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Guide to the Identification of Bearing Tree Remains

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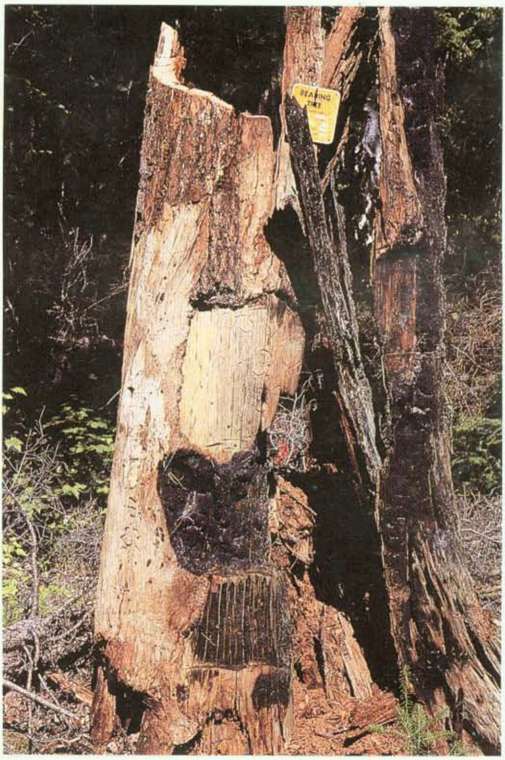

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FRONT COVER GRAPHIC

White Pine Bearing Tree

T. 45 N., R. 43 W. Closing corner between sections 33 and 34 on the Michigan-Wisconsin state line.

South between sections 33 and 34, var 6-1/4 E.

54.00 intersect state line 4.00 chains west of 22 mile post from which a spruce 6 in. in diameter bears N. 65 degrees E., 18 lks. dist., and a w.pine 24 in. in diameter bears N. 55 degrees W., 11 lks. dist.

This stately sentinel has stood guard over its corner since July 21, 1852. When recovered on August 11, 1975, it was a long-dead pine stub, only 2 - 4 inches larger than when it was scribed by Algernon Merryweather in 1852. The tree was located in a black spruce swamp and lacked the customary names and dates of the cruisers who had visited it over the years, indicating that in all probability, it had not been previously recovered. The corner was monumented by Richard L. Drahn, Forest Land Surveyor on the Ottawa National Forest, which is located at the western end of Michigan's upper peninsula.

PREFACE

Twenty-five years of retracement on the Ottawa National Forest have done much to formulate my outlook on the original surveys. First, I am convinced that my hot meal and warm bed at the end of a long day is a vast improvement over what the original surveyors had to put up with in the 1840's. Second, it has brought names like William Austin and John Burt to my lips, where they are uttered in a reverent, half-whisper. These men, and a thousand others like them, carved out a nation with a survey of such magnitude that it nearly boggles the mind. Step by step, mile after mile, township after township, they struggled--blazing, scribing, and discovering what this great Nation contained. Aside from the rectangular grid that they stretched out across Michigan's upper peninsula, they discovered much of the iron and copper deposits, documented the timber types, collected mineral samples, meandered the lakes and streams, classified the soils, and commented on the potential locations of grist mills, sawmills, and other developments. All of this they entered into their field notes and diagrammed on their plats. Such comments in their notes as "free floating copper nuggets in stream bed" sparked a later mineral claim that today is a small town. Their documented insight helped give this Nation that extra push that thrust us into the 20th century. Their notes, however, give little indication of the tremendous hardships they faced in struggling ahead--just one more mile--in the completion of their contract. Somewhere along my travels I came across excerpts from notes and letters that touch upon what it must have been like back in the 1840's.

Letter from William Ives, Esq.
Grand Isle, November 8, 1880

Mr. William Burt,

Dear Sir: I will answer your inquiries as well as I can recollect. I have no journal for the year 1844. In the summer of 1844, Dr. Douglas Houghton got a contract or permission to survey a large tract of the mineral country bordering on Lake Superior. We went to Mackinaw in a steamboat, and from there we went to the mouth of the Escanaba River which empties into the Little Bay de Noquette, in a batteaux. We built a small flat boat and towed our provisions up the river 10 or 15 miles, wading in the water most of the way. We noted variations of the needle from 83 east to 83 west. We were over 4 days

SPECIES--The surveyors and their crews were all accomplished woodsmen. In 25 years of retracement in the western part of Michigan's upper peninsula, I've found that the incidence of miscalled bearing tree species is virtually nonexistent.

SIZE--It is generally assumed that the size of the original bearing tree was estimated rather than actually measured. With practice, most cruisers today can estimate diameters to within 2 inches. Allowing for the growth characteristics of different species, site conditions, cutting history, and stand conditions, one can estimate the size class of the bearing tree being sought.

BEARINGS--The bearings given from the corner to the bearing trees are, for the most part, slightly more reliable on the primary control lines. From the original notes, it appears that, where possible, the solar compass was employed at the section corners for continuation of the primary lines and for the laying of the lateral lines. Where magnetic compasses were used, needle variations from the work done 135 years ago may vary from 2 to 5 degrees.

DISTANCES--Although a few discrepancies in the distance from the corner to the notch of the bearing tree blaze marks have been noted, the distances are highly reliable. They will normally control over the bearings. Being given to the nearest link (.66 feet), distance allows for minor deviation in the true corner position.

As the scribing on our Forest slowly eroded away, some of us involved with our retracement program gradually built up the ability to identify many of the species in a badly decayed state. Being an experience type of learning process, it was time-consuming, taking 4 to 5 seasons to become proficient. We needed a more positive, rapid method of correct species identification.

Humans' discerning nature, since about the time they climbed down out of the trees, has been directed towards determining the difference between objects in their environment. They have learned to determine by sight, sound, smell, taste, and feel just which plants they can eat and which ones they cannot; which stones are good for making arrowheads and which ones are not; which animals are easily caught for food and which ones are themselves the hunter. Everything encountered has been examined, categorized, and placed in its own little niche in the overall order of things.

running this 6 miles on account of stormy weather; there were 6 inches of snow at one time. We had only 2 days' provisions in 5 days, except that we caught three porcupines the fifth day. I well recollect the soup we had for breakfast the morning of the fifth day, it was made of the moldy scrapings of a flour bag and a few sour dried apples; and for dinner we had a porcupine divided amongst us which we roasted on sticks, and for supper--porcupine soup."

Letter from H. Mellen, Esq.
Romeo, Michigan, November 1, 1869

William Burt, Esq., Marquette, Michigan:

"I shall remember whilst I live the circumstances under which we were placed at the time. The compass needle was entirely useless. The sun was obscured at 11 o'clock, a.m., shortly after the discovery of the iron. A rain set in, in the afternoon, which lasted for about 30 hours, followed by a heavy fall of snow, and for 5 days we subsisted on one and one-third day's provisions. Mr. Ives came up with us on the 21st, on crutches, still very lame from a thorn in the knee. His sufferings from his lameness and working his way through the snow were great. I never saw bushes so densely loaded as they were at that time."

Much of the original work done by these brave, hardy men is in grave danger of being lost forever. The activities of people, wildfire, and the ravages of time have all taken their toll. Although attempts have been made to preserve and record these original corner locations, not one corner in 1,000 has been correctly and adequately perpetuated in most rural areas in the northern Great Lake States.

The original corner posts on the forest and their respective bearing and witness trees were all carefully blazed and scribed. Now, scribing remains at perhaps one corner in 500; soon it will be one in 1,000; and by the turn of the century it will be all but gone.

Although it is possible to mathematically determine where the original corners should have been placed had current technology been available 150 years ago, there is no way to position the corner exactly where it had originally been placed, except through remaining field evidence of the original survey.

The profession of land surveying is kind of like a horse pulling a cart up a hill. The basic part of the unit--retracement--is the horse; he pulls the cart (or surveys) ahead. Very little has been done to strengthen the horse. The BLM's pamphlet entitled "Durability of Bearing Trees," Don Lappala's (Ottawa National Forest Land Surveyor, retired) pamphlet entitled "Retracement and Evidence of Public Land Surveys," and this decayed wood guide are about all I've encountered. Into the cart (surveys) we've put such advancements as computers, GPS systems, laser range poles, north seeking gyros, and on and on. It doesn't take long and the cart starts dragging the horse around. All the surveys in the world stand on very weak ground without a good foundation of retracement.

Being basically somewhat pessimistic, I've always had some serious apprehension on proportionate measurement or accepting undocumented local usage corners. It doesn't take long to math point a corner, just outside of a swamp, when the notes and the bearing tree species indicate that the point was acutally in the swamp. I'm also a devoted disciple of a fellow by the name of Murphy who described a basic law and numerous corollaries that, in short, say "If there's a possibility of anything going wrong--it will," and at the most inopportune time, like after I've subdivided about 4 sections all based on a double proportioned section corner. Essentially what I say to the world when I elect to math point the corner is: "Look, I've looked for it and I can't find it, and as good as I am, if I can't find it, nobody can." Well folks, sooner or later that Murphy fellow will dig it up.

A couple of examples if I might:

There's a State here in the Midwest that, after the pine cuts in the 1890's and the inevitable fires that followed, petitioned the General Land Office to resurvey the better part of four townships in the heart of lake country. The town, range, and subdivision corners were all reset with brass caps and steel accoring to accepted procedures. It didn't take long after that, with everybody wanting his or her own little shangri-la in the north woods, that the lakes were all platted and millions of dollars worth of development had been invested. A few years ago, a land surveyor I know sat down on a log to eat lunch in the middle of his project area and, lo and behold, there about 150 feet south of the townline brass cap was an original townline bearing tree.

Same State, different surveyor. I was helping a land surveyor cut out a 7-acre lot in a section that had been subdivided sometime earlier. The township had been resurveyed in the early 1960's with concrete and brass and was one of those "wild" townships with weird shaped sections. I had hunted the area for a number of years and knew where the east quarter corner brass cap was, so I was leading the way in. Bent over with a 3805 on my back and whatever else I could carry, we were hoofing it down a powerline to the brass cap. About 100 feet or so from the corner, I was about to step over a badly decayed pine log when I stopped--the hair rose on the back of my neck as I stood looking down at the half flattened log. My partner asked what was wrong. I pointed to the log and said "I think that's a bearing tree." He asked me where the corner was and I told him it's at least 100 feet east and then north of the powerline. I got down on my knees and after some effort, managed to roll the log over. There it was, scribing, just bigger than life. We found out later that one of the original bearing trees was a white pine, 8 inches DBH, S 58 degrees W, 27 links.

Back in the early 1960's, when I first started with the Forest Service, we were on a retracement project in the north half of T.45 N., R.37 W. What little pine did grow in the area had been cut, but the hardwoods and other softwoods were for the most part untouched. Original scribing was recovered at about 75 percent of the corners. By last summer, some 25 years later, less than 2 percent of the corners in our project areas still had fragments of scribing left. The era of monumenting only those corners with scribing is long over, but sufficient original evidence still remains to recover the original corner location.

Over the years, our retracement procedures have produced a recovery rate of about 70 percent. After establishment of a proportionate point by survey methods, another 10 percent are monumented from the decayed remains of the original bearing trees.

One important factor in our retracement program is the accuracy of the vast majority of the original surveys on the Ottawa National Forest. The consistency of the original surveys often allows us to get down to within 20 to 30 feet of the original corner location with compass and chain. The original surveyor's use of 2 to 4 line trees plus natural feature ties on each 1/2 mile gives us an advantage in corner recovery not shared by the rest of the Great Lake States area.

