



Monitoring Climate Change Effects Through FHM

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Climate Change

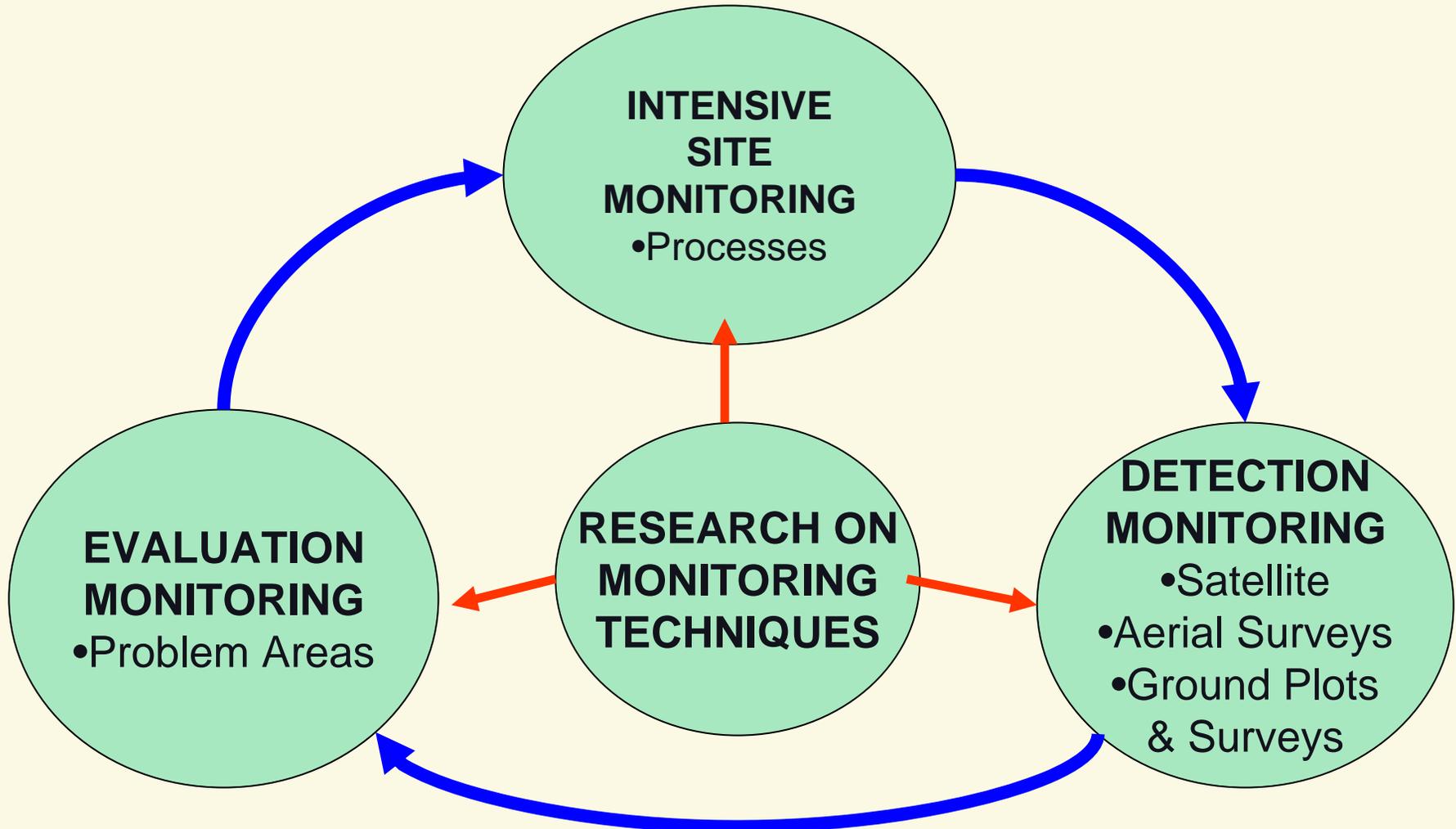
- The effect of climate change on forests is hard to predict
- Current hypotheses suggest that the effects of global climate change could:
 - Result in species shift,
 - Increase invasiveness,
 - Increase drought and fire disturbance
 - Lead to extinction



