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2 / 7 / 07

Overview

During a recent storm, trees in the Native Growth Protective Area adjacent to the Red Hawk community fell and damaged a home. A request was made for a proposal for services to assess the situation and provide guidance. The proposal was made on the following basis.

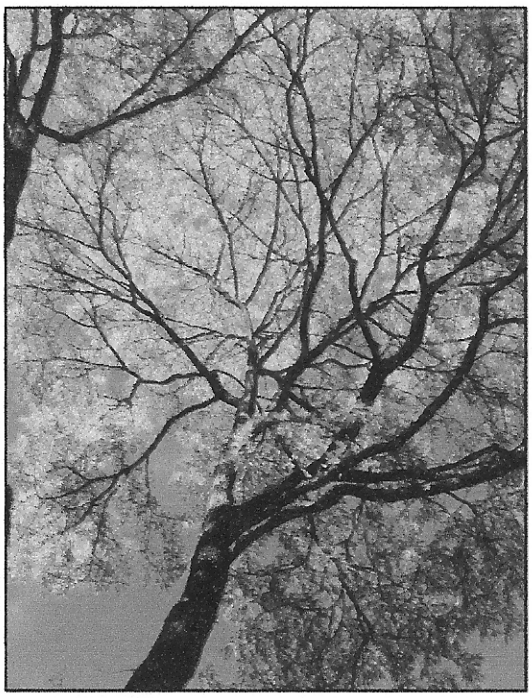
- To inspect fallen trees following recent windstorms.
- To determine the cause of failure.
- To assess the effect of the tree failure and the cause of tree failure on the remaining trees.
- To collect samples for examination and lab analysis to assess the nature and degree of any pathogens.
- To provide a report with recommendations for action to reduce the likelihood of failure.

Tree Inspection

To develop an accurate picture of tree health and condition, information must be gathered about the multiple, changeable, factors which influence tree vitality and stability. Vital, healthy tree growth is the result of a complex

association of internal and external influences and to consider each tree as an isolated entity is to fall short in understanding the whole picture. As a practical matter, this information must be gathered and structured in the best way to communicate the results of the observations and to impart any recommendations for treatment.

Individual tree inspection begins at ground level; tree genus and species is determined and soil quality, rooting conditions, soil level, irrigation and drainage characteristics are observed. Soil is a living micro-system that relies on an active working relationship between structural and living organic components. The structural condition of the soil is most commonly adversely affected.



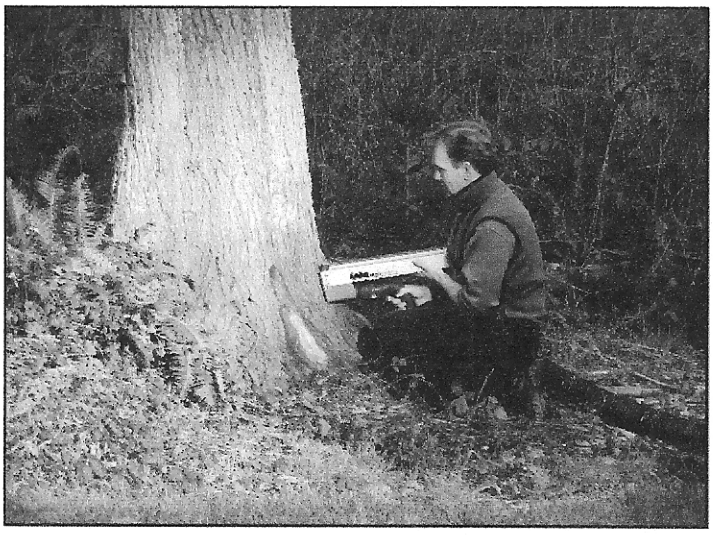
The quality of the soil may be assessed in its ability to contain and disperse available moisture and the level of soil compaction may be tested to evaluate the aeration capacity of the soil. Some soil types are easily compacted and although they are high in nutrient quantity, little of that nutrient quality is available to the growing tree. Compact soils also cause problems by restricting the trees ability to discharge the gasses produced as part of the growth cycle.

