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NEW TOOLS FOR TREE DECAY
DETECTION

1. Trees Are Remarkable Organisms
2. Trees are Subject to Decay Creating Risks
3. Effective Use of Decay Detection Tools
4. Tomorrow's Tools

1. Remarkable Organisms

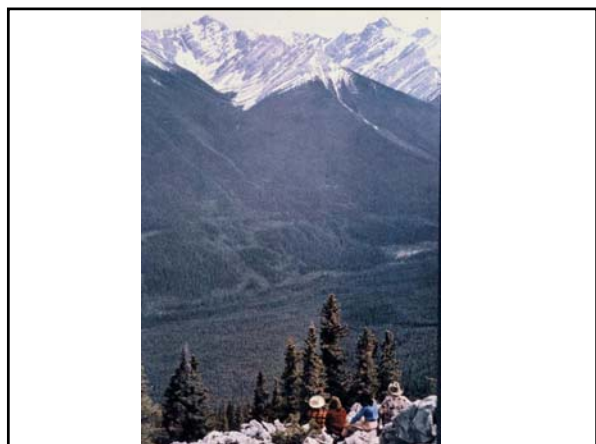


Sequoia sempervirens



Bristlecone Pine (*Pinus longaeva*)





Crowther, TW "Mapping tree density
at a global scale," Nature September
2015



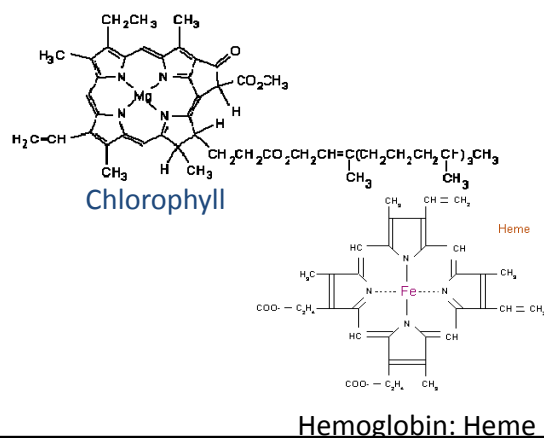
3.04 Trillion Trees: (43% tropical; 24% dense boreal areas; 22% in temperate zones.) Losing 15 billion annually, 46% loss to land use change, deforestation



Co-Evolved with Humans



Chlorophyll and Hemoglobin



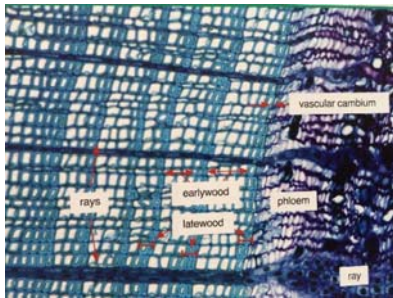
2. Tree Are Subject to Decay Creating Risks



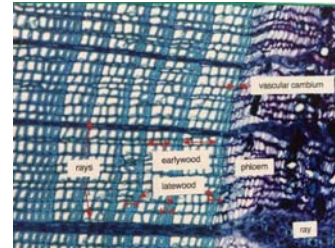
Wood decay fungi



Wood is secondary xylem composed primarily of cellulose and lignin

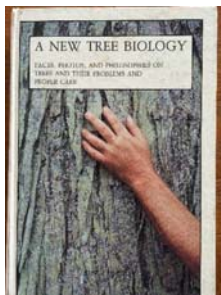


Whitish string-like cellulose adds strength and flexibility under tension; dark-colored lignin forms a rigid matrix of cell wall between the cellulose. Decay decomposes wood & strength.

