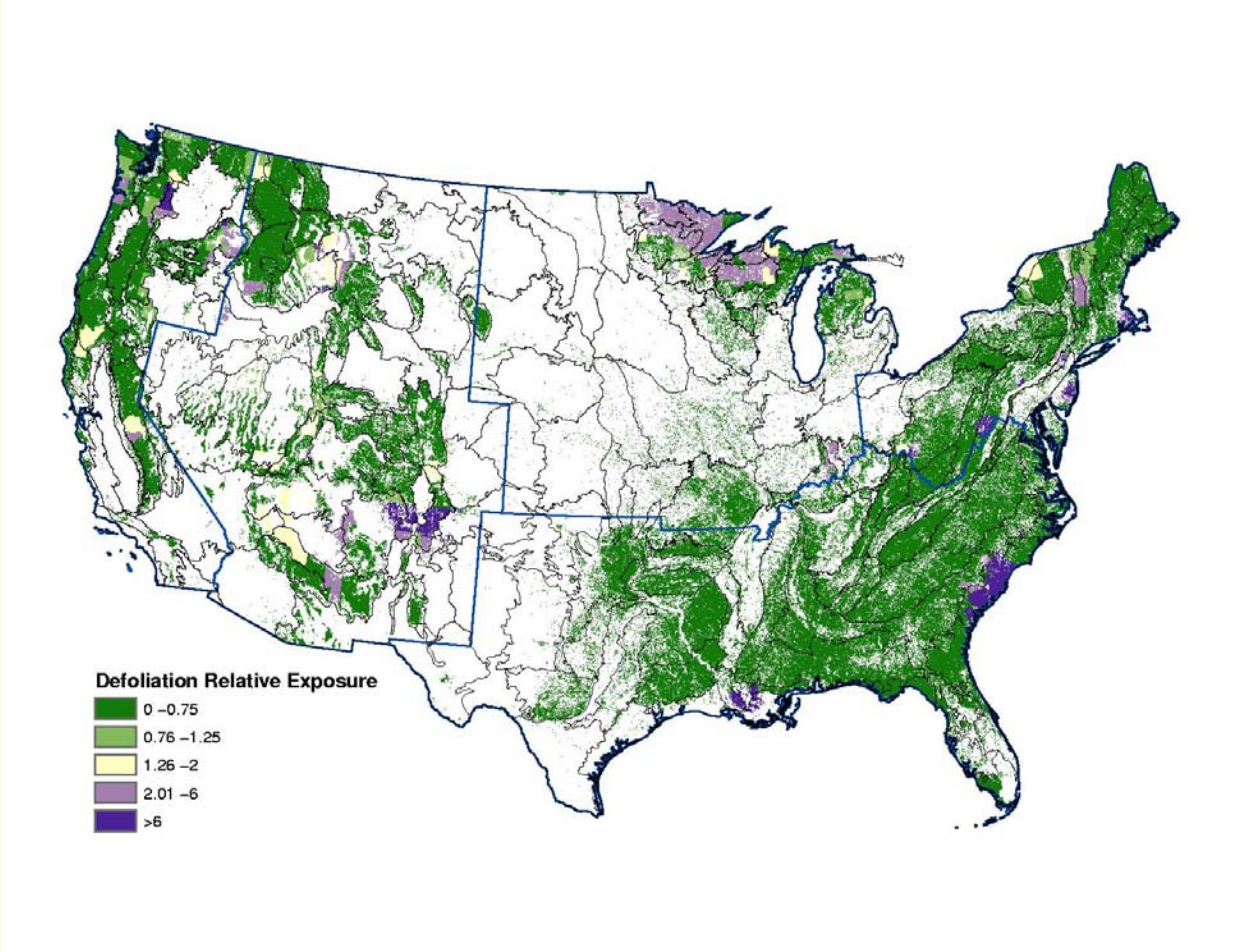


Mortality from Aerial Survey



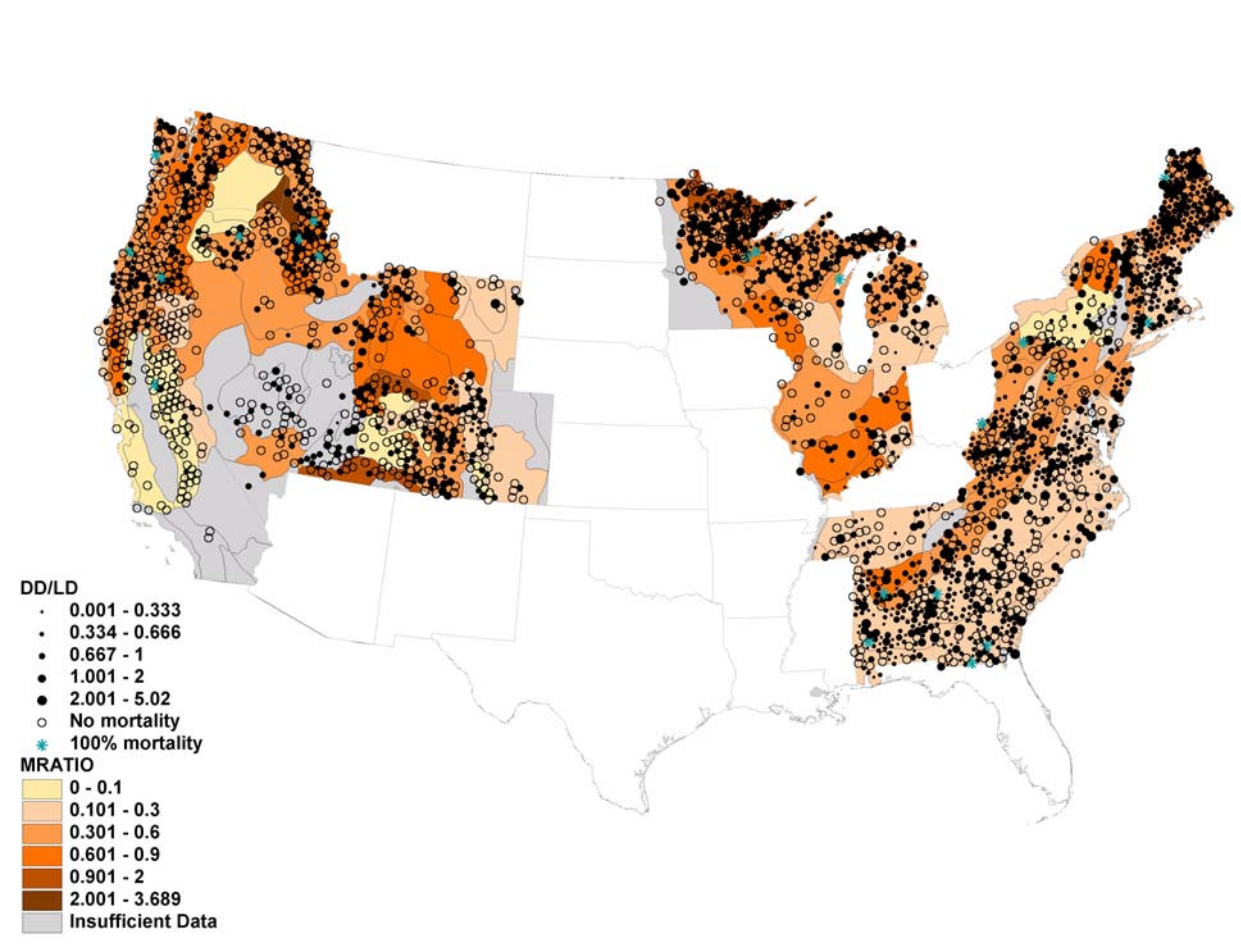
The 1998-2004 relative exposure by FHM region for forested areas with currently (2004) active mortality-causing agents.

Defoliation from Aerial Survey



The 1998-2004 relative exposure by FHM region for forested areas with currently (2004) active defoliation-causing agents.