The visible parts of the tree, the trunk, branches and leaves live in balance with the unseen roots. Damage to the soil leads to inhibited root growth and causes a lack of vitality and decline within the tree as a whole. Soil compaction is commonly the result of heavy traffic in the root zone. The effects of soil compaction may not become apparent in the tree for decades following the initial compaction event.

If signs of stress are present, a soil test may be made to assess the fertility of the soil. Testing establishes the presence and degree of vital nutrients and micro-flora. Vital soil is essential to vital tree growth, the presence of nutrients and organisms within the soil mean that growth can continue. An imbalance of nutrients can cause poor vitality; often exhibited by leaf discoloration or lack of annual growth. Poor nutrition will slow growth and can diminish the trees natural defense mechanisms and expose the tree to disease.

In nature, few tree species grow alone; the forest is their natural and protected setting. Whether native or introduced, irregardless of a trees origin, trees in a landscape setting demand special attention. Although bound by the genetic code of its predecessors each tree is also the product of its local environment in terms of health and stability.

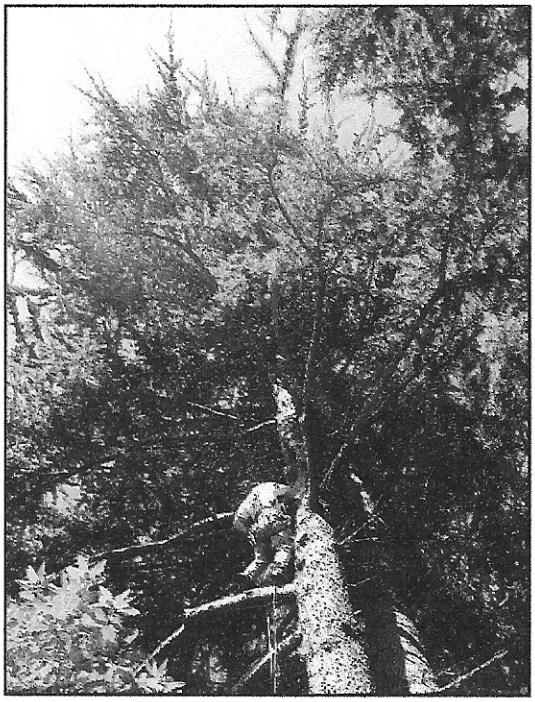
Looking at the overall picture, the health of the soil, turf and other plants and trees can reveal the cause of disease, or indicate potential problems. The presence of certain species of fungus can indicate decay. Certain decay fungi may destroy support tissues and leave conductive tissues unharmed. The tree may appear healthy and continue to grow until the internal decay outpaces the new outer growth.



A root crown examination may be necessary if root decay is suspected. By removing the soil at the base of the tree, the location, health and condition of the absorbing and support roots can be determined.

In the primary examination of the root crown and trunk a mallet is used to test for loose bark. Bark lifting can indicate dead or hollow areas and give signs of the presence of decay in the root crown zone and at the base of the trunk. The

mallet may be used to "sound" for decay but has limited reliability. If decay is suspected the tree will be tested using the Resistograph. The Resistograph is an instrument that inserts a constant velocity probe into the suspect area of the tree. The resistance to the probe is graphed by the machine. The graph profile can tell a great deal about the internal character of the wood. Internal defects can be detected, cracks, hollows and early stage decay. The type of decay and its effect on the stability of the wood depends on the species of fungus involved. Soil and root tissue samples may be taken to determine the cause of disease by laboratory testing.