At the corner, the Deputy Surveyors provided us with certain information about the bearing trees used. As with the rest of the information contained in the original notes, this bearing tree information was recorded accurately and reliably and must be taken into account in the analysis of the field evidence.

The plant world is no exception. Each species has its own set of identifying characteristics--some visible at a glance, others apparent only to the trained eye under close examination. These identifying characteristics are what makes a hemlock a hemlock rather than a sugar maple, a red pine, or some other species. Along with the obvious differences of leaf, bark, and seed, there are also basic differences in the cellular characteristic of each species, no matter how closely related. These "cellular fingerprints" for each species often remain identifiable long after the tree has died and the leaf, bark, and seed characteristics have disappeared. It is primarily through these "cellular fingerprints" and field observation of the typical decay patterns of the different tree species that identification is possible, occasionally right up to the time that the melting snow pack carries the last of it down into the soil.

Although the woods that are involved in this key are all found in the northern Great Lake States, the key can easily be modified to include woods from other areas. A word of caution might be in order at this time concerning the use of this material. It will not prove to be a substitute for key observation and sound judgment. Seldom do broad, general statements, as are contained in the species narratives, apply to all examples of a particular species. The conditions affecting a decaying tree, such as moisture, soil type, soil acidity, etc., may produce a wide variety of decay characteristics. Even such "typical" biological characteristics as vessel size and arrangement may have their exceptions. It might be prudent to send samples, where critical, to a research lab for identification by a qualified wood technologist.

By a process of elimination and with a little practice, one should be able to walk through the key to a point where one's knowledge of growing habits and other considerations provide correct identification. Quite often, it may be enough to know what species a particular sample is not. For instance, if in trying to locate a hemlock bearing tree within a search area, one can only find wood having vessels--a characteristic of the hardwoods--it doesn't make much difference whether the samples are yellow birch or basswood; you just know it is not a hemlock. Just as a cabinetmaker can differentiate at a glance samples of black walnut, cherry, butternut, cedar, etc., one can easily identify many decayed woods under a 10X lens.

The narrative of each species will include:

> WOOD DESCRIPTION--Particulars such as relative resistance to decay, potential for sprouting, typical decaying color, texture, and other possible identifying characteristics.

BARK DESCRIPTION--The bark of some species occasionally outlasts the wood. The narrative describes the characteristics and their relative value in species identification.

CELLULAR STRUCTURE--An arrangement visible at 10X magnification and measurable with a 7X comparator is covered. These "fingerprint" characteristics often remain the prime identifiers in badly decayed specimens.

STUMP HOLE--Although far from a positive identifying characteristic, many species tend to leave similar stump holes under similar conditions, such as soil type, soil moisture, and slope. At best, this can be used as collaboration evidence only.

SITE--Each niche in the environment has conditions perhaps best suited to a particular group or species. Although some species may display a wide range of growing sites, others are highly selective as to habitat.

ASSOCIATIONS--Instances such as relative occurrence; attack by specific fungi, stains, and molds; and associations with other plants all tend to point a finger at the correct species.

The ability to identify the species of decayed woods, in retracement, is as basic and as important as the ability to correctly measure a distance. Without the ability to correctly identify the species of the line and bearing trees established by the original surveyors, one might better spend her or his time observing nature at the corner site than attempting to recover the original corner location.

The tools-of-the-trade for field identification of decayed woods are inexpensive, especially in light of what most other field equipment costs. I would recommend having the following:

Magnifier - of 10X or better. Illuminating magnifiers, while convenient, are not essential.

Comparator - of about 7-10X, with small circles graduated in microns from 100 microns up.

Razor blade - (or extremely sharp hobby knife) for cutting the sample for examination. Often the best method of preparing a sample is simply to break it at right angles to the growth rings, reducing the tendency of the vessels to collapse when cut.

Identification key and species narrative - At the start of our cellular examination project of decayed woods, we sketched what we viewed through a 10X hand lens at corners with positively identified bearing trees. We examined individual species over a wide range of decay stages, taking notes and occasionally photographs of what we observed. Once confident of identification, we sent samples of green and decayed woods to the Forest Service Forestry Sciences Laboratory in Rhinelander, Wisconsin, for photography at 10X magnification.

The basic structure of most keys, conveniently enough, can be diagrammed as a tree, with the main trunk being the basic topic of the key--in this case, the vessel structure of wood. Each fork in the tree asks a question, the answer to which directs the examiner up the proper branch to the next fork and another question, until the final fork where the answer to the question provides the correct species identification, at the end of the branch.

Caution: It may well be expected that variations will occur not only from one geographical area to another, but perhaps even within specific locales. The key and the narratives should all be hand tailored to each specific locale. This work has been done not so much as an ending point in the art of decayed wood identificaiton, but rather as a place to begin in identifying the tree species referred to in the original surveys. Properly used, it should provide another usable tool in retracement; improperly used, it could well be a crutch--capable of more harm than good.

Richard Drahn
Land Surveyor

INTRODUCTION

Tree and macroscopic wood identification can be performed using the naked eye. Microscopic wood identification must be done by enlargement under a hand-held lens or a microscope.

Initial observation of a decayed stump and knowledge of the species and tree growth under a variety of site conditions may be all that is needed for positive identification by the experienced observer. When additional proofs are needed, exposing or removing the decayed wood from the stump for viewing under a hand lens and comparing with corresponding color prints using the cellular structure key should enable the observer to identify the species.

The species identified by the colored prints are mostly native to the northern Great Lake States, and are used as bearing trees in the survey of the rectangular public land survey system.

DEFINITIONS

Annual growth ring - The total increase in a tree's diameter laid down in one season. Viewed in cross-section, the growth ring is a series of concentric rings, each containing springwood and summerwood.

Bark - The exterior portion of a tree consisting of corky, fibrous tissue that covers and protects the growing portion of the wood lying beneath its surface.

Conifer - Used synonymously with softwood in this text.

Cross-section - A reference cut of wood tissue taken at right angles to the trunk, characterized by an end view of vessels or tracheids, and growth rings.

Diameter at Breast Height (DBH) - 4.5 feet above ground.

Frass - The debris or excrement produced by insects.

Hardwood - A generalization used to describe the deciduous broadleaf trees, such as the oaks, maples, birches, etc., whose wood contains vessels.

Micron - A unit of measurement equal to one-thousandth (0.001) of a millimeter.

Parenchyma cells - The small, thin-walled, secondary vessels lying in thin lines generally parallel to growth rings. These are key identifiers in the elms.

Platelets - The individual, separable layers of tree bark. Size, color, and texture of platelets are occasionally prime identifiers.

Radial section - A reference cut of wood tissue taken from the outside edge of the tree to the center, characterized by a side view of vessels or tracheids, and growth rings.

Ray - A series of small cells arranged so as to appear in a thin line formed at right angles to the growth ring. Size, arrangement, and spacing of the rays aid in wood identification.

Resin ducts - The small ducts or channels found in some conifers and visible in cross-sections as whitish or bluish specks. They are also visible in radial and tangential sections.

Softwood - A generalization used to describe the conifers, such as the pines, spruces, tamaracks, etc., whose wood does not contain vessels.

Springwood - That part of the annual growth ring laid down earlier in the growing season. Generally less dense than the summerwood.

Summerwood - That part of the annual growth ring laid down later in the growing season. Generally more dense than the springwood.

Tangential section - A reference cut of wood tissue taken parallel with bark and growth rings, characterized by a side view of vessels or tracheids, and rays. It does not cross growth rings.

Tracheids - As used in this text, the elongated cells that constitute the greater part of the structure of softwoods.

Tylosis - A fine, membranous occlusion in vessels of hardwoods (particularly white oak) that often appears, under low magnification, to completely block the major vessels. It is a prime identifier in differentiating between white and red oak.

Vessels - As used in this text, the small, tubelike openings in cross-sections of hardwoods, visible with 10X magnification. Size and arrangement of these vessels aid in wood identification.

Vessels (diffuse porous) - The arrangement of hardwood vessels characterized by vessels of similar size uniformly dispersed throughout the springwood and summerwood.

Vessels (radially porous) - The arrangement of hardwood vessels characterized by an alignment of the vessels across the growth ring rather than parallel to it.

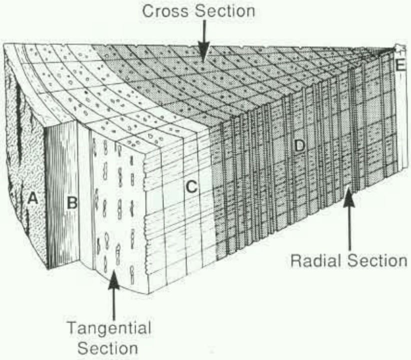
Vessels (ring porous) - The arrangement of hardwood vessels characterized by a series of very large vessels laid down in the springwood. Summerwood vessels are usually considerable smaller and dispersed.

Vessels (semi-ring porous) - The arrangement of hardwood vessels characterized by a gradual decrease in the size and number of vessels across the growth ring.

Porous wood - Wood with vessels present, as viewed in the cross-section; typically the hardwoods.

Nonporous wood - Wood lacking vessels; typically the softwood or conifers.

A Wedge-Shaped Block From the Mature Trunk of a Hardwood Tree



A - Outer bark — Dead, fissured, and brown

B - Inner bark—Living, light color

C - Sapwood—Four growth increments

D - Heartwood—Darker color than sapwood

E - Pith—Center of stem; may not be visible in a mature block of wood

PREPARATION OF SMALL WOOD BLOCKS FOR PHOTOMICROGRAPHY TO SIMULATE VIEWING THROUGH A 10X HAND LENS

FRESH WOOD

1. Store freshly cut block in freezer to retain moisture.

2. Just prior to sectioning, soak blocks in water until fully saturated.

3. Trim blocks to size--about 1/2 inch square.

4. Prepare smooth transverse surface with Reichert sliding microtome.

5. Slowly air-dry blocks.

6. Store in dust-free location until photographed.

7. Block surface is now ready for photography.

DECAYED WOOD

1. Soak block in water until fully saturated; may require vacuum for full saturation.

2. Trim block to size, about 1/2 to 3/4 inch square.

3. Begin infiltration with Carbowax (polyethylene glycol) 1500 under vacuum at 50 degrees Centigrade for 24 to 48 hours.

4. Gradually add Carbowax 4000 at 12- to 24-hour intervals until desired consistency is attained to hold decayed block intact.

5. Remove block from Carbowax, cool, and trim off excess Carbowax.

6. Prepare smooth transverse surface with Reichert sliding microtome.

7. Block cannot be photographed at this stage because of high reflectivity of the Carbowax.

8. Gradually remove Carbowax from prepared surface of block by careful washing and rinsing with water. Air-dry between

washings to observe progress and condition of block surface. Removal of too much Carbowax from heavily decayed samples results in excessive warp and distortion of block surface and, in some cases, disintegration of the entire block. Some Carbowax must therefore be retained in the block as a cementing substance; this results in a certain degree of gloss in the final photographs.

PHOTOMICROGRAPHY

1. Photomicrographs, at about 8X, made with a Topcon Reflex camera and bellows mounted on a special stand.

2. Surface reflected light was provided by 3 high-intensity lamps.

3. Film was Kodak EHB - 35 for tungsten light. ASA - 125.

CELLULAR STRUCTURE KEY

One key to wood identification is the distinguishable cellular features found in each of the tree species. The presence of vessels, ducts, and rays of various sizes and locations, along with cellular variations, provides a means for species identification. As the wood decays due to moisture changes, soil conditions, and the spread of fungi, cellular structure features are altered. It is important to expose or extract the least decayed part of the tree stump to examine key identifiers.