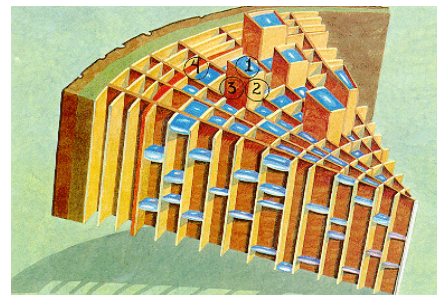


Dunstar, Tree Risk Assessment 2013, ISA p65

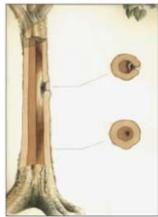
Alex Shigo, Plant Pathologist USDA Forest Service



Codit-tree response to decay



Decay at wound

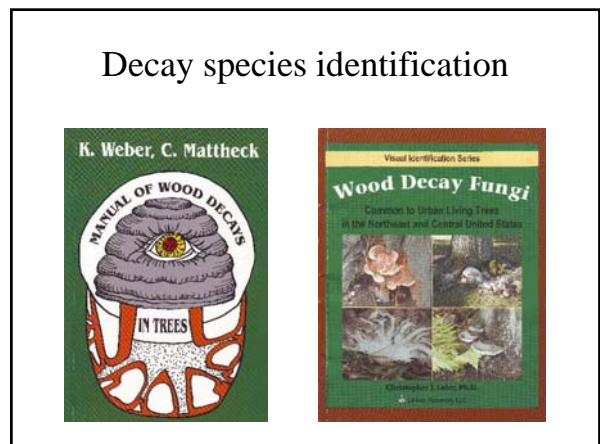


Decay upward and inward

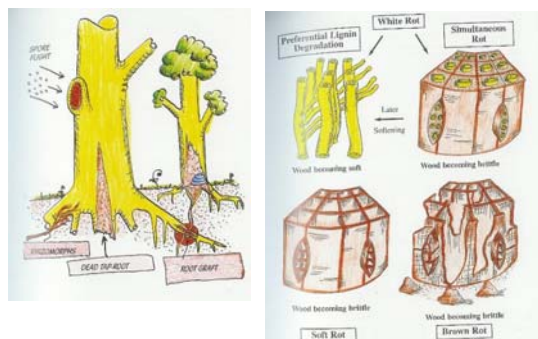


Monona Drive Honey Locust Failure
May, 2005

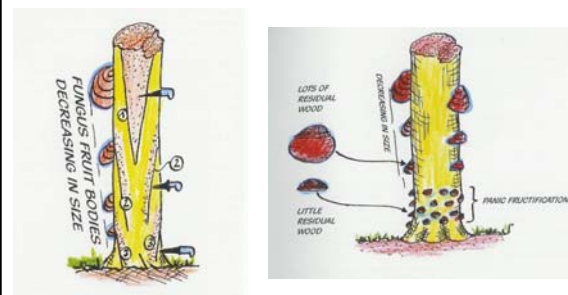




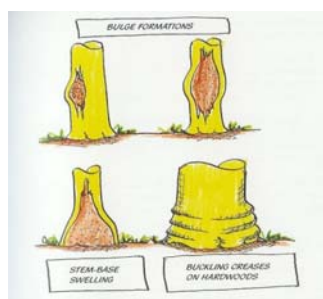
Point of entry and wood degradation



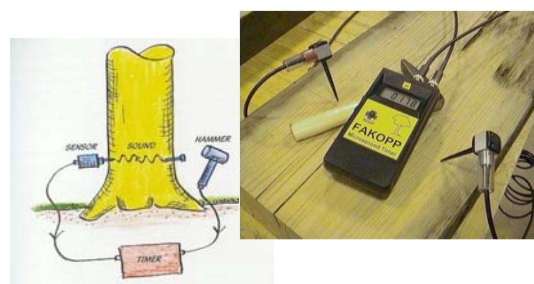
Size and location of fruiting bodies



Bulges and bottlebutts



3. Effective Use of New Tools: Stress wave timers



2. Stress Wave Timing *Decay detection*

- ☐ Perpendicular to grain
- ☐ Impact-induced



Divos

Reference stress wave velocity and transmission times in radial direction

Species	Radial stress wave velocity (m/s)	Radial stress wave transmission time (μs/ft)
Beech	1570	183
Black fir	1480	206
Larch	1490	205
Linden	1690	180
Maple	1690	180
Oak	1620	188
Poplar	1140	267
Scolch fir	1470	207
Silver fir	1360	224
Spruce	1410	216