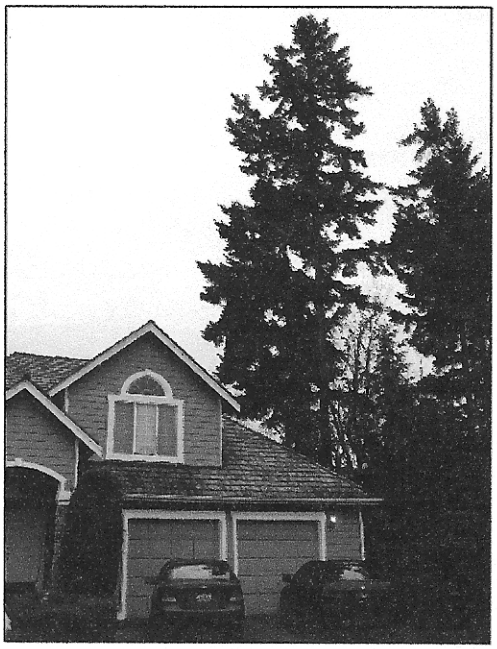


The inspection continues with an evaluation of the tree crown, first by eye or with the use of binoculars then, if necessary, by climbing into the canopy of the tree. The color, size and condition of the leaves, trunk, branches and twigs is assessed. The form and formation of all the trees components give information about health, vitality and structural strength. The crown density, the number of leaves on each stem, and past and current growth extension, indicate current health and reveal previous problems. Changes in growth rate in past growth may indicate prior disease or injury.

An evaluation of the general growth habit will reveal any problems related to vigor, or the genetic component of tree growth. Previous treatments such as pruning or cabling are observed, the quality of the work, and its effect on the tree. Any growth abnormalities are noted: weak limbs, discolored or missing bark, cracks or cavities in branches or trunks. Indications of disease are observed within the canopy of the tree, disease may be indicated by leaf blight, stem canker, fungal growth or insect and bird activity.

Trees produce adaptive growth to compensate for the stress related to growth and injury. The shape and formation of limbs and trunks can show the ability of the tree to compensate for weakness or indicate internal problems that may lead to limb or trunk breakage. The interpretation of these changes in form is part of a growing body of knowledge pioneered in Europe. The knowledge is not new but the application is: Dr. Claus Mattheck of the Karlsruhe Institute and colleagues, have developed a system of structural evaluation based on the principals of bio-engineering. I have chosen to use this approach to augment my own knowledge and experience.

Observations



The tree that failed was a Douglas fir (*Pseudotsuga menziesii*). The tree failed at the roots and fell in the direction of the prevailing wind. The concern is that the conditions that lead to the failure of the fir may cause failure in the remaining trees that are in striking distance of the surrounding homes.

Examination of the roots of the fir show that the tree is infected by the root decay fungus *Phellinus wierii*, this fungus causes Laminated Root Rot.

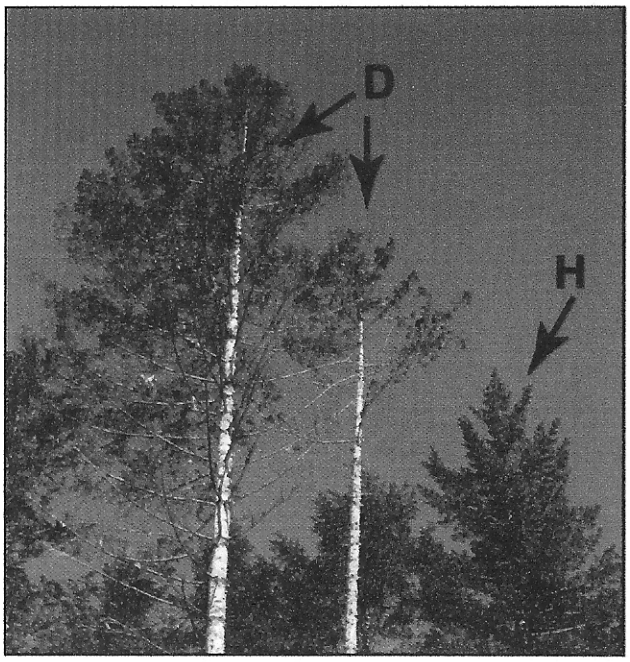
Laminated Root Rot also known as yellow ring rot affects conifers in Japan, Manchuria and western North America from southern Oregon to British Columbia. In North America two distinct forms exist. In Washington state one form occurs through the eastern Cascades and eastern Washington. The second form is found here in western Washington. Different species are affected by the different strains. The eastern form primarily affects Western Redcedar (*Thuja plicata*) and the western form affects the Douglas fir (*Pseudotsuga menziesii*).