To obtain a sample from a tree stump, make a cross-sectional cut using a sharp razor blade or knife or, if possible, break off a piece of stump by hand. A sharp cut or a broken sample will result in the least disturbed and best end view of the wood cells and vessels. The sample should be examined under a 10X or better hand lens and under a 7X or better comparator to determine the size of the vessels.

The cellular structure key is designed so the user can follow paragraph numbers found at the beginning of each paragraph through paragraph continuation referrals found at the end of each subparagraph clause until the proper species is determined. The narrative description and colored prints of cross-sections for each species are referenced by page number to help confirm the identification.

The use of the key is demonstrated in the following example. Beginning at Paragraph 1, the user notes that the wood sample has vessels present. Paragraph 1a describes this condition as "Hardwoods," and guides the user to Paragraph 2. Under Paragraph 2, the user notes that the wood sample has vessels ring porous, which corresponds to Paragraph 2a. Paragraph 2a narrows down the possibilities to ash, elm, or oak, and directs the user to Paragraph 3. Under Paragraph 3, the user notes that the wood sample has large vessels with predominant broad rays, easily visible, which corresponds to Paragraph 3a. Paragraph 3a identifies the sample as oak, and directs the user to Paragraph 4. Under Paragraph 4, the user notes that the wood sample has open springwood vessels and distinct, thick-walled, aligned, and rounded summerwood vessels, which corresponds to Paragraph 4a. Paragraph 4a identifies the species as northern red oak, and directs the user to page 51 for a narrative description and cross-section colored prints for this species to confirm proper identification.

Paragraphs 2 through 15 - Hardwoods
Paragraphs 16 through 20 - Conifers

1. a. Vessels present - Hardwoods - 2
   b. Vessels absent - Conifers - 16

2. a. Vessels ring porous; abrupt changes from springwood to summerwood - ash, elm, oak - 3
   b. Vessels semi-ring porous; springwood vessels decrease in size and frequency from springwood to summerwood - Butternut, cherry, walnut - 14
   c. Vessels diffuse porous; American beech, aspen, basswood, birch, maple - 8
   d. Vessels radially porous - American hornbeam (blue-beech), eastern hophornbeam (ironwood) - 13

3. a. Vessels large at 200 to 430 microns in diameter; predominant, broad rays easily visible - oak - 4
   b. Vessels 150 to 290 microns in diameter; rays visible at 10X - ash, elm - 5

4. a. Springwood vessels open. Summerwood vessels distinct, thick walled, aligned, and rounded. Northern red oak (page 51)
   b. Springwood vessels occluded with tylosis. Summerwood vessels thin walled, indistinct, irregularly shaped, and not well aligned. White oak (page 53)

5. a. Single row of vessels - elm - 6
   b. Two to four rows of vessels - ash - 7

6. a. Prominent, well-defined, and wavy bands of parenchyma cells in summerwood visible without hand lens. American elm (page 41)
   b. Parenchyma cells visible with hand lens. Cells arranged in interrupted, shallow, undulating line. Red elm (page 43)

7. a. Numerous small and often paired vessels in summerwood. White ash (page 21)
   b. Relatively few vessels seldom paired in summerwood. Black ash (page 23)

8. a. Narrow and very wide rays. Larger rays three to five times wider than vessels. American beech (page 29)
   b. Narrow rays. Rays rarely twice as wide as vessels - aspen, basswood, birch, maple - 9.

9. a. Vessels randomly paired - maple - 10
   b. Vessels often paired or grouped - aspen, birch, basswood - 11

10. a. Rays prominent, of two distinct widths, and contrastingly light compared to surrounding wood. Large rays barely visible to the eye. Small rays visible at 2X to 4X. In light-colored decayed wood, vessel edges often stained light brown. Sugar maple (page 49)
    b. Rays of random widths are irregular and obscure. Visible with hand lens. Decayed wood vessels unstained. Red maple (page 47)

11. a. Rays barely visible at 10X to 20X. Rays extend over many growth rings. Aspen (page 17)
    b. Rays visible at 10X. Rays appear contrasting, distinct, and continuous across many growth rings - basswood, birch - 12

12. a. Growth rings not distinct. Transition from springwood to summerwood not noticeable. White birch (page 31)
    b. Growth rings show slight change from springwood to summerwood. Often a faint, continuous, reddish-brown line between annual rings. Summerwood is 20 t0 30 percent of annual ring width. Great variation between growing sites. Yellow birch (page 33)
    c. Growth rings faint to noticeable, with a gradual color transition from springwood to summerwood. Single, uniform, and unbroken band of cells at start of spring growth. Cells marginally visible at 10X and distinctly visible at 20X. Summerwood may be 30 to 60 percent of annual growth width. Basswood (page 25)

13. a. Vessels sparse and elongated, combined in pairs or short columns at right angles to growth ring. Thin cell wall between pairs or groups. Rays small and indistinct. Eastern hophornbeam (Ironwood) (page 45)

b. Vessels thick walled, rounded, and profuse, decreasing slightly in number from springwood to summerwood, and rays are nearly as wide as vessels. American hornbeam (Blue-beech) (page 35)

14\. a. Wood typically semi-ring porous, generally with abrupt changes in vessel size and density at transition of springwood to summerwood. Largest vessels 60 to 100 microns narrower than largest rays. Black cherry (page 39)

b. Wood marginally semi-ring porous without distinct transition from springwood to summerwood. Most vessels considerably larger than rays - butternut, walnut - 15

15\. a. Growth rings distinct. Rays relatively straight and continuous across many growth rings. Vessels well rounded, and infrequently elongated or multichambered. Butternut (page 37)

b. Growth rings indistinct to obscured, with wavy rays not appearing continuous across many growth rings. Majority of vessels appear slightly elongated with frequent double or multichambered, very elongated vessels. Black walnut.

16\. a. Resin ducts absent - balsam, cedar, hemlock - 17

b. Resin ducts sparse - spruce, tamarack - 19

c. Resin ducts common, appearing as white to blue-gray spots in cross-section. Appear as flecks or streaks in radial or tangential section - pine - 20

17\. a. Growth rings prominent, with a relatively abrupt and jagged transition between springwood and summerwood. Start of springwood evidenced by thin line of whitish cells visible at 10X. Individual cells not discernible. Typical odor from fresh cut into advanced stages of decay. Hemlock (page 59)

b. Growth rings faint to more or less predominant, with a gradual change between springwood and summerwood. Growth rings become obscured with decay - balsam, cedar - 18

18. a. End of summer growth has contrastingly darker row of vessels prior to start of springwood formation. Wood structure appears crystalline under 10X magnification. Shows jagged edges if split cross-grain. Has characteristic odor of cedar. Northern white-cedar (Page 57).

b. End of summer growth may show a thin, whitish line. Lacks single layer of darker cells. Occasional pitch pockets in wood. Decays rapidly and loses cellular structure characteristics. Balsam fir (Page 55).

19. a. Resin ducts small and sparse, often in pairs. Abrupt change from springwood to summerwood. Cross-grain rays remain well-defined with advancing decay. Horse urine odor lasts into advanced stages of decay. Tamarack (Page 73).

b. Cross-grain rays faint and continuous. Growth rings prominent with more or less abrupt transition from springwood to summerwood. Characteristic odor from firm wood. Black spruce (Page 69).

c. Cross-grain rays very faint and not continuous. Transition of springwood to summerwood gradual. Growth rings not as prominent as black spruce. White spruce (Page 71).

20. a. Growth rings vary from distinct to marginal, with gradual transition between springwood and summerwood. Resin ducts prominent, often paired, and randomly dispersed throughout spring and summer growth. Resin ducts appear 100 microns or larger in diameter under 7X comparator. In early decay of solid wood, resin ducts appear gray to blue-gray. Individual cells discernible across entire growth ring at 10X to 20X. A light-colored wood with noticeable turpentine odor. White pine (Page 67).

b. Distinct growth rings have abrupt transition between straw-colored springwood and much darker summerwood. Retains marked color difference well into decay process. Majority of occasionally paired resin ducts confined to late springwood and summerwood growth. Resin ducts appear 100 microns or less in diameter under a 7X comparator. Individual cells visible only in summerwood at 10X to 20X. Pink to reddish-colored wood retains very strong turpentine odor well into decay process. Red pine (Page 65).

c. Distinct growth rings with abrupt, even-lined transition between springwood and summerwood. Seldom-paired resin ducts usually visible in or near darker summerwood. Ducts noticeably smaller than 100 microns in diameter under 7X comparator. Wood has light color and turpentine odor that fades rapidly with decay. Odor remains longest in resin-laden branch knots. Jack pine (Page 63).

QUAKING ASPEN (*Populus tremuloides*)
BIGTOOTH ASPEN (*Populus grandidentata*)

WOOD

Wood and decay characteristics are similar in both species. Decay is very rapid. Sprouts from stump and roots.

a. Reddish orange - uncommon. Stump rapidly takes on a reddish orange to reddish tan color, appears dry to powdery, and fractures into small 3/4" x 3/4" x 2" blocks, usually being longest in the vertical direction. As decay continues, blocks crumble apart, soon forming an orange unstructured mass that is near powdery when dry, pasty when saturated. Usually associated with unsprouting stumps. May be intermixed with normally decaying aspen stumps.

b. Light gray to cream colored stump, generally forming a stringy fibrous mass. As decay continues, portions of the inner stump may become nearly snow white, damp to the touch and appear to contain only the lignin portion of the wood tissue. White portions are easily penetrated with slight finger pressure. Portions of the stump may feel slimy. A blue-green stain often occurs on decaying aspen, usually when the wood is still relatively firm and portions of the bark are attached.

BARK

Bark tends to decay slightly more slowly than the wood, and is usually present and identifiable until wood is almost completely gone. The bark of mature trees, near groundline, is usually a mottled light to dark gray, tinged with black. It is usually 1/2 inch to 1 inch thick, separated by deep fissures, with the top of the platelets being more or less flat, from 1/2 inch to 3/4 inch wide, and has almost a woody texture. Often, inner decayed portions of the stump are retained in place by the bark.

CELLULAR STRUCTURE

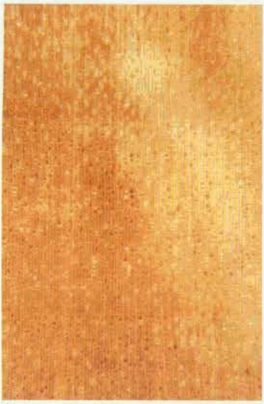
Decay of the wood tissue is usually so rapid that the bark and decayed wood mass characteristics, rather than the vessel arrangement, provide the most reliable method of identification. Vessels are diffuse porous, from 50 to 100 microns in diameter, and usually in pairs or groups. The greatest size and density of the vessels is located in the springwood, gradually decreasing in size and occurrence throughout the summerwood.

GREEN

DECAYED

GREEN

DECAYED



STUMP HOLE

The stump hole is occasionally ringed with small sprouts, usually distinct, 6 to 12 inches deep, and only slightly larger than the tree's stump diameter for cut and dead-in-place trees. On upland sites, windthrown trees leave a fairly larger trench-like hole, nearly as wide as long, and often 1 to 1-1/2 feet deep.