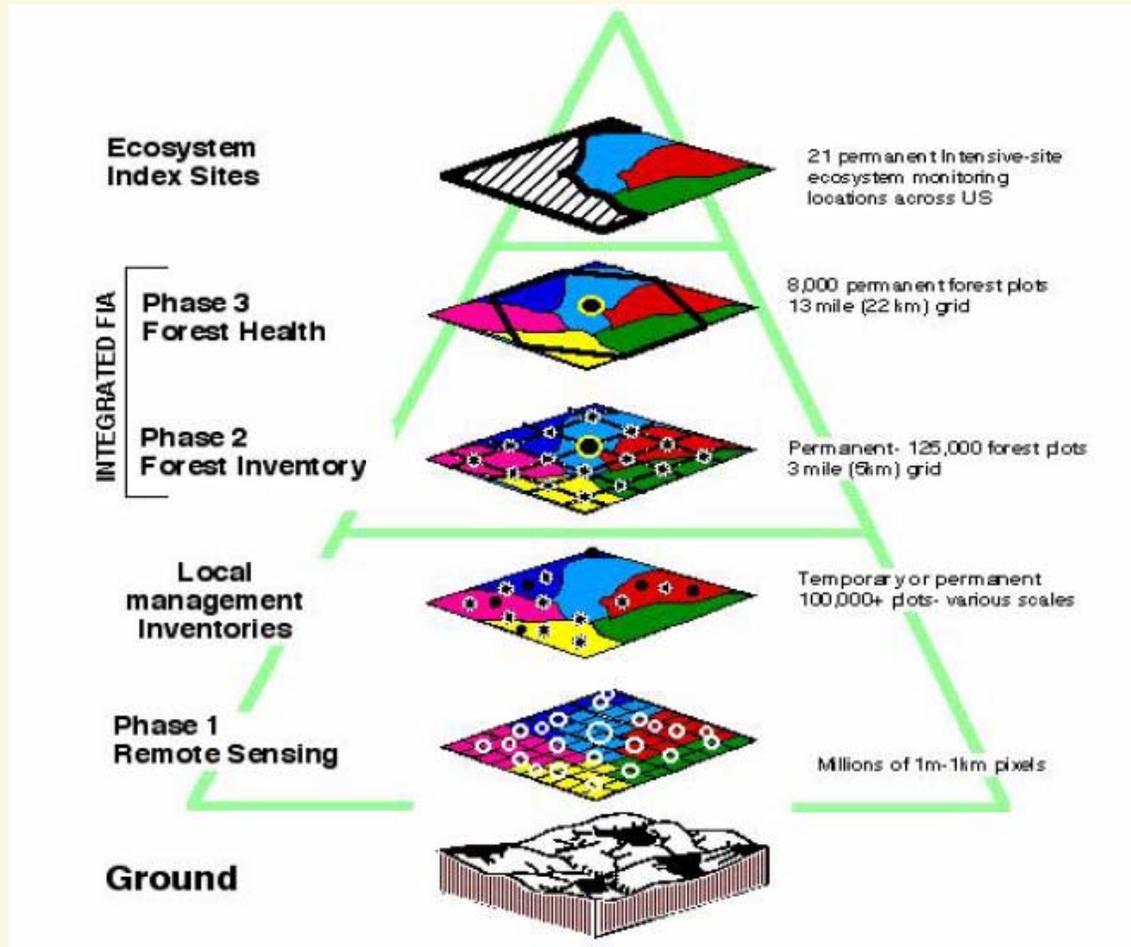
FHM Objectives:

- 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



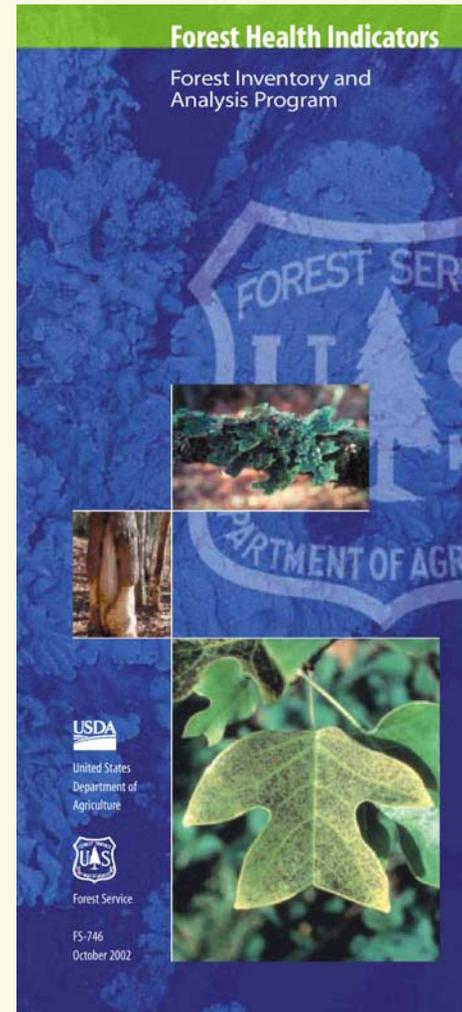
Integrated Monitoring Framework





Forest Health Indicators

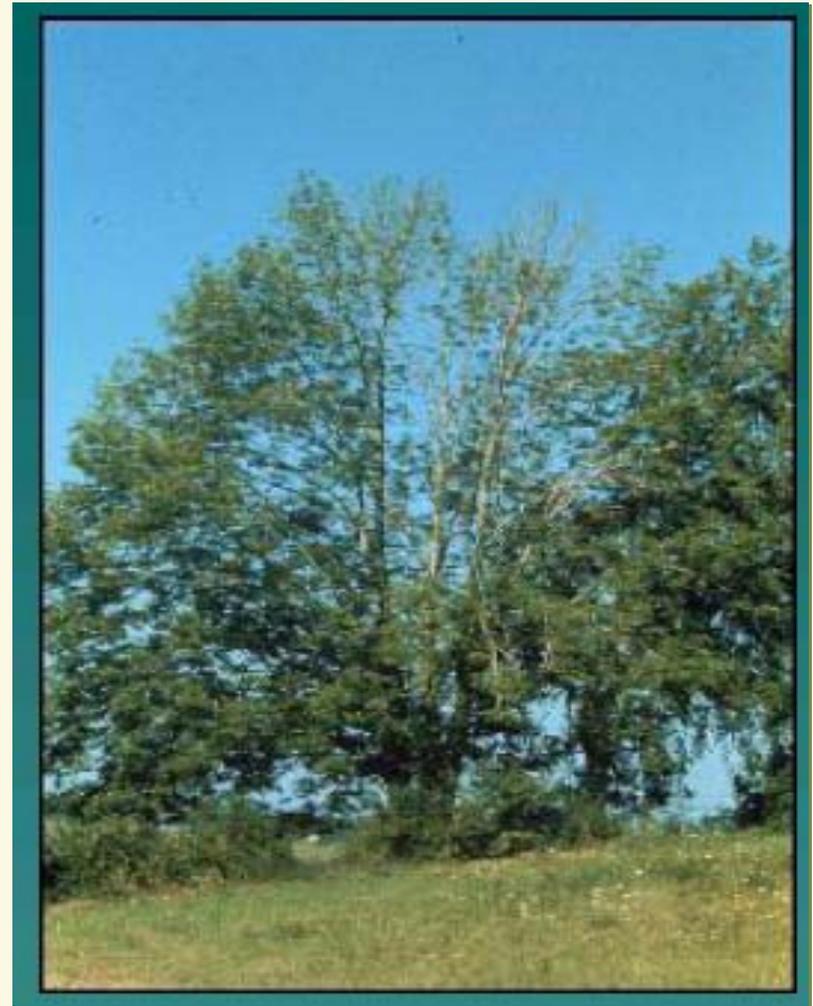
- Tree Growth
- Tree Regeneration
- Tree Crown Condition
- Tree Damage
- Tree Mortality
- Lichen Communities
- Ozone Bioindicator Plants
- Soil Morphology and Chemistry
- Vegetation Structure
- Plant Diversity