Mortality from Plots

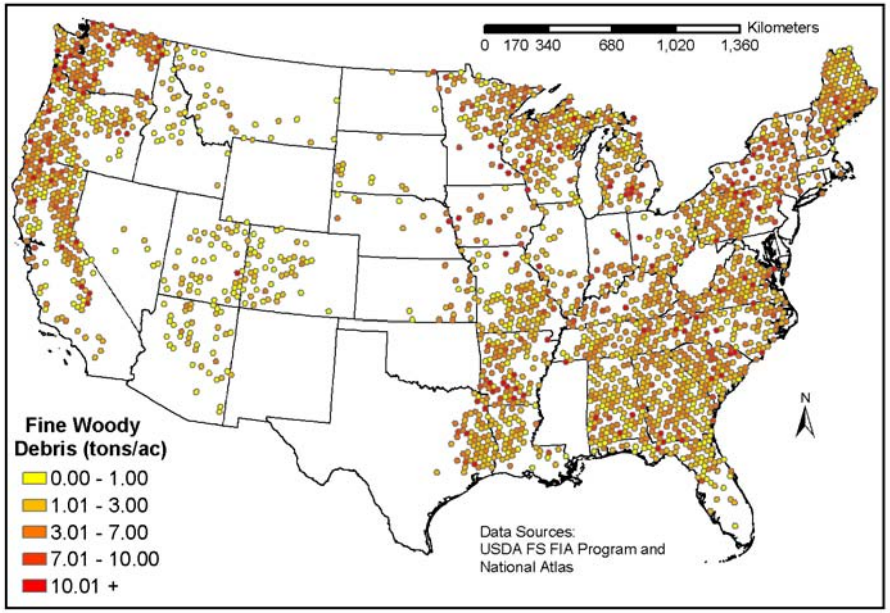


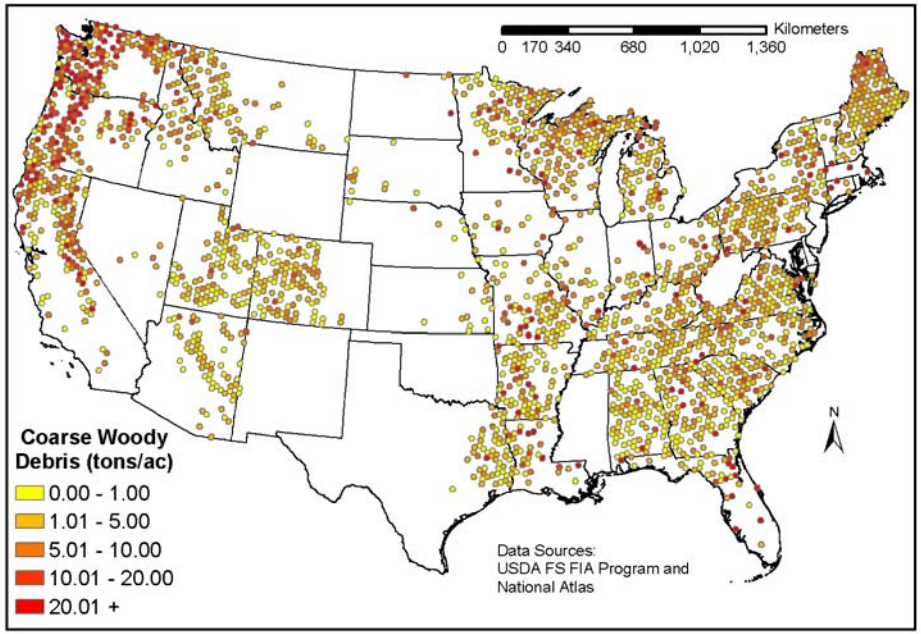
Tree mortality expressed as the ratio of annual mortality volume to annual gross growth volume (colored polygons). The black circles represent the ratio of the average diameter of trees that dies to the average diameter of surviving trees as of the most recent measurement of each plot.