SITE

These species are found on a wide variety of soil types, from heavy clays to sterile sands, and from well-drained uplands to marshes and swamps.

ASSOCIATIONS

The aspens may be found in varying numbers in mixed hardwoods or conifers or in nearly pure stands. They have been observed in close proximity to all other Great Lake States species. Numerous fungi and mushrooms are associated with aspen though none have been observed that persist year-round or provide even probable identification.

WHITE ASH (*Fraxinus americana*)

WOOD

The wood decays rapidly. It sprouts readily from cut stumps, dead-in-place trees, and often from windthrown trees.

a. Black - rare, usually those few trees where root sprouts or other close vegetation is not present. When moisture content is low, the decay rate is slow, and similarly to sugar maple, the wood remains firm in the middle and flakey on the outside.

Note: Limited field encounter for comparison.

b. Reddish black and mottled tan to brown with dryer portions of stump black - generally associated with stump sprouts or close ground vegetation. The moisture content is high, decay is rapid, and roots from sprouts and other vegetation penetrate stump--seeking moisture. Stump tends to break into large rectangular reddish brown blocks on the interior in early decay stages. Mid-stage of decay is a dark reddish brown to reddish black stringy mass. At final stage of decay, mass is nearly black, almost without texture, and slimy when saturated.

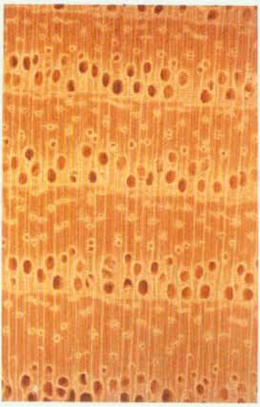
BARK

The bark decays rapidly, remaining longest just above groundline. Strong resemblance to basswood, which often occupies the same area. Light to medium gray, only slightly darker than basswood. Platelets are rougher than basswood, are not nearly as flat on the surface, and lack the parallel, continuous pattern common to basswood. Fissures tend to break outline into elongated diamond patterns.

CELLULAR STRUCTURE

Vessels are ring porous, varying in size from 150 to 260 microns in diameter in the springwood, and are 2 to 4 pores deep. Often numerous smaller vessels, singly and in pairs, are located in the summerwood. These numerous, often paired summerwood vessels differentiate white ash from black ash, which has considerably fewer summerwood vessels which are only seldom paired. Orientation of paired or grouped vessels is generally parallel to the growth rings.

GREEN



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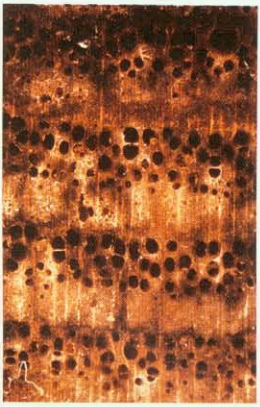


STUMP HOLE

Due to the high occurrence of sprouting, the stump hole is usually 50 percent larger than the tree's diameter and about 6 to 12 inches deep. When the tree has been windthrown, new trees may grow from the root mound.

SITE

The white ash is found on well drained upland sites, more generally in silts and loams, though they will grow well on steep slopes in clay soils. It is rarely observed on poorly drained sites or in swamps.

ASSOCIATIONS

The white ash is most often found as a single tree, or occasionally as the predominant species with sugar maple, basswood, aspen, and less often with northern red oak, american elm, and red maple. Several fungi attack white ash, though none seem to be confined only to ash, and none seem to outlast the normal decay range.

BLACK ASH (*Fraxinus nigra*)

WOOD

The wood decays rapidly. Although it is occasionally known to sprout from cut stumps, its survival rate is poor and seldom will even one sprout reach maturity. Due to swampy site locations, typical decay process is the rapid sloughing off and decay of the bark, usually in 2 to 4 years. The wood generally turns a uniform tan to light brown throughout the tree, darkening to a dark brown and eventually deteriorating to a blackish brown stringy mass. In initial stages, where general shape of the trunk is still intact, the tan to light brown summerwood is offset by the black to dark charcoal gray springwood containing the major vessels.

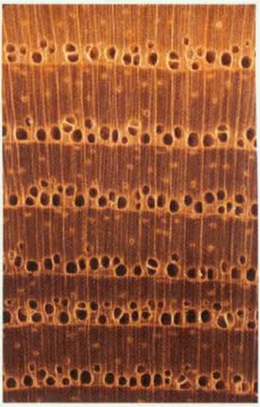
BARK

Bark decays very rapidly, retaining major characteristics only 1 to 2 years. Relatively thin, 1/4 to 3/8 inch on mature trees, scaley and loose, wiping off to a powdery dust with slight hand pressure. If saturated, it is almost "muddy" to the touch, leaving hands dirty.

CELLULAR STRUCTURE

Vessels are ring porous, varying in size from 160 to 260 microns in diameter and arranged in 2 to 4 layers in the springwood. In contrast to white ash, the summerwood of black ash has relatively few of the smaller vessels which are occasionally paired.

GREEN



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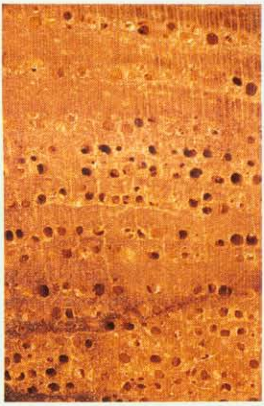


STUMP HOLE

Due to a shallow fibrous root system and general site conditions, the stump hole from black ash ranges from a shallow, irregularly shaped depression to nonexistent. Not being very subject to windthrow, nonexistent is the general rule of thumb.

SITE

Black ash is normally found only on poorly drained soils in swamps and bottom lands. It is tolerant of areas that are subjected to seasonal periods of inundation.

ASSOCIATIONS

Being relatively intolerant of heavy overstory, black ash is usually found in fairly open association with red elm, red maple, swamp yellow birch, cedar, and occasionally black spruce and tamarack.

BASSWOOD (*Tilia americana*)

WOOD

The wood has a medium decay rate; its appearance varies according to site location. It sprouts from stump.

a. Black with thin fragile plates. This type of decay is most common in well drained upland hardwoods when few or no sprouts grow from the stump. Once completely black on the exterior, the inner is generally uniform and stump may be easily broken apart. The inner portions are often brown, which distinguishes the basswood from sugar maple, yellow birch, or elm. Color usually varies in each stump with other portions tan to light buff, with occasional patches of off-white tissue that are damp to the touch and have little resistance to penetration by finger pressure. The decay process ends up as a loose pile of irregularly shaped flakes, similar to sugar maple. It is difficult to identify in final stages.

b. Gray fibrous, soggy mass with little to no definite shape. This method of decay occurs most often on silty or less well drained soils or when numerous stump sprouts or other vegetation keep moisture content high. When in this stage, definite cellular structure deteriorates rapidly. It may be confused with red maple in its similar decay stage. Bark fragments in this rapid decay stage often remain just above groundline though a good portion of the fiber does break down. Fibrous decay may combine with black color on portions of stump.

BARK

In the black decay stage, bark may last as long or slightly longer than that of sugar maple. Platelets are flat, 3/8 to 5/8 inch wide, separated by deep narrow fissures and have a parallel, regular pattern. Texture is more fibrous than that of maples or elms and, in cross-section, is a unifrom light to dark gray, not mottled as with American elm. In the gray fibrous type of decay, bark maintains the same texture with a slightly lighter gray color and tends to curve outward and down, away from the stump. It is not uncommon to find 4- to 8-inch wide by 4- to 10-inch long portions of bark still intact and identifiable. Bark identification distinguishes basswood from red maple in the same type of decay.

CELLULAR STRUCTURE

Vessels are diffuse, usually of varying size from 60 to 160 microns in diameter, and occasionally randomly paired or in groups but not to the extent of yellow birch. Unless saturated, the vessels are usually open and unstained--differing from sugar maple, whose vessels appear clogged and often stained light brown around the edges.

GREEN

DECAYED

STUMP HOLE

When windthrown, basswood tends to leave a trenchlike stump hole similar to sugar maple. The black decay stage generally leaves a shallow stump hole only slightly larger than the stump diameter of the tree with three to seven main root holes around the perimeter. The gray, fibrous decaying process is normally associated with stump sprouts and occasionally three to four generations of sprouts may arise from one original tree. The stump hole may then be of considerable size with the present sprouts being 5 to 10 feet from the location of the parent tree.

SITE

This species is an upland hardwood, occuring on well drained sites. It is usually associated with the heavier soils in the silts and clays series and is uncommon in the well drained more sterile sands and gravels unless fragi-pan or high watertable is present.

ASSOCIATIONS

Basswood frequently sprouts from stumps. Often damper sites containing large numbers of basswood trees also have a high occurrence of the relatively uncommon, black stemmed maidenhair fern. Direct association has not been determined, but clumps of the ferns often occur in round 3- to 15-foot patches as if associated with the root remains of trees long since dissolved back into the soils. The gray type of fibrous decay, when wet, often has an odor similar to soggy newspapers, distinguisishing it from red maple which usually has only a musty damp smell.

WOOD

The wood decays rapidly, with sprouting occurring occasionally when intensity of light is proper. Initial decay results in a black, crispy to flaky exterior with the firmer interior remaining whitish to grayish. Final decay results in an unconnected mass of thin, brittle, black ribbons, which are the denser broad rays characteristic of the oak family. Final ribboned decay pattern is similar to the elm's.

BARK

The bark decays rapidly, but can remain in large blocky chunks near groundline. Often, these trees were just bark scribed--as the bark even on large trees is very smooth. On trees that were only bark scribed, no scribed wood face will be found.

CELLULAR STRUCTURE

Growth rings are marginally indistinct, being a diffuse porous wood. Vessels are 50 to 90 microns in diameter with tyloses present in the heartwood. Large broad rays similar to the oak's are very easily seen; narrow rays are much more abundant than the broad rays.

GREEN

DECAYED

STUMP HOLES

A fairly deep stump hole is left by beech. The taproot system is present in most of the oak family and, as a result, windthrown trees are rare. Most trees, decayed by the heartwood fungi, become decadent from within, die, and break off--leaving a deep stump hole, on most occasions, where they stood.

SITE

Beech is more often found on the better upland sites where northern hardwoods are present. It does occur on poor sites but does not grow to large trees on these marginal areas.

ASSOCIATIONS

It is found scattered among the other species of maple, elm, basswood, and oak in the hardwood forest. It is readily attacked by the heartwood fungi, and numerous fruiting bodies are common.

WHITE BIRCH (*Betula papyrifera*)

WOOD

The wood decays rapidly, sprouting abundantly, and the parent tree position may remain ringed with sprouts for many generations. Wood decays into a white, stringy mass held together by a sheath of bark. On very large specimens decay is nearly identical to the orange blocky decay pattern of yellow birch.

BARK

Bark remains will persist for many years after wood has totally decayed away. White, curly flakes of bark are most often found, and are considered the prime identifier.

CELLULAR STRUCTURE

Being a diffuse porous wood, growth rings are indistinct. Vessels are 60 to 160 microns in diameter, are often paired or occasionally tripled, and appear, with a 1OX hand lens, as figure "8's" in cross-section. Rays are very fine and continuous as fine, white lines.

GREEN

STUMP HOLES

Stump holes are not well-defined as the tree is shallow rooted. Trees generally are not large, resulting in stump holes that are hard to distinguish. Occasionally, however, under the proper site conditions, a small stump depression is identifiable.