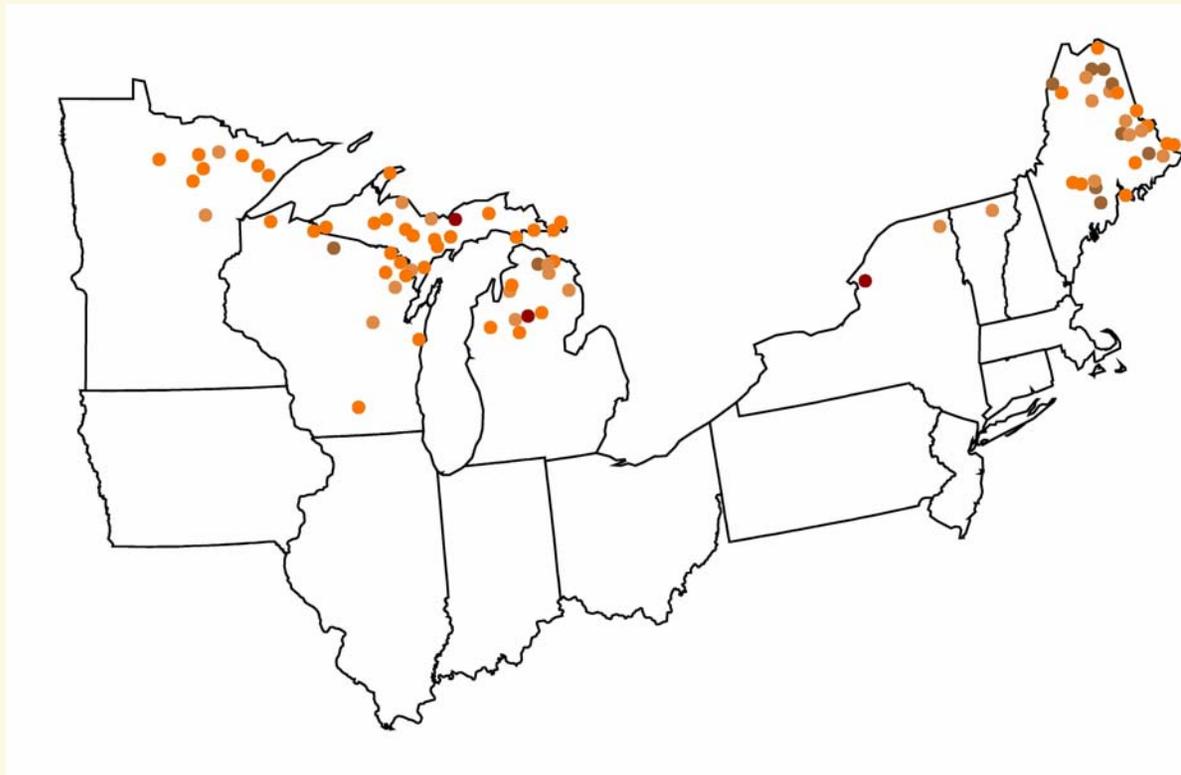
Crown Condition

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



Crowns

- Abnormal levels of crown dieback detected in northern white cedar
- EM project in progress



Percent crown dieback; plot averages

- 0 - 5
- 6 - 10
- 11 - 25
- 26 - 50
- > 50

KaDonna Randolph, in 2006
National Tech. Rep. (in prep)

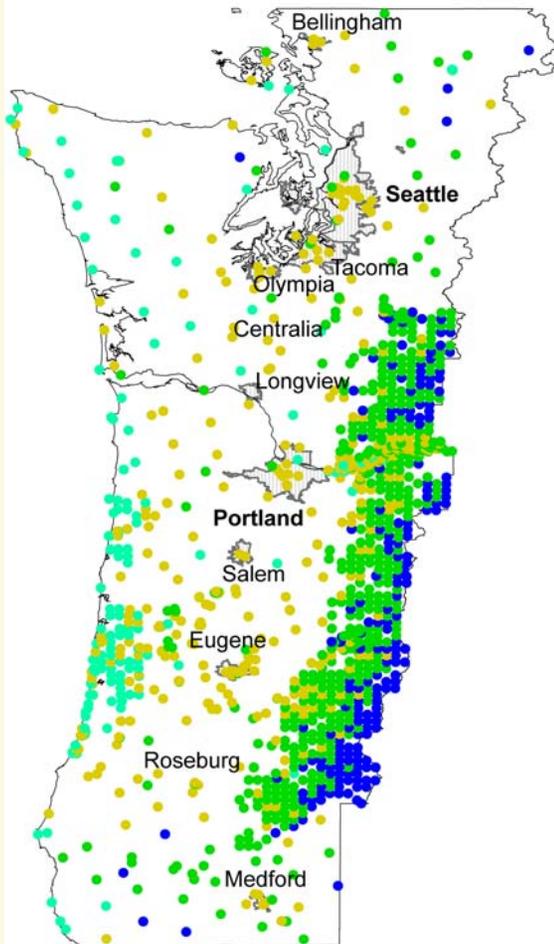


Lichen Communities

- 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



- PNW Climate Gradient Model developed
- Predicted warming will result in dramatic change in lichen zones
- Alpine lichens communities threatened