Crown Conditions from Plots

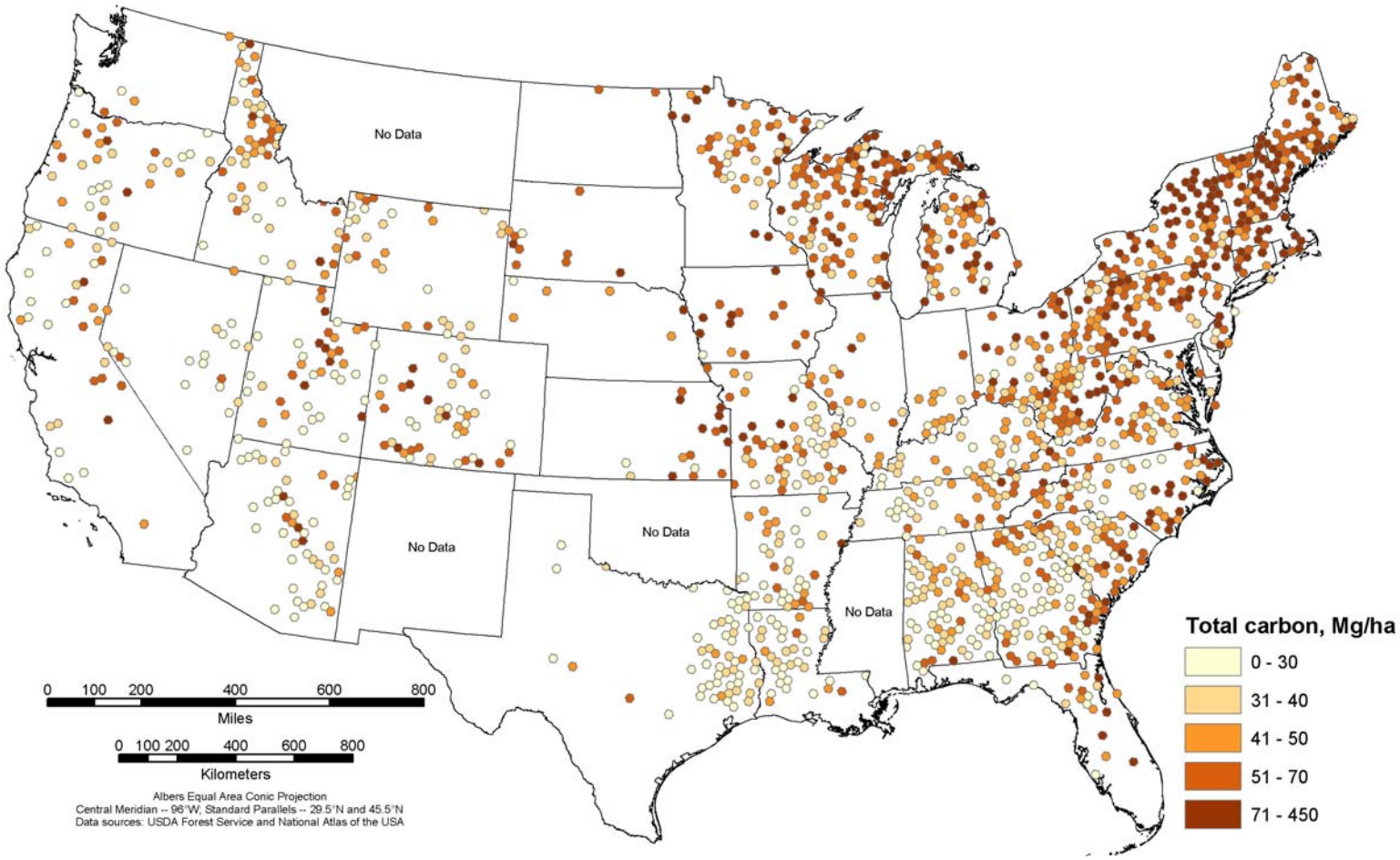
Percent of plot basal area (BA) associated with poor crown condition.

Down Woody Material





Total Soil Carbon



Future Challenges

- Stress key strengths of FHM
  - Partnership-based
  - Innovative
  - Comprehensive
  - Science-based
- Be “Real Time”
  - Timely detection, analysis, and reporting of adverse changes in forest health to facilitate effective management response
- Look Beyond the Grid
  - Look back – analyze trends, integrate diverse data sources
  - Look forward – forecast future conditions, analyze risks
  - Design new approaches for detection of invasives