SITE

White birch is normally found on the poor sites, usually getting started where fires, windthrow, or catastrophy have hit the forest area. It can be found from the very wet swamps to the very dry jack pine stands. It occurs from pure stands to a solitary tree far removed from other white birch.

ASSOCIATIONS

White birch is most common with aspen and on pine sites. It occurs often in stands where fire has eliminated a red pine stand.

YELLOW BIRCH (*Betula lutea*)

WOOD

The wood is decay resistant, and its appearance varies according to site location.

a. Black to gray with thin, fragile, rapidly decaying black flakes. Stumps in this stage of decay are generally brittle. Inner portions are white to buff colored, and although very similar to sugar maple and American elm, usually lack the random black decay lines common to sugar maple. Often, portions are stained green to blue-green.

b. Reddish brown to orange in moister sites, similar to hemlock or spruce. At mid-stage of decay, wood breaks into large, firm, blocky pieces. Later stages turn the wood to a shreddy fibrous orange to buff colored mass, with an occasional external hull ring similar to hemlock.

c. The wood occasionally has the appearance of cedar or pine; dry, uniform surface and is light buff to tan. This appearance is rare.

d. A blue-green stain often is associated with yellow birch in the black decay stage. This stain is also noticed in northern red oak and occasionally in early stages of decaying aspen when bark is still attached. There are no other woods observed having this stain.

BARK

The bark provides a positive identification of yellow birch, as fragments often remain after wood fiber has completely decayed. It may be found as small, thin, yellowish to buff colored flakes or larger masses between major roots. Large, woody bark platelets may look like paper birch, though they are usually more yellowish. Prominent lenticels remain on bark until completely decayed. Thin bark, when still damp, will burn with a black greasy smoke.

CELLULAR STRUCTURE

Vessels are diffuse porous, uniform in size, and have a high incidence--greater than 50 percent--of occurring in pairs or often in short rows of three to four, lying parallel to the usually indistinct annual growth rings. Paired vessels appear under a 10X lens as small figure eights (8 or). Vessels in a dry, fresh-cut or broken sample are usually open and very small (from 60 to 160 microns in diameter), only slightly larger than sugar maple.

GREEN

STUMP HOLE

Large and shallow in areas with high watertables; 1 to 2 feet deep by 3 to 5 feet wide by 5 to 15 feet long for windthrown trees in better drained soils. In heavy clay soils with dead-in-place trees, large open root holes (occasionally lined with bark) ring the tree's location.

SITE

The tree occurs usually among hardwoods to swamp hardwoods.

ASSOCIATIONS

The yellow birch is often attacked by a hoof-shaped fungus common also to the aspens. Fungus is decay resistant, often lasting as long as the birch bark. Yellow birch often takes root on the remains of other trees, usually hemlock or other birch, but is occasionally seen on cedar, spruce, balsam, or basswood. It has not been observed on maple, ash, or aspen.

BLUE-BEECH (American Hornbeam) (*Carpinus caroliniana*)

WOOD

Although rarely used as a bearing tree by the original surveyors, blue-beech is common enough locally that identification should be considered to determine not so much what it is, but what it is not. The species in particular and the genera in general tend to be prolific sprouters, short lived, poorly formed, and rarely exceed 6 inches in diameter. Blue-beech, both bark and wood, decay rapidly, possibly within 5 years where moisture content is high. Decay soon results in a soft textured, gray, stringy, loosely bound mass that separates easily with the fingers. Final state is a gray to tannish-white unstructured mass, slippery to slimy when saturated.

BARK

The bark decays rapidly. It is relatively smooth, asymetrical, and medium to dark gray.

CELLULAR STRUCTURE

Due to extremely fast rate of decay, vessel structure deterioration is rapid, but if present, provides easy identification. Although basically diffuse porous, a high concentration of continuous rays structures the alignment of the vessels (70 to 110 microns in diameter) in a radially porous pattern, one to two vessels wide between the rays in a stacked or storied appearance. Short, lateral decay pockets are very common, even in green wood, tending to concentrate in the summerwood when viewed in cross-section.

GREEN

STUMP HOLE

Due to small crown size and over-storying by other trees, blue-beech is seldom windthrown. Due to high propensity for sprouting, the extremely small-to-obscure stump hole is normally ringed with numerous sprouts.

SITE

Although blue-beech has been observed over a wide range of upland sites, it appears to do best in the heavier soils where drainage is somewhat restricted. It has not been observed in swamps or bogs.

ASSOCIATIONS

Although observed in close proximity to a majority of the upland hardwoods, it appears most frequently with red maple, American elm, and in the wetter areas with offsite aspen. Has not been observed in close proximity to upland hemlocks, cedar, or heavy concentrations of mature balsam or spruce. Blue-beech appears intolerant of heavy shade, germinating best after heavy logging, in clearings, abandoned roadways, and abandoned farmlands.

BUTTERNUT (*Juglans cinerea*)

WOOD

The wood decays very rapidly, sprouting occasionally. Most trees are from seed origin. Wood decays in dark colored masses. All evidence of the tree disappears rapidly after it dies.

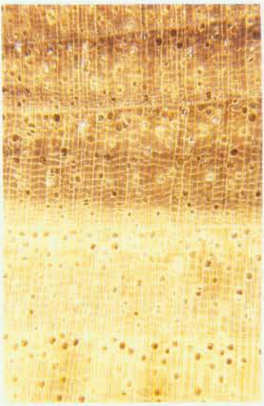
BARK

The bark is in long stringy strips and, after falling to the ground and getting saturated, decays rapidly and disappears in a few growing seasons.

CELLULAR STRUCTURE

Vessels are semi-ring porous and 160 to 260 microns in diameter. Rays are uniform and similar in size. Growth rings are distinct and can easily be counted. Growth is usually rapid on most sites.

GREEN



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STUMP HOLE

The stump hole is not very prominent. Many trees are windthrown because of the rapid growth and large crown-to-root ratio they develop. When trees do die in place, stump holes are shallow and it will be difficult to tell where the tree once stood.

SITE

Butternut is introduced into a stand where an opening or heavy cutting has taken place. They need high light intensity to germinate and develop. Good heavy soils are the rule, but butternut occasionally will be seen on or near rocky outcrop areas because of clearings that often develop there.

ASSOCIATIONS

Red oak and paper birch are usually present with butternut.

BLACK CHERRY (*Prunus serotina*)

WOOD

The wood decays rapidly, exceeded only by aspen and ironwood. Color of wood rapidly changes from dark red to reddish black, then to a yellowish orange. Structure becomes initially blocky, while in the reddish color, then changes rather rapidly to a yellowish orange stringy mass, which is slimy to slippery when wet. Final stage normally consists of a leached tan to yellowish unstructured mass--powdery when dry, slimy when wet.

BARK

The bark decays rapidly except in major root folds and consists of a series of irregularly shaped plates of varying sizes. When present, charcoal-gray to black bark platelets with prominent horizontal lenticels are the prime identifiers of black cherry.

CELLULAR STRUCTURE

Vessels are semi-ring porous with springwood vessels gradually decreasing in size and frequency throughout the growth ring. Vessels are relatively thick walled, range in size from 60 to 100 microns in diameter, and tend to occur in pairs or small groups. Cross-grained rays are numerous, continuous, and of two distinct sizes--the larger being wider than the largest vessel and the smaller being one-half to one-quarter the diameter of the larger. Rays remain conspicuous well into the decay process.

GREEN

DECAYED

STUMP HOLE

Because of its deep spreading root system, black cherry is not highly subject to windthrow, but larger trees (when downed) leave a narrow trench up to 8 feet long and 1 to 1-1/2 feet deep. Dead-in-place trees leave a fairly shallow depression, only slightly larger than the stump itself.

SITE

Black cherry is primarily an upland hardwood species, rarely observed in relation to the swamp timber types. On the upland sites it is more often observed on the heavier soils or where drainage is not too well established.

ASSOCIATIONS

Numerous fungi attack black cherry in the early stages of decay, though none appear to be selective to cherry in the advanced stages. A condition known locally as black rot appears common to black cherry in the northern Great Lake States, resulting in large, hard, knobby, black growth protrusions. Decay of these protrusions appears slow, and fragments of brittle black rot often retain their identity well into the decay process, providing an identifier to the presence of black cherry.

Black cherry is normally associated with sugar maple, basswood, white ash, aspen and is occasionally found with red maple, American elm, and yellow birch.

AMERICAN ELM (*Ulmus americana*)

WOOD

The wood is decay resistant, probably slightly less so than sugar maple, and almost always black with thin brittle plates very similar to sugar maple. Inner wood is usually light brown to buff colored, occasionally gray to off-white, and rarely dark brown. Random, 1/32 inch thick, wavy lines of decay, usually black (but occasionally dark charcoal gray), appear in the wood. In advanced stages of decay, the elm wood is reduced to black flakes or thin fragile ribbons of wood 1/32" x 1/8" x 1/2" to 4" in size. Evidence of the ribbon shape remains up to the last shred. This differentiates the elms from sugar maple and yellow birch, which normally have irregularly shaped flakes.

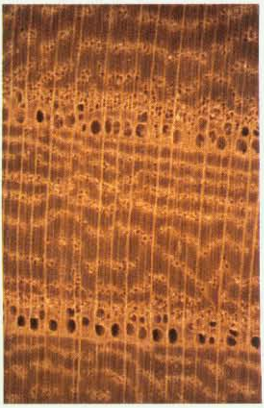
BARK

The bark, although rapidly decaying, provides positive identification of American or red elm. The surface color of the bark varies widely, and when dry ranges from light to dark gray. Texture of American elm bark is a relatively thick build-up of 1/16- to 1/18-inch plates of about equal thickness attaining depths of up to 3/4 inch. American elm platelets are generally flat-topped with more or less diamond shaped fissures, usually 1/2 to 3/4 inch wide in cross-section and are arranged in alternate light and dark layers. In comparison, red elm bark platelets are rough, usually less than 1/2 inch wide, separated by nearly parallel fissures, and their thickness seldom exceeds 1/2 inch in cross-section. Red elm lacks the alternate light and dark platelets of the American elm, and has a brown to reddish-brown uniform color.

CELLULAR STRUCTURE

Vessels are ring porous, large, varying in size from 200 to 270 microns in diameter, and appear as a well defined single band (rarely 2 to 3 bands) of cells. Between the rings, or major vessels, and more or less parallel to them are numerous wavy bands of small, thin-walled parenchyma cells--barely visible without a hand lens. In decayed wood, these wavy bands of cells may appear as no more than a light colored wavy line. Unless saturated, major vessels are open and show no evidence of discoloration or stain.

GREEN



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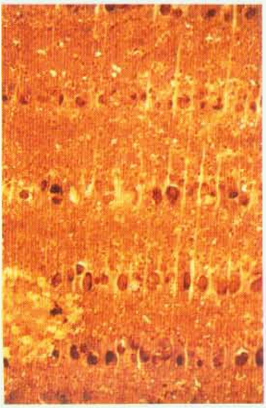


STUMP HOLE

Elms have a spreading root system, and large windthrown trees often leave a large trench-shaped hole and adjoining dirt mound. Dead-in-place trees may leave a shallow indistinct depression about 50 percent larger than the diameter of the stump. In extremely wet sites, windthrown stump holes may be shallow and 10 to 20 feet in diameter, with the downwind side being one-third to one-half filled with root mass and debris.

SITE

The elms are a moisture seeking species, generally growing in swamps, drainages, or on heavy silts or loams in areas with high watertables.