Climate zone	Year 2000 (°C)	Year 2040 (°C)	
	Mean	Predicted minimum	Predicted maximum
Maritime	10.2	11.7	13.4
Lowland	9.6	11.1	12.8
Montane	7.2	8.7	10.4
High elevation	4.9	6.4	8.1



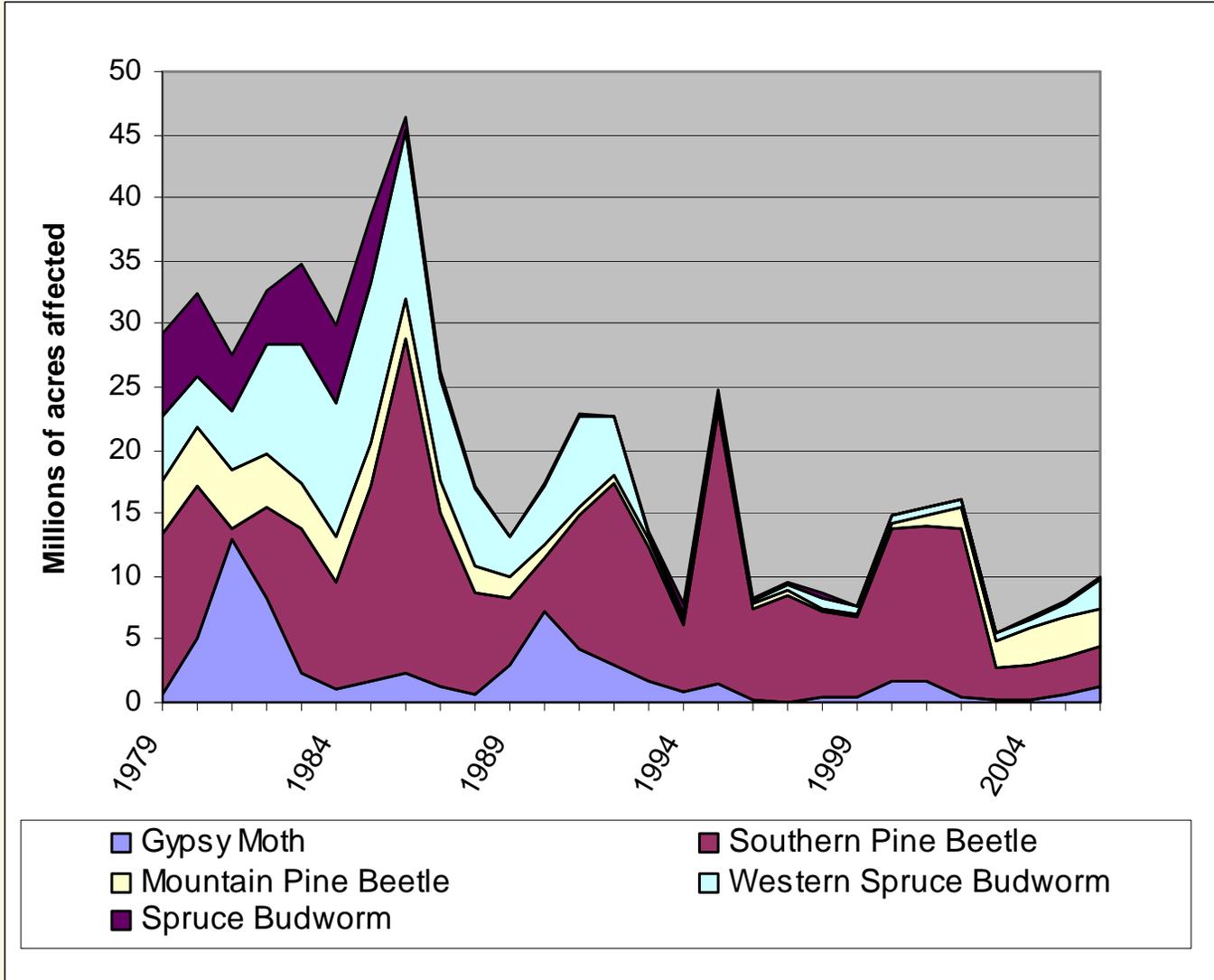
Vegetation Diversity and Structure

- 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

Major Pest Activity



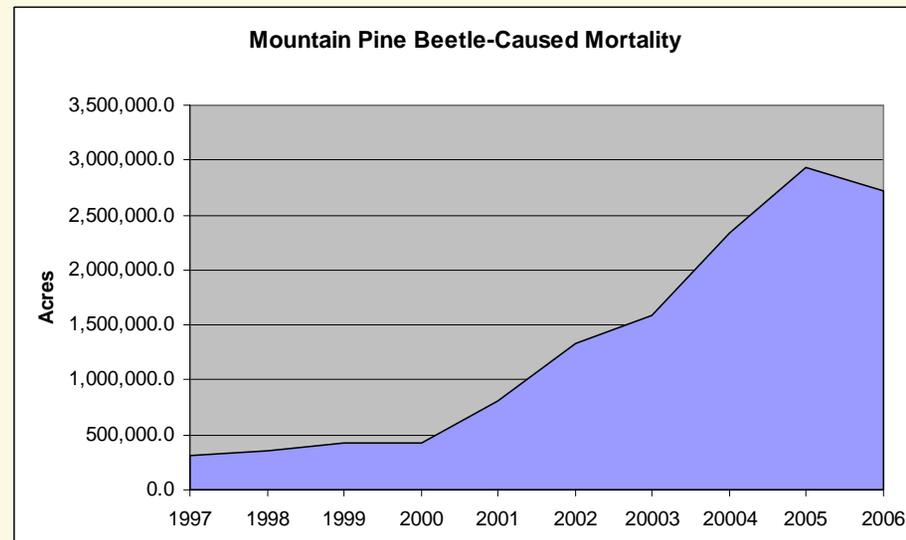
Mountain Pine Beetle (*Dendroctonus ponderosae*)



- Outbreaks increasing in area throughout the Western US since 2000
- Greater activity at higher elevations in white bark pine