239A Stress Wave Timer
Metriguard, Inc.
www.metriguard.com



FAKOPP Microsecond Timer
FAKOPP Enterprise
www.fakopp.com



Sylvatestduo
CBS-CBT
www.sylvatest.com

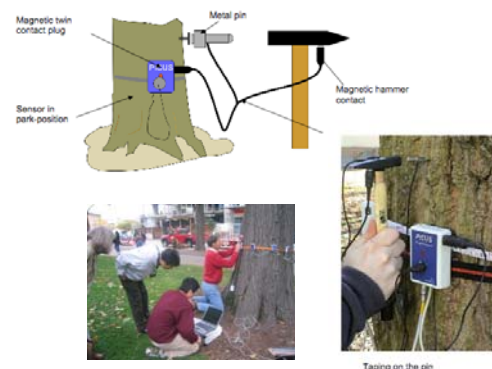
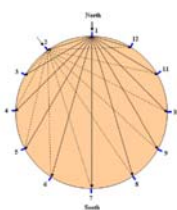
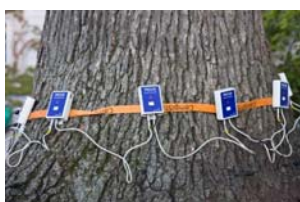


TreeCheck Sonic Wave Tree Decay Detector



Acoustic Tomography

- Employs multiple sensors (8-32) to measure stress wave transmission time at multiple directions
- Creates image of distribution apparent acoustic velocity in the cross section



Acoustic tomography

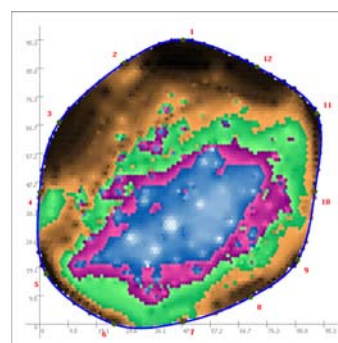
Stress wave timers 2

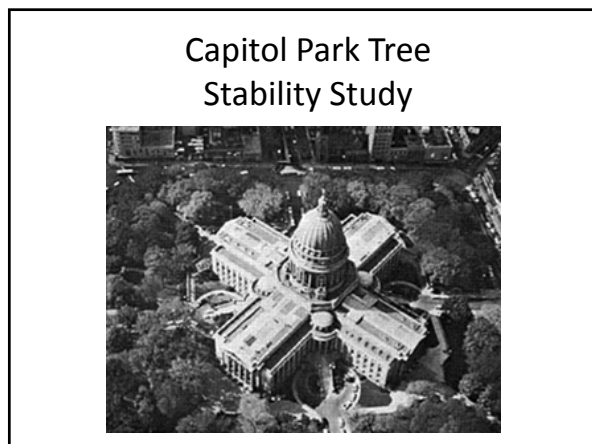
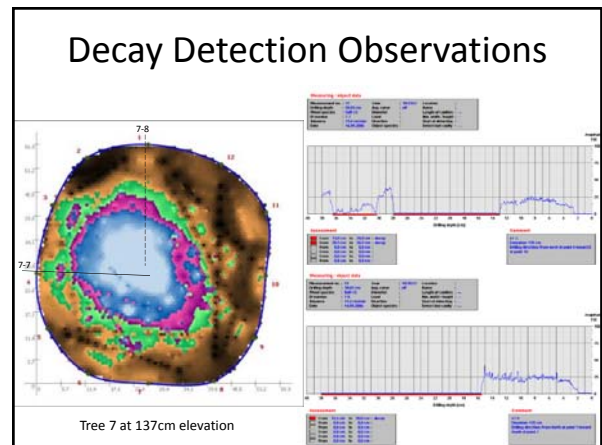
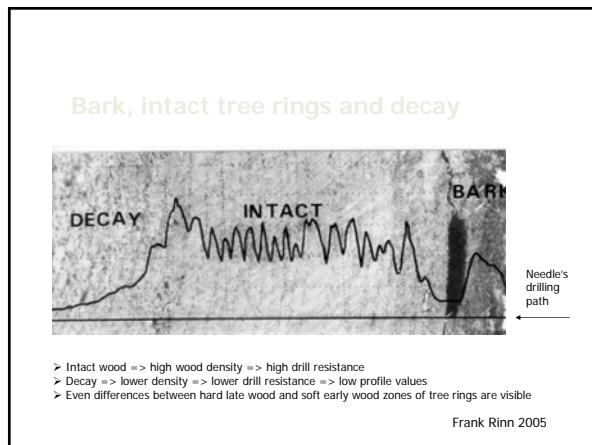
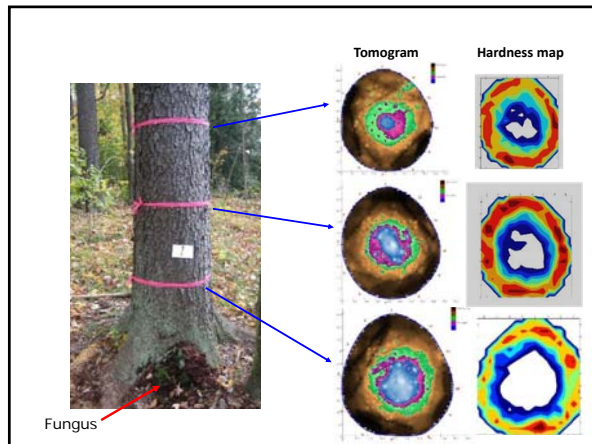