ASSOCIATIONS

American elm usually is found in damper portions of upland hardwood sites of basswood, sugar maple, and yellow birch, or along edges of swamps with conifers, red elm, and red maple. It is not common in areas subjected to periodic flooding, and is only rarely observed as the dominant tree in dry mature upland hardwood stands. There are no observed fungi indigenous solely to the elms.

RED ELM (*Ulmus rubra*)

WOOD

The wood is decay resistant, probably slightly less so than sugar maple. It is almost always black with thin brittle plates very similar to sugar maple. Inner wood is usually light brown to buff colored, occasionally gray to off-white, and rarely dark brown. Random, 1/32-inch thick, wavy lines of decay, usually black, but occasionally dark charcoal-gray. In advanced stages of decay, black flakes of the elm are reduced to thin fragile ribbons 1/32" x 1/8" x 1" to 4" in size. Evidence of the ribbon shape remains up to the last shred. This differentiates the elms from sugar maple and yellow birch, which have irregularly shaped flakes.

BARK

The bark, although rapidly decaying, provides positive identification of American or red elm. The color varies widely and, when dry, ranges from light to dark gray. Red elm bark platelets are rough, usually less than 1/2 inch wide, and are separated by nearly parallel fissures. Bark thickness seldom exceeds 1/2 inch in cross-section and lacks the alternate light and dark platelets of American elm, having a brown to reddish brown uniform color. In comparison, the texture of American elm bark is a relatively thick build-up of 1/16- to 1/8-inch plates of approximately equal thickness attaining depths of up to 3/4 inch. American elm platelets are generally flat-topped with more or less diamond shaped fissures, usually 1/2 to 3/4 inch wide in cross-section and are arranged in alternate light and dark layers.

CELLULAR STRUCTURE

Vessels are ring porous, large, varying in size from 200 to 290 microns in diameter and appearing as a well defined band of cells 2 to 4 cells deep, visible without a hand lens. The wavy bands of parenchyma cells of red elm are smaller than those of American elm, and are not visible without a hand lens. Parenchyma cells are smaller and arranged in shallow, undulating lines. Unless saturated, major vessels are open and show no evidence of discoloration.

STUMP HOLE

Elms have a spreading root system, and large windthrown trees often leave a large trench-shaped hole and adjoining dirt mound. Dead-in-place trees may leave a shallow indistinct depression about 50 percent larger than the diameter of the stump. In extremely wet sites, windthrown stump holes may be shallow and 10 to 20 feet in diameter, with the downwind side being one-third to one-half filled with root mass and debris.

SITE

The elms are a moisture-seeking species, and generally grow in swamps, drainages, or on heavy silts or loams in areas with high watertables.

ASSOCIATIONS

Red elm usually occupies the wettest upland sites with yellow birch or red maple and is tolerant of areas of periodic flooding where it is associated with black ash and yellow birch and occasionally with black spruce, cedar, and tamaracks. There are no observed fungi indigenous solely to the elms.

IRONWOOD (*Ostrya virginiana*)

WOOD

The wood has a rapid decay rate, and a size seldom exceeding 10 to 12 inches DBH. Due to size, the tree seldom windthrows, usually dying in place and then rotting off at the groundline in a few years. If the dead tree is supported by other vegetation, the decay rate on the portions exposed to air is relatively slow with the wood remaining extremely hard. Surface of decaying wood is mottled, having portions being charcoal-black, gray, tan, and occasionally brown. Inner wood is usually buff colored, light tan, or yellowish tan. As decay continues, inner wood takes on small areas of light bluish gray giving the wood almost a "dirty" appearance. In light inner portions, random lines of decay appear charcoal-gray, brown, or tan. Inner portions are never white or off-white. The tree usually maintains its shape until decay is well advanced and then total structure collapses, probably with the winter snow pack. Ironwood does not usually appear brittle and flaky as do sugar, elm, basswood, and yellow birch.

BARK

The bark usually lasts well into the rapid decay process, particularly where portions of the tree are kept off the ground. It eventually peels away in long 4- to 10-inch strips, curving heavily away from the stem. The bark usually remains light gray to light brown until falling to the ground where it decays in one to two seasons. Bark texture is slightly fibrous, shredding easily when rubbed and extremely thin, generally being less than 1/4 inch thick. It is arranged in narrow bands up to 1/4 inch wide, which are separated by narrow, shallow parallel fissures.

CELLULAR STRUCTURE

Due to the extremely fast rate of decay, downed trees maintain good vessel structure for only a relatively short time before taking on a porous honeycombed appearance. The wood is diffuse porous with the vessels not being uniformly distributed throughout the growth ring, but tending to be aligned in irregular rows across the growth ring. Vessels are small and not uniform in size, ranging from 60 to 160 microns in diameter, and have a tendency to pair up with a thick wall between the adjoining vessels. The vessels in decayed wood remain open and unstained.

GREEN

DECAYED

STUMP HOLE

Due to the usually small size of ironwood trees and their tendency not to windthrow, stump holes, when found, are usually irregular and small. Lack of large major roots, and a tendency to seed on the mounds created by other windthrown trees that are subject to erosion, is probably largely the reason why most ironwoods leave little to no trace of their presence.

SITE

The ironwood is common in well drained upland sites. It is not observed in poorly drained areas. It has a tendency to seed on exposed mineral soil of windthrown trees, and is observed on a wide variety of soils.

ASSOCIATIONS

The ironwood is usually associated with sugar maple, white ash, basswood, and upland yellow birch and elm. They are occasionally mixed in with paper birch, aspen, or upland red maple. They are unobserved in predominantly coniferous vegetation.

RED MAPLE (*Acer rubrum*)

WOOD

The wood decays rapidly. Sprouts occur from stumps--occasionally from viable roots of windthrown maples.

a. Gray - When numerous sprouts are present or other vegetation is close enough to maintain high moisture content, decay color is light gray to grayish tan. Decay is more or less uniform throughout, with the texture rapidly becoming fibrous and stringy. Bark often remains partially intact, maintaining the stump's form and providing positive identification. Unlike basswood, there is no characteristic odor.

b. Orange to reddish orange decay color is uncommon and usually associated with wetter sites with few or no sprouts. Decay appears to be considerably slower, with the general stump form outlasting all of the bark except the thicker portions located between major roots. Wood becomes blocky, as with yellow birch or hemlock, although natural fracturing tends to result in much smaller blocks. If exposed to open sunlight or wind currents, the texture becomes powdery and the wood disintegrates when squeezed. If continuously wet or saturated, wood becomes finely granulated, washing away with the rain.

c. Black to charcoal-gray, solid, rare. Occasionally, with large trees that are exposed to continuous sunlight and air currents, nonsprouting red maple may turn black to charcoal-gray, decaying similarly to basswood in color. Field observations tend to show that, if site conditions change and wood moisture content increases, the orange type of decay will begin.

BARK

The bark decays rapidly--seldom, except possibly in gray decay stage, outlasting wood. It is generally composed of long, narrow, flat platelets, tending to curl away from the rest of the bark at the ends. Narrow fissures between major plates are often crosshatched with cracks and minor fissures. Irregular vertical alignment of bark.

CELLULAR STRUCTURE

Vessels are diffuse porous and are arranged singly or are occasionally paired, and are distributed uniformly throughout the growth ring. Vessels are very small, ranging from 60 to 80 microns in diameter.

GREEN

DECAYED

STUMP HOLE

Windthrown trees in wet sites generally leave a shallow, large diameter indistinct depression. Windthrown trees on higher sites usually leave a narrow shallow trench. Windthrown trees occasionally send up sprouts from the stumps. Dead-in-place or cut trees generally propagate sprouts. Parent trees with sprouts usually leave distinct stump holes 1/2- to 1-foot deep, often 50 to 100 percent larger than the tree's DBH.

SITE

Although often found on well drained upland sites, it is usually found on heavier soils and the more poorly drained sites, swamp edges, and river bottoms.

ASSOCIATIONS

Although numerous fungi are associated with red maple, none appear to thrive solely on this species or to outlast the wood itself. Red maple is generally associated with the more lowland species, but may also be found with the upland hardwoods and even in sterile sites with jack pine and paper birch.

SUGAR MAPLE (*Acer saccharum*)

WOOD

Wood from the sugar maple is decay resistant, usually black, appearing as a fire-charred stump. It is rarely dark gray to buff colored. Its decay rate is similar to the black decay rate of yellow birch, though generally more sound. Where relatively sound, broken inner portions range from off-white to buff colored, occasionally brown--rarely gray--with meandering 1/32- to 1/64-inch black lines of decay. Decay is slow, from outer edges inward, eventually being reduced to small 1/8- to 1/14-inch black irregularly shaped 1/32-inch thick flakes that differ from the similar decay of the elms, which have 1/32-inch thick by 1/8-inch wide black ribbons. Arrangement of flakes on sound stump is usually perpendicular to growth rings.

BARK

The bark has a fairly fast rate of decay, especially below ground. Remaining bark in major root folds discolors to dark brown to gray in irregular shaped platelets of uniform color and varying thickness. Differs from American elm, which retains its light-dark color contrast in cross-section. Differs from basswood, which is a single mass with roughly parallel fissures.

CELLULAR STRUCTURE

Vessels are diffuse porous, uniform in size, and only occasionally paired. In off-white to buff colored wood, vessels often appear filled and stained light brown around edges of the vessel wall. Vessel sizes are very small--from 70 to 90 microns in diameter--about the smallest of the Great Lake States species vessel size.

GREEN

DECAYED

STUMP HOLE

The stump hole on dead-in-place sugar maple is generally about 50 percent larger in diameter than the tree and is relatively deep. On windthrown trees, it is usually 1 to 2 feet deep, 3 to 5 feet wide, and 6 to 12 feet long. Orientation of the trench is 90 degrees to the direction of the fall. Often, the thin, 1/8- to 1/4-inch, irregularly shaped flake may be found in the root holes after the surface evidence has decayed.

SITE

Sugar maple is an upland hardwood, only rarely found in wet or poorly drained soils.

ASSOCIATIONS

Several shelf fungi have been observed on sugar maple, though none appear to be confined solely to this species. Their decay is much faster than that of the tree and by the time the wood has reached the black flaky stage, no evidence can be found of the fungi. Yellow birch has not been observed taking seed on sugar maple. There remains a possible association with the relatively uncommon black stemmed maidenhair fern on damper sites. These ferns have been observed growing in a 10- to 15-foot radius of decayed sugar maple stumps.

NORTHERN RED OAK (*Quercus rubra*)

WOOD

The wood is decay resistant, and the tree is a prolific sprouter.

a. Dark gray to mottled brownish black, often heavily stained blue-green deep into the firmer portions of the wood. Cut stumps have a tendency to erode from the surface inward, leaving "rays" of extremely hard wood 1/8 to 3/16 inch wide by 3/4 to 3 inches long protruding from the top and/or sides of the stump 1/8 to 1/2 inch. Orientation of the "rays" is in the radial section. Gray stage is usually associated with nonsprouting cut stumps in dry areas.

b. In the final decay stage, the wood is reddish-brown to bright orange, occasionally with dryer portions of stump being blue-green stained and dark gray to brownish-black. This type of decay is usually found in relation to heavy sprouting, deep shade, and high moisture content. Wood decays initially into irregularly shaped, large blocky structures, easily separated, then to a fibrous mass with inner portions generally firmer, usually reddish-brown to brownish-black. Final stage usually is a reddish-orange to bright orange unstructured mass that often leaves the soil orange stained once the wood is completely decayed. Final orange stage is powdery when dry and soggy to slimy when wet.