- Expanding range in BC



William M. Ciesla, Forest Health Management International, www.forestryimages.org



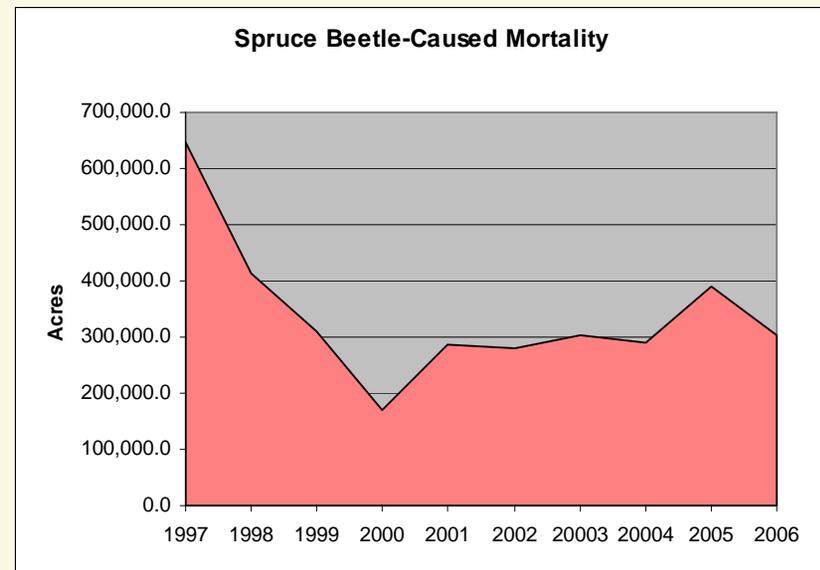
Spruce Beetle (*Dendroctonus rufipennis*)

- Alaska experienced large outbreak in the late 90's with mortality rates exceeding 90% in many areas
- Favorable weather conditions (mild winters and warm summers) have led to increasing populations in AZ, CO, MT, UT, and WY



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William M. Ciesla, Forest Health Management International, www.forestryimages.org