Acoustic tomography
Fakopp 2D



200cm







Tests and Tools to Measure

- Visual Tree Assessment



Tests and Tools to Measure

- Fakopp Microsecond Timer Test



Tests and Tools to Measure

- Picus Sonic Wave Test

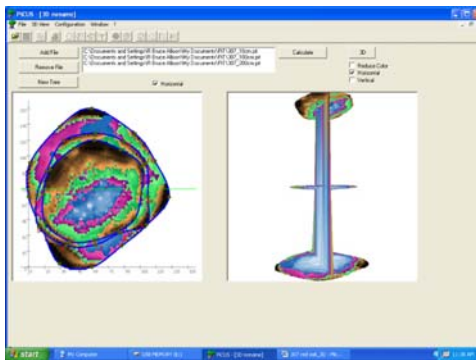


Tests and Tools to Measure

- Resistograph

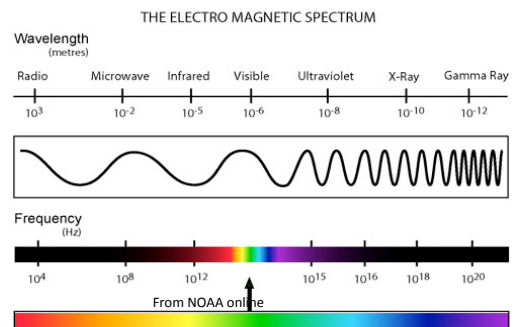


3D Image





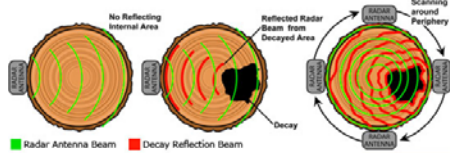
4. Tomorrow's Tools



Other tools:

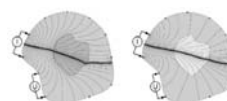
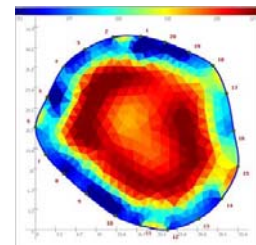
Ground-Penetrating Radar (GPR)

- Well-established in geological and environmental engineering fields
- Novel and new application in tree inspection
- Multi-elevation circumferential scans and single point inspections possible
- Detect cavities and decayed wood
- Image of predicted internal cross-sectional view



Other tools:

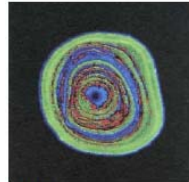
Electrical Impedance Tomography (EIT)