BARK

The bark decays much more rapidly than the wood. The bark is dark brown to grayish-black, 3/8 to 3/4 inch thick, and separated by shallow fissures 1/4 to 3/8 inch deep. On mature trees and at ground level, platelets are usually flat topped and smooth, occasionally with lateral fractures. Texture is woody with a fibrous to stringy layer where it is in contact with the wood.

CELLULAR STRUCTURE

The vessels are ring porous, very large--200 to 430 microns in diameter--open, arranged 1 to 4 vessels deep, and visible without a hand lens. Occasional groups of smaller size cells generally arranged in short undulated lines in the summerwood at right angles to the growth rings. Major difference between the white and red oak groups are:

a. Red Oaks: Springwood vessels are open; summerwood vessels are easily visible with a hand lens, thick-walled, rounded, and aligned.

b. White Oaks: Springwood vessels are occluded with tyloses; summerwood vessels are indistinct even with a hand lens, thin walled, often angular, and not usually aligned.

GREEN

DECAYED

STUMP HOLE

Due to its deep taproot, northern red oak is not highly subject to windthrow. Cut and dead-in-place trees generally leave a deep, distinct stump hole, only slightly larger than the diameter of the stump.

SITE

Northern red oak is an upland species, only rarely observed on the more poorly drained areas. Though usually more abundant on the granular soils, it is often found on heavier soils where drainage is good.

ASSOCIATIONS

It is found as a scattered tree or occasionally as the dominant species in relation to white ash, sugar maple, basswood, and other upland hardwoods. A blue-green stain is often found on stumps when still firm, penetrating down the vessels deep into the wood. Fungi fruiting bodies do not appear to be common in the advanced stages of decay.

WHITE OAK (*Quercus alba*)

WOOD

The wood is very resistant to decay and will remain solid for many years. It is usually deteriorated by insect activity more than by wood rotting fungi, leaving a dark colored black to reddish deposit of frass. Trees often grow very large and live to 500+ years, leaving large masses of bark and decayed materials where they stood.

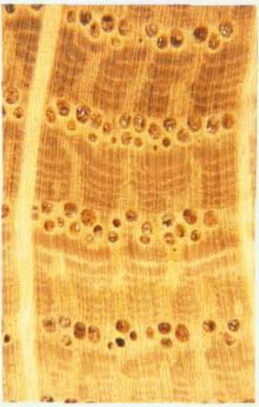
BARK

The bark is also very resistant to decay and will remain in the stump mound for many years. It is usually blocky in structure, laminated with light bands, and is the prime identifier on badly decayed specimens.

CELLULAR STRUCTURE

White oak is a ring porous wood, the large springwood vessels being 180 to 380 microns in diameter, and the summerwood vessels considerably smaller. It is radially banded by very large, broad rays 150- to 400-microns wide. The vessels in white oak are filled with a fine membranous material (Tyloses).

GREEN



DECAYED

STUMP HOLE

As most trees die in place and are seldom windthrown, they leave a very deep stump hole. The taproot of the white oak is very deep and slow to deteriorate because the wood and bark are highly resistant to decay.

SITE

White oak appears on a wide range of sites. It does best on heavy, wet sites; however, it may often be found on sandy, well-drained upland sites as well.

ASSOCIATIONS

The trees are usually found as individuals, scattered in among many other hardwood species, seldom occurring as a pure stand of white oak.

BALSAM FIR (*Abies balsamea*)

WOOD

The wood decays rapidly, turning within a few seasons to a gray to light tan (occasionally orange) stringy mass. As rapid decay progresses from the outside inward, the majority of tissue dissolves away leaving a fibrous to stringy unstructured grayish mat. No characteristic odor or splitting properties are associated with balsam.

BARK

The bark decays more quickly than the wood, remaining longest in major root folds where it may approach 1/2 to 3/4-inch thick, with a smooth to warty texture. Pitch pockets in bark, common to balsam, decay at about the same rate as the bark, so they are not a lasting identifier.

CELLULAR STRUCTURE

As with hemlock and white cedar, balsam lacks the resin ducts of the pines, spruces, and the tamarack. Transition of springwood to summerwood is gradual, with actual point of transition becoming indistinct as rapid decay progresses. A thin, interrupted row of cells appears as a faint white line between the summerwood and the following year's springwood–remaining distinct occasionally until the decay reaches an unstructured mass.

GREEN

DECAYED

STUMP HOLE

Due to its shallow spreading root system, the stump holes of windthrown balsams are shallow, rather small, and without a large accumulation of debris. Dead-in-place trees leave an indistinct to nonexistent stump hole.

SITE

Although not uncommon on upland sites, balsam appears more prominent in wetter or heavier soils, in swamps, and on stream bottoms. Occasionally it is found in abundance in sour sphagnum bogs.

ASSOCIATIONS

Although found singly or in scattered groups with sugar maple, white ash, and other upland species, it is more often found in association with other lowland or swamp species where it is often the predominant species. Although several species of fungi are common to decayed balsam, apparently none persist long enough into the decay process to aid in identification.

WOOD

The wood is very decay resistant. Exterior stump appearance is tan to a light yellowish-brown, with the inner portions being a lighter tan to straw color. Unless subject to long periods of saturation or heavy ground fire, cedar, when cut, has a characteristic odor that is not easily confused. Even in extremely wet sites, cedar splits easily with the grain and the inner portions appear dry. Cut stumps and stubs often decay slowly from the inside out, with the outside eroding slowly, one growth ring at a time. Final stage of decay reduces cedar to a yellowish or tan fibrous mass, tending to separate with the growth rings. A bluish stain occasionally is found on more sound portions of the wood. The wood is highly subject to ground fire on portions above ground. Fire charred, blocky fragments remaining in root holes have a "crystalline" appearance under a 10X hand lens.

BARK

The bark decays rapidly in relation to the wood, but when present is usually a fibrous to stringy, brown mass, tending to pull away from the wood in narrow strips. On downed, moss-covered logs, the moss often aligns with the bark prior to its decay and when pulled from the tree, shows evidence of the parallel bark alignment.

CELLULAR STRUCTURE

Being a conifer, cedar does not have vessels as do the hardwoods. It has distinct growth rings, with the springwood being a light straw color and relatively large (75 to 90 percent of growth ring) compared to the reddish-brown summerwood. The transition from springwood to summerwood is fairly gradual. Resin ducts are not present, separating cedar from the pines, spruces, and tamarack.

GREEN

DECAYED

STUMP HOLE

Due to its shallow, wide-spreading root system, cedar does not leave a distinct stump hole. On upland sites, dead-in-place or cut trees leave only a ring of holes from major roots, several times the diameter of the tree. In wet sites and swamps where it is more subject to windthrow, cedar usually leaves only a shallow, indistinct depression.

SITE

Although not uncommon on upland sites in the heavier soils, cedar is more generally found along the lowlands and areas of poorer drainage, and often in deep sphagnum bogs.

ASSOCIATIONS

Cedar tends to seed better on exposed mineral soil, and often the exposed roots of cedar indicate the eroded stump mound of another tree. Though it may be found as a scattered tree with upland hardwoods, it is more commonly associated with lowland species such as yellow birch, red maple, black ash, balsam, and tamarack--where it may be the dominant species. Fruiting bodies of fungus on decaying cedar are rare.

HEMLOCK (*Tsuga canadensis*)

WOOD

The wood is decay resistant. Appearance varies according to site location. The wood has characteristic odor.

a. Orange to reddish-orange. The decay of stump or windfall is generally uniform throughout, turning rapidly to a bright orange to reddish-orange and remaining essentially the same color until completely dissolved back into the soil which it usually stains the same color. Wood structure initially becomes fragile, breaking easily into large, uniform, blocky chunks. The wood breaks parallel with and perpendicular to the growth rings. Final stages of decay reduce the stump to a uniform mass of bright orange fibrous tissue easily separated with the fingers. Bark remains essentially intact and in large plates, slowly rotting at the groundline allowing stump to slump outward. This type of decay is usually associated with hemlocks in moist sites, either on heavy soils in level terrain or under a heavy overstory of vegetation. It is easily distinguished from the similar decay process of yellow birch and spruce by the presence of bark. It is highly resistant to ground fires in this stage due to high moisture content.

b. Tan to grayish-brown. This type of decay process is generally found on more granular or better drained soils and often in clearcut conifers or open mature hardwoods. Lower moisture content appears the cause, as this type of decay is most common with stumps and stubs rather than windthrown trees. Bark generally sloughs off early and the exterior 1 to 3 inches of the stump dry out, remain solid, and become a tan to grayish-brown. The interior portion of the stump changes to a brownish-yellow or yellowish-orange fibrous mass and decays much more rapidly. The outer shell slowly decays more or less uniformly down from the top, leaving a thin ring at the groundline with a deep hole in the middle. This decay process is more susceptible to fire, due to the lower moisture content of the outside shell. Hemlock knots or branch stubs are resistant to decay and light ground fire. With windfalls long decayed, the angle of the knots and the direction of their increasing size indicates the location of the stump.

BARK

The bark has a high concentration of tanic acid and is highly decay resistant but susceptible to ground fire. It generally remains sound, particularly the massive portions between major roots, and even when damp (not saturated) the bark has a light to dark reddish-gray flaky appearance on the surface. Inner portions are bright purple to a cinnamon red. No other bark in the northern Great Lake States has this color, so the bark provides positive identification, often retaining its color and shape after the wood is completely decayed. When saturated for long periods, bark color changes to a dark brown. Individual bark platelets in cross-section are approximately 1/2 to 3/4 inch wide and 1/8 inch thick. The relatively thick platelets differentiate hemlock from the other conifers, which have thinner platelets.

CELLULAR STRUCTURE

Hemlock, being a conifer, does not have vessels as do the hardwoods, and lacks the resin ducts of the pines, spruces, and tamarack. Growth rings are prominent and visible without a hand lens, having a pronounced band of darker summerwood. The light tan springwood comprises 60 to 75 percent of the growth ring and rather abruptly changes to the reddish brown summerwood. The occasional pitch pockets found in balsam are not present.

GREEN

DECAYED

STUMP HOLE

Windthrown hemlocks often create a large trench-like hole and corresponding mound. With dead-in-place trees, the stump hole will usually be only slightly larger than the diameter of the stump and 1 foot to 1-1/2 feet deep. On heavy, impervious clay soils, the stump hole may appear only as a series of major root holes. Hemlock bark may often be found deep in the root holes long after the wood has decayed.

SITE

Hemlocks are found from well drained uplands to poorly drained swamp edges, and are only rarely observed in sphagnum bogs or acid swamps. They may occur singly or in dense, solid, even-aged stands.

ASSOCIATIONS

Yellow birch tends to seed more on the stumps of hemlocks than on other species. A yellow birch with an exposed root system often indicates the location of a hemlock stump, generally in the orange phase of decay. Hemlock bark, knots, and wood--when solid or nearly so--have a characteristic odor that readily differentiates it from tamarack and the pines. Several fungi attack hemlock in the early stages of decay, but none seem to be prevalent in advanced stages.