Pine mortality in the Southwest



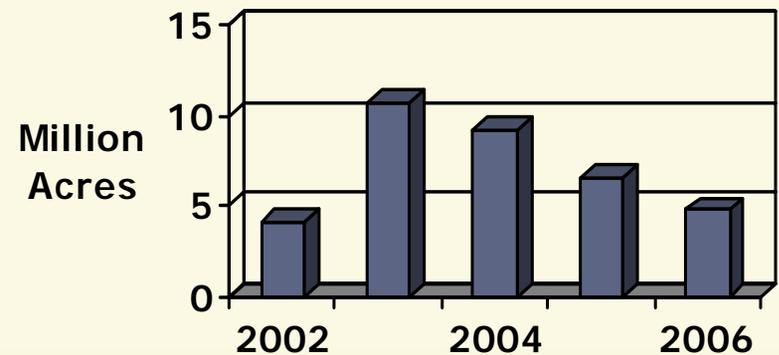
Ponderosa pine in Arizona - 2003

Photos – FHP R3



Piñon pine in New Mexico - 2003

Bark Beetle Caused Mortality in the Western US





Evaluation Monitoring

- Designed to determine the extent, severity, and causes of undesirable changes in forest health identified through Detection Monitoring
- EM has supported a number of projects related to the potential impacts of climate change

Evaluation Monitoring

Species Shift

- GIS-based landscape-scale prediction system for pinyon pine decline in the southwestern United States
- Yellow-cedar decline: evaluating key landscape features of a climate-induced forest decline (Hennon & Whitter)
 - Better understand the cause of the decline
 - Help develop a conservation strategy (see poster)
- Assessment of the extent, severity, and impact of alder dieback and mortality in Alaska



Lori Trummer, USFS R10 FHP

Evaluation Monitoring

Species Shift

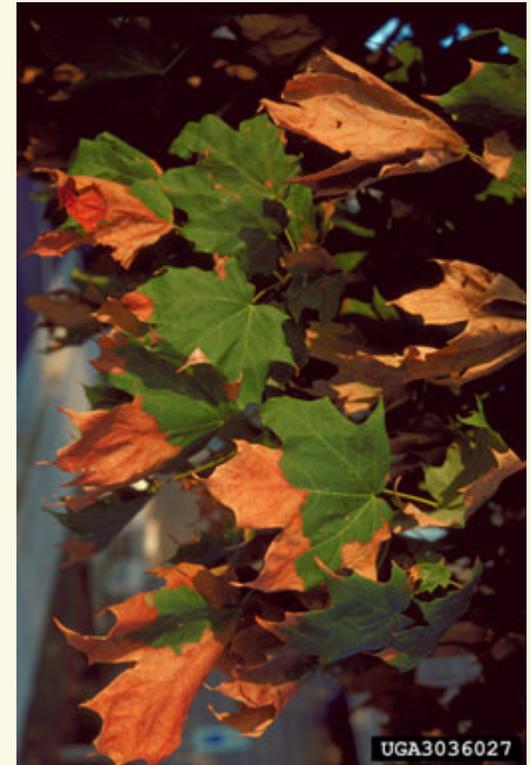
- Whitebark/High Elevation Pine – key climate change indicator species
 - Determine the condition of whitebark pine in the northern region
 - Monitoring westwide distribution and condition of whitebark pine and limber pine
 - Monitoring the status and condition of whitebark pine in the greater Yellowstone ecosystem
 - Status of high elevation 5-needle pines in Washington and northern Oregon
 - An assessment of white pine blister rust on high elevation white pines in California
 - Evaluation of foxtail pine in California



Evaluation Monitoring

Drought

- Drought impact on forest health in the southeast - an analysis based on FHM/FIA data
- Modeling the impact of drought on growth and mortality in eastern forests
- Southern California forest health assessment - analysis of status and trend, post drought -induced bark beetle mortality events of 2002-2003
- Ecological impacts of drought stress in Alaska birch stands



Evaluation Monitoring

Fire

- Modeling fire spread and intensity across bark beetle-affected landscapes
- Monitoring tree deterioration following stand-destroying wildfires
- Contribution of landscape level bark beetle outbreaks to fuel loading and fire behavior in pine forests of the Southwest



Evaluation Monitoring

Invasive Species

- Ecological impacts of invasive species after fire
- Response of peri-urban exotic bark beetles response to wildfires in Southern California



Leigh Dawson, Wallowa Whitman National Forest



Evaluation Monitoring

Extinction

- Thankfully, nothing to report. Yet.