The disease occurs mainly in forests that are managed for timber production but is often found in landscaped settings where stands of trees remain following the clearing of a wooded area. Trees susceptible to the disease in Western Washington include; Mountain Hemlock (*Tsuga mertensiana*) Douglas fir (*Pseudotsuga menziesii*) Grand Fir (*Abies grandis*) Pacific Silver Fir (*Abies amabilis*) and White Fir (*Abies concolor*).

Symptoms and Diagnosis

Trees may be infected at a young age but the disease is seldom noticed until the trees are at least ten years old. Most destruction occurs in trees between 25 and 125 years old. The majority of the trees are blown down while still alive. Failure is due to root decay caused by the fungus, *Phellinus weirii*, which digests the woody support roots while absorbing root activity continues. New growth continues while older root and trunk tissues are decayed. The typical pattern of decay shown in the photograph above leaves only stubs of support roots showing following failure.

Laminated root rot spreads on site by growing through the soil via root contacts. Diseased trees and the stumps of fallen trees should be considered infection sites and the fungus is capable of surviving on decaying stumps for over 50 years. An area of fifty feet around a diseased stump is a potential infection zone, all susceptible trees that fall within this area may be infected.

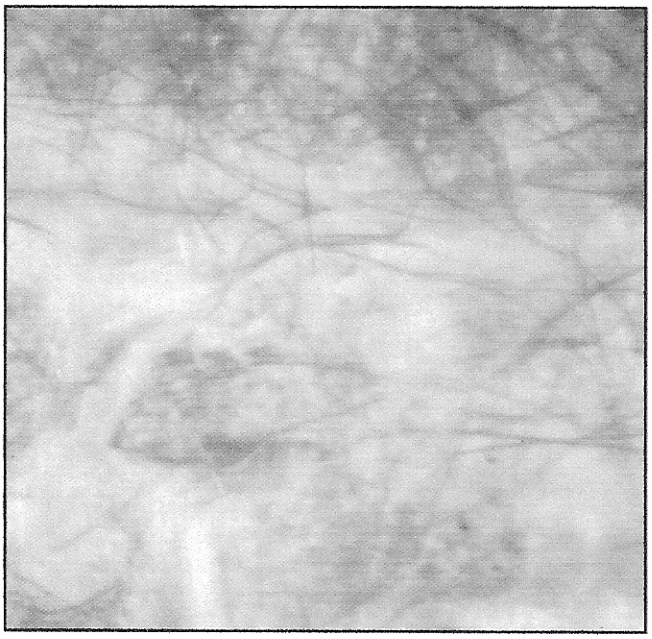


The above ground symptoms of the disease are often subtle. The growth within the upper canopy of some trees is reduced; this can cause a "rounding of the crown". Shown as **D** in the photograph at left. Conifers typically have a dominant central leader shown as **H.** When the disease slows growth the leader is first affected, the surrounding limbs continue to grow forming the rounded crowns shown above. A disease center may be indicated by a group of trees with rounded crowns surrounded by trees with strong central leaders.

The base of some trunks may be decayed at the root crown level close to the ground. This decay can be detected in standing trees with the use of the Resistograph.

Positive diagnosis of Laminated Root Rot is made through the microscopic examination of root tissues. Shown at right the hair like growth is known as setal hyphae and is a fungal structure which shows that *Phellinus weirii* is present.

Extensive de-lamination of wood tissues and decay are to be expected where setae are present.