JACK PINE (*Pinus banksiana*)

WOOD

Decay is rather rapid when moisture content is high, resulting initially in a red to yellowish-orange blocky structure and progressing to a stringy to fibrous tan or yellowish unstructured mass. On drier sites, decay is considerably slower, starting on the interior of the stump, proceeding outwards--eventually leaving a thin gray to tan outer hull of semi-sound wood and a rust or yellowish, stringy, unstructured center mass. Jack pine cones are highly resinous and decay resistant when closed and, if undisturbed by fire, may become a prime identifier.

BARK

The bark decays rather rapidly, remaining longest in major root folds. When present, portions often encrusted with pitch deposits become prime identifiers.

CELLULAR STRUCTURE

Wood appears very fine-grained with individual cells ranging from indistinct to obscured at IOX. Resin ducts, which appear as white flecks in cross-section, are seldom paired, tend to concentrate near or in the darker summerwood, and are noticeably smaller than 100 microns (75 to 90 microns) in diameter under a 7X comparator. There is an abrupt transition from springwood to summerwood, and relatively distinct growth rings remain prominent well into the decay process.

GREEN

DECAYED

STUMP HOLE

Due to its partial taproot system and generally smaller size, jack pine is usually not highly subject to windthrow. Dead-in-place trees leave a deep, persistent stump hole, slightly larger than the tree's diameter.

SITE

Jack pine is generally associated with the drier, sterile sands and gravels, but is occasionally found in deep bogs and on windswept rock outcrops.

ASSOCIATIONS

Jack pine is commonly found in pure stands or as a prominent species in association with aspen, birch, red maple, red and white pine, balsam, and white spruce. Hazelbrush is a common associate in stands with high concentrations of jack pine. No fungi have been observed as characteristic identifiers in advanced stages of decay.

RED PINE (*Pinus resinosa*)

WOOD

Due to high concentration of pitch, red pine is very resistant to decay and to light and medium ground fire. Where large stumps remain exposed to sun and wind, moisture content is low and decay is almost nonexistent--with 70- to 80-year-old stumps still sound. Decay progresses slowly from the interior outward, separating first into pinkish to rust colored blocks, then slowly dissolving. Inner portions of exterior hull and exposed major roots remain a light pink to deep red, depending on pitch content. There is a heavy turpentine odor to sound wood.

BARK

The bark decays relatively rapidly on exposed portions but persists in major root folds as a series of thin orange flakes up to several inches thick. Orange flakes slowly darken until becoming brown to dark maroon.

CELLULAR STRUCTURE

Growth rings are distinct with a relatively abrupt change from springwood to summerwood. The majority of the occasionally paired resin ducts tend to be confined to the latter half of the springwood and appear 80 to 110 microns in diameter under a 7X comparator. Rays are uniform, faint, and continuous across many growth rings--becoming indistinct as decay progresses.

GREEN

DECAYED

STUMP HOLE

Except under swamp and bog conditions, red pine leaves a very large, shallow depression and an associated debris mound when windthrown. Larger specimens cut at the turn of the century are still intact and often sound. Smaller red pine stumps in advanced stages of decay will probably leave a shallow depression with a series of major root holes ringing a poorly formed taproot hole.

SITE

Although more often found on the upland granular soils, red pine has nearly the same latitude of sites as white pine, being found also on the better drained silts and clays. On occasion, red pine has been observed in true swamp and bog sites, usually where organic depths are less than 2 feet.

ASSOCIATIONS

Although found in pure stands on upland granular soils, red pine more often occurs as a scattered or solitary tree within the stand. Most abundant of its associates are white and jack pine, aspens, and maples, although its latitude of growing sites often places it in close association with a majority of the Great Lakes States species.

WHITE PINE (*Pinus strobus*)

WOOD

The wood is decay resistant. Sapwood is white to yellowish-white, turning tan to reddish-brown as decay progresses. A resinous odor is nearly always present on fresh split samples unless deeply fire-charred or saturated for long periods. Where moisture content is high, as under heavy overstory, white pine tends to decay uniformly throughout, similarly to hemlock. Wood gradually discolors to a uniform reddish-brown, separating into small, blocky, rectangular pieces. As decay continues, blocks erode away to dust, and when not saturated, can be reduced to powder when rolled between the hands. In exposed sites the stump decays from within, as described above, until only a thin, fragile, grayish-tan hull remains. Final decay of hull is extremely slow. Stumps in open areas, which were cut at the turn of the century, often still show little evidence of tissue breakdown of the hull.

BARK

Bark is often several inches thick on trunks, and up to 6 inches thick between major root folds. It is also resistant to decay when dry, although highly susceptible to ground fire. Bark platelets are medium to dark brown, with occasional areas of brownish-orange, and are usually less than 1/16 inch thick. Bark is easily broken apart by hand. Occasional deposits of pitch found mixed with bark fragments retain the typical "pine" odor and taste for a considerable time. White pine knots or branch stubs are highly resinous and extremely resistant to decay, retaining their "pine" odor long after other portions of the tree have dissolved back into the soil.

CELLULAR STRUCTURE

Growth rings of green wood are relatively indistinct, becoming more distinct with the slow discoloration of the wood. The springwood is usually wider than the summerwood and the transition between them is gradual. Resin ducts are common in white pine, usually appearing as a single large cell in the cross-section and as a whitish- or occasionally bluish-gray fleck when cut or split with the grain. Resin ducts remain prominent well into the decay process.

GREEN

DECAYED

STUMP HOLE

Large windthrown trees usually create a very large diameter, shallow, irregularly shaped depression with the downwind debris mound being fairly large, 1 to 2 feet high, 5 to 10 feet wide, and occasionally up to 20 feet long. Soil type is the prime factor for size and shape. Dead-in-place and cut stumps do not leave a stump hole as such, but rather a circular series of root holes often 1-1/2 to 2 times the stump diameter. In extremely heavy clays, complete decay may leave little to no evidence of a stump hole, even from very large trees.

SITE

White pine has probably the greatest latitude of growing sites of all the Great Lake States species, being found from rocky outcrops to deep sterile sands and from impervious clays to spagnum bogs.

ASSOCIATIONS

Due to the wide latitude of growing sites, white pine may be associated with almost any combination of other conifers and hardwoods, as well as even-aged pure stands. The sapwood may often be found stained a bluish color. Fomes anosus fungus is often associated with the pines. Where portions of the tree lie in water, or are covered with spagnum moss and moisture content is continuously high, thin, white, threadlike myceliums occasionally develop between growth rings. Fruiting bodies of fungus are extremely rare on white pine.

WOOD

The wood decays rapidly when moisture and oxygen are available. When dry or submersed, decay rate is retarded so that the wood could remain for many years. Normally, the wood will decay into stringy fibrous threads caused by the long cells in the wood. Later, the wood will decay into a purplish-black blocky structure. Growth rings are distinct and often are very narrow on the more poorly drained sites normally associated with black spruce.

BARK

The bark is composed of very thin, small irregular scales that slough off the tree early and decay rapidly.

CELLULAR STRUCTURE

The wood is made up of tracheids 25 to 30 microns in diameter. Rays are usually single-cell wide. Resin ducts are 50 to 90 microns in diameter and appear as small white dots with a 10X hand lens, very sparse. Growth rings remain distinct to faint as decay progresses.

GREEN

STUMP HOLE

The stump hole ranges from a large (10- to 20-foot), shallow, irregularly shaped, indistinct depression to nonexistent. Black spruce is very shallow rooted due to the wet sites it grows upon. Black spruce on higher, better drained sites may develop a small stump hole slightly larger than the stump diameter. Windthrown trees on the same site leave only a shallow depression.

SITE

Pure stands of black spruce are most common in deep bog sites. Individual trees are found mixed with other swamp conifers on the more poorly drained swamp edges. The species is unobserved on well drained upland sites.

ASSOCIATIONS

Tamarack and cedar are the most common species found mixed with black spruce. Sphagnum moss is the most common forest floor with black spruce. There are no fungi typical to advanced stages of decay.

WHITE SPRUCE (*Picea glauca*)

WOOD

When moisture content is high, the wood decays rapidly into an orange, stringy, fibrous mass with white pocket-rot common. Growth rings are usually large on good sites. Trees usually are individually scattered in with other species.

BARK

The bark can often be found as small plates in the root folds, often remaining long after the woody material is gone.

CELLULAR STRUCTURE

The wood is made up of tracheids 25 to 30 microns in diameter. Rays are usually single-cell wide, indistinct, and interrupted. Resin ducts are very sparse, 50 to 90 microns in diameter, and appear as small white dots using a 10X hand lens. Transition of springwood to summerwood is gradual, becoming indistinct to obscured as decay progresses.

GREEN

DECAYED

STUMP HOLE

The stump hole is nearly nonexistent as white spruce is very shallow rooted. On upland, well-drained sites, a small stump hole from dead-in-place trees may develop. When windthrown, the stump hole is a shallow, 5- to 15-foot diameter, irregular, indistinct depression.

SITE

Generally, white spruce develops scattered about the forest. It can be found from the deepest swamp to the highest ridge, but is most common to the swamp edge on moist sites mixed with aspen and balsam fir.

ASSOCIATIONS

Balsam fir and pine are common associates of white spruce. No fungi have been observed on white spruce in the advanced stages of decay.

TAMARACK (*Larix laricina*)

WOOD

The wood is extremely decay resistant. It is not uncommon for dead-in-place trees to stand for 60 to 70 years. On fresh cut trees, a whitish to light brown sapwood is followed by a reddish-brown heartwood. On long-dead trees, the exterior usually retains a medium to charcoal-gray color, with the interior gradually separating into a brown to reddish-brown blocky structure. External decay, where exposed to air, is extremely slow--eroding gradually away on the surface one growth ring at a time. When saturated, wood has a distinct odor similar to horse urine. When dry, a resinous odor is usually present. Surface pitch deposits, when hardened, show little evidence of decay, and when struck a sharp blow, fracture to a fine white powder. Wood burns with a black greasy smoke and pungent odor.

BARK

The bark often persists in patches on exposed portions of stump and just at groundline. When dry, bark is gray to reddish-brown on the exterior and orange to reddish-brown underneath. Bark is a series of overlapping 1/16-inch platelets, irregularly shaped and 1/2 inch to 3/4 inch wide. Individual platelets are generally thicker than in spruce and pine and thinner than in hemlock.

CELLULAR STRUCTURE

Growth rings are distinct with the springwood tan to reddish and the summerwood reddish-brown to near black--depending on stage of decay. Springwood comprises about 75 to 90 percent of the cross-section with an abrupt change to the darker summerwood. Resin canals are present, often paired, located in the summerwood, and visible with a hand lens, separating tamarack from cedar, hemlock, and balsam. The wood contains a high number of fine rays perpendicular to the growth rings, aligning the individual cells in distinct parallel groups 2 to 6 cells wide.

GREEN

DECAYED

STUMP HOLE

On upland sites, windthrown trees leave a shallow, large diameter, irregular depression. Dead-in-place trees leave a small, shallow, irregular depression. Due to extremely slow rate of decay, wood fragments of tamaracks killed by larch sawfly around 1910 are usually still present in stump holes. In sphagnum bogs and swamps, stump holes range from indistinct to nonexistent.

SITE

Tamaracks are only seldom found on open upland sites. Tamarack is usually found in the lowlands, from stream and swamp edges to deep sphagnum bogs. Being relatively intolerant of heavy shade, site is usually open or even-aged.

ASSOCIATIONS

The tamarack is more generally found in pure stands or in open association with lowland balsam, black spruce, and swamp hardwoods. Fungus fruiting bodies are uncommon on tamarack, though thin, white, thread-like myceliums occasionally develop between growth rings on downed trees.

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