Portable CT scanner
Habermehl & Ridder (1976-8) using Cs-137



Fig. 3: Mobile CT-Scanner MCT 3



CT slice

Portable x-ray CT scanner
Morio Onoe et al. (1984), University of Tokyo

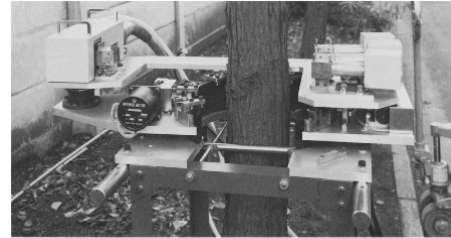
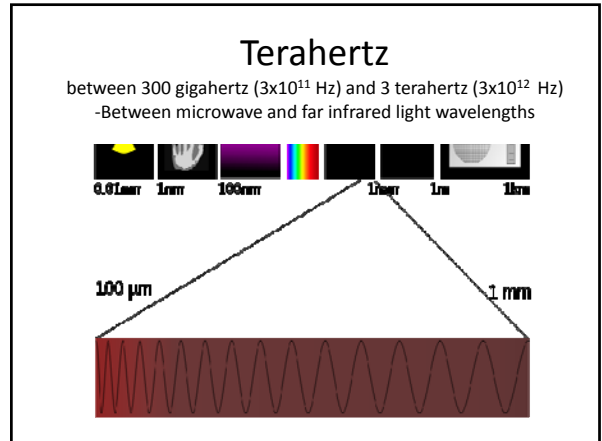
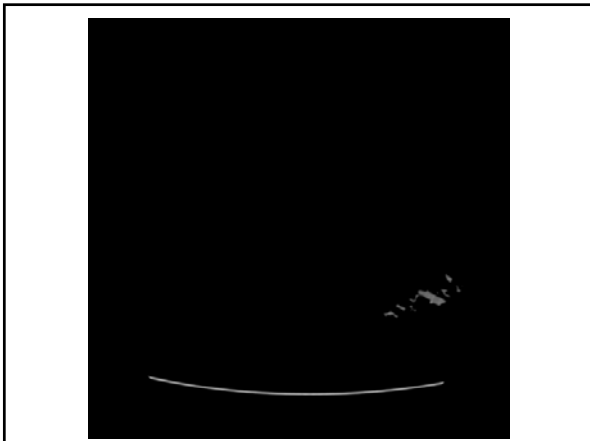
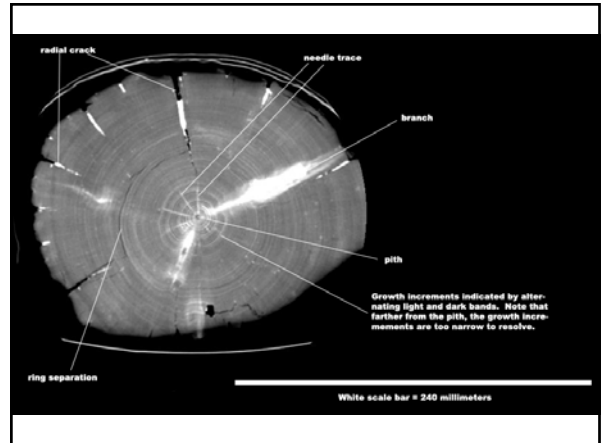
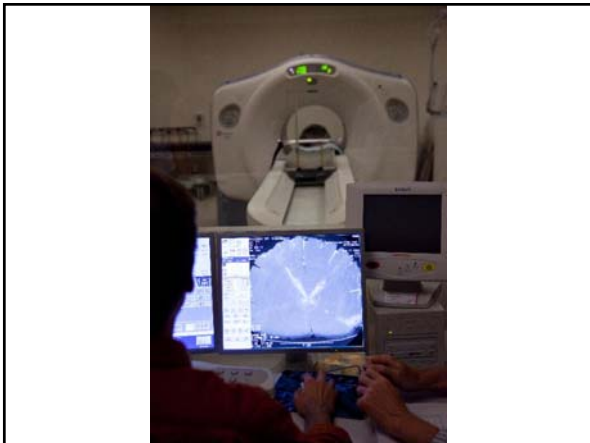


Fig. 1. A portable CT measuring a Japanese cypress tree.





Terahertz CT imagery of a tooth and
maple samara