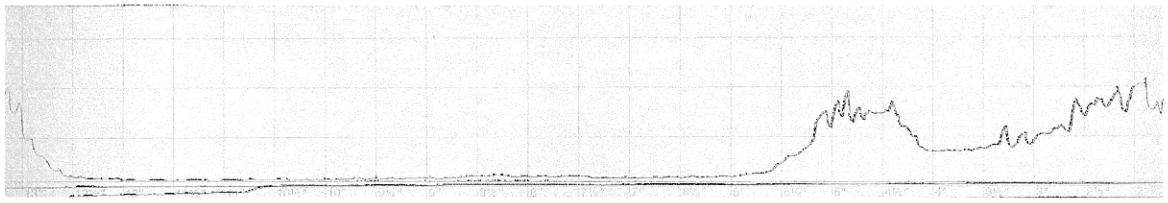
The photograph at left shows the fallen tree. The decay, described above is extensive in the root of the tree and extends into the trunk. To assess whether neighboring trees were subject to similar decay they were tested with the Resistograph.

The Resistograph is an instrument, or rather a family of instruments, for detecting decay and defects in trees and timber. The instrument measures the resistance to a needle inserted into the wood under constant drive. In the M300 model, the constant drive is provided by either a crank and fly wheel or a battery driven electric motor, while the F400 relies on a battery driven motor alone. The M300 tests to a depth of 12" and the F400 to 16"in depth.

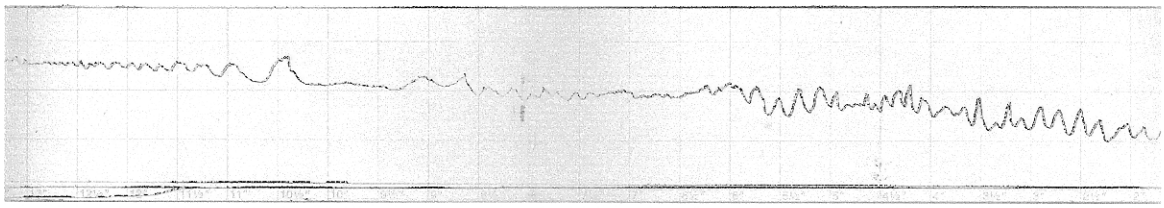
The resistance to the needle tip is transferred through an "intelligent" satellite gearbox to a pointer on the top of the instrument that maps the result on a waterproof wax paper printout. Drilling resistance correlates to the physical properties of the wood. Defects such as cracks areas of decay, hollows and to a certain extent tree ring structures can be detected and mapped. The resistance is mapped on a 1:1 scale on the wax paper, giving a clear graphical representation of the mechanical properties of the wood. The Resistograph utilizes a 3mm needle tip and a 1.5mm flexible needle that tends to "squeeze" between the fibres of the wood causing very little wounding.

The Resistograph charts are shown below and should be read from right to left, areas of lower strength are shown by a lower reading on the scale. I have retained the original charts along with a computer based copy of the results.

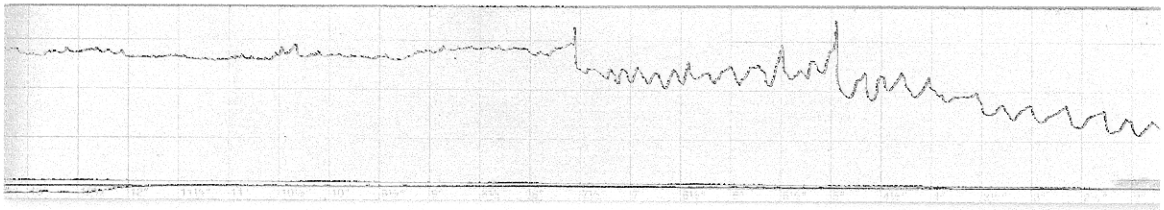
Test 1 was done on the fallen tree shown as F on the sketch below. The test was made at ground level and shows sound wood followed by an internal hollow. The center of the tree is subject to advanced decay.

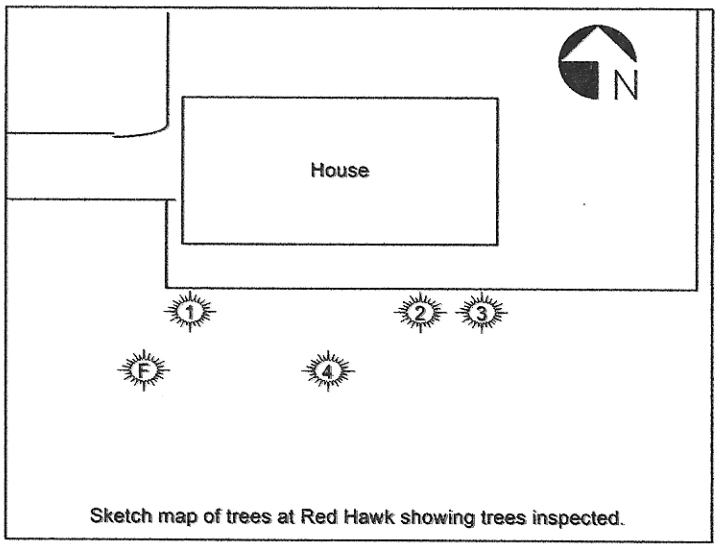


Two trees were tested and are shown on the sketch below. The test below was made on Tree 2. The test shows a normal profile of gathering resistance with small areas low resolution indicative of early decay.



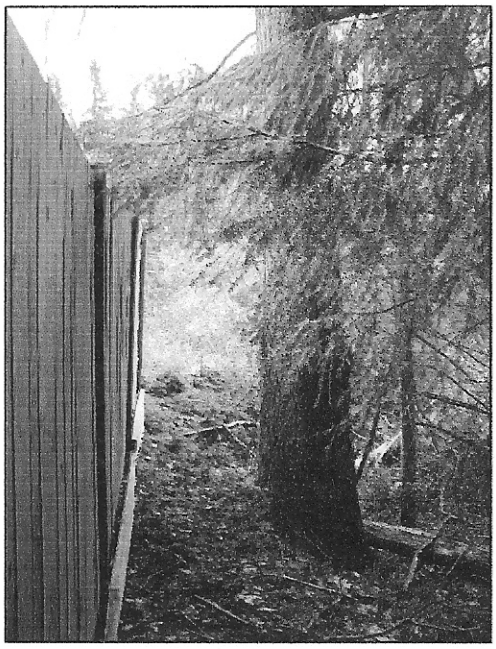
Tree 3 was also tested the test shows a normal profile to a depth of 7.5" the graph then loses detail and no annual growth increments are visible. Early decay is suspected toward the center of the tree.





Sketch map of trees at Red Hawk showing trees inspected.

Conclusions



None of the trees that were inspected show signs of advanced disease; however two trees are of concern. Trees 2 and 3 are located in close proximity to the fence; they are shown in the photo at left. These trees appear to have been buried during site development. Grade changes of this kind can favor the development of root diseases. The Resistograph tests indicate some alteration in the composition of the wood toward the center of the tree at the root crown. This could indicate early decay associated with root decomposition. Given the proximity of the trees to the house the trees should be reduced to habitat snags within the next two years. I would also recommend further evaluation by inspection every two years.

Given the nature of Laminated Root Rot as discussed in the preceding section, progressive replacement plantings are advised. The following is a list of trees that are Resistant and Immune to this variety of Laminated Root Rot.

Resistant.

Alaska Cedar	*Chamaecyparis nootkatensis*
Incense Cedar	*Libocedrus decurrens*
Ponderosa Pine	*Pinus ponderosa*
Port- Orford Cedar	*Chamaecyparis lawsoniana*
Redwood	*Sequoia sempervirens*
Western redcedar	*Thuja plicata*

Immune.

All broadleaf trees (deciduous)

Bigleaf Maple	*Acer Macrophyllum*

Red Alder	*Alnus rubra*
Vine Maple	*Acer circinatum*

I hope this information proves useful. Please let me know if you have any further questions.

Yours sincerely

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