



Authors

Daniel L. Cassens, Professor of
Wood Products and Extension
Specialist, Purdue University

Edith Makra, Chairman,
Illinois Emerald Ash
Borer Wood Utilization Team

Urban Wood and Traditional Wood: **A Comparison of Properties and Uses**

Trees are cultivated in public and private landscapes in and around cities and towns. They are grown for the tremendous contributions they make both to the environment and the quality of people's lives. In this urban forest, trees must be removed when they die or for reasons of health, safety, or necessary changes in the landscape. The wood from these felled landscape trees could potentially be salvaged and used to manufacture wood products, but not in the same way as forest-grown trees.

The traditional forest products industry is based on forest-grown trees; its markets and systems don't readily adapt to this new source of urban wood. The urban forest grows different trees in a different manner than the traditional forest, and the wood properties can be different as well. However, there are market opportunities for urban

wood. This publication describes some key differences between wood products from traditional forests and those available from urban forests. Because the urban wood industry is emerging and the knowledge base is still sparse, conclusions drawn in the publication are based on knowledge of urban forestry and of the traditional forest products industry.

Forest Management

Traditional forests are either managed specifically to produce commodity wood or to meet stewardship objectives compatible with responsible harvesting, such as for watershed and wildlife. Harvesting is typically done in accordance with long-term forest management plans that sustain forest health and suit landowner objectives.



Methods of timber evaluation, logging, and marketing are well established. Logging, transport, and processing are efficient when large volumes of trees, usually in prime condition, are harvested from forestland. Trees are felled and usually skidded or dragged, full-length, to collection points or landings for transport by logging trucks. In smaller hardwood operations, the tree-length stems are usually bucked into logs at the landing and the logs sorted based on quality, then transported. The unused branches of the crowns and defective material are usually left on-site to naturally decompose. Where markets exist, this material can be chipped for pulp and paper, or even fuel.

Urban forest management is very different, because urban forests are very different. Some remnant forest trees exist in urban landscapes, but most urban forests are composed of dozens of different exotic and native species of shade, ornamental, and coniferous trees. These trees are intentionally planted throughout landscapes that they share with people and urban infrastructure—buildings, power lines, roads, lawns, and flowerbeds.

Simultaneous harvesting of nearby urban trees rarely occurs. Most often, dead, dying, and damaged trees are removed one at a time. A valuable landscape tree is sometimes removed only after extensive arboricultural care—such as pruning, pest treatments, and structural bracing to prolong the tree’s life. A tree standing close to valuable infrastructure must be felled carefully by a skilled arborist, who sometimes must use a crane to lift large logs over buildings. The small spaces for felling operations and the substantial weight of the logs typically requires the cutting of the bole (i.e., main trunk) into short, manageable, but potentially less valuable lengths. Logs and all tree debris must be carefully and promptly hauled away, especially from backyards and public spaces. Arborists’ equipment must be nimble enough to work around small urban landscapes. Commercial logging trucks and equipment are not suited to most urban tree removal work, and standard removal operations must be adapted to harvest salvageable saw logs. The extra skill, time, and equipment involved make urban tree removal considerably more expensive than traditional forest logging (Figure 1).

Processing Wood

Primary wood manufacturing is the milling of logs into lumber by sawmills. Secondary manufacturing makes lumber into finished products, such as furniture and cabinets. In both segments of the wood industry, processing equipment has changed greatly in the last two decades. Sophisticated, highly efficient, and mostly computerized machines now have the capability to mass-produce wood products. Mass customization, where the



Figure 1. Removal of most urban trees requires specialized equipment and a skill set different from commercial logging skill. All of the tree—not just the trunk—must be removed. Credit: Kramer Tree Specialists, W. Chicago, IL. Used with permission.

customer chooses from a set of possible alternatives, is also commonplace.

Equipment manufacturers have also “downsized” all types of equipment, making it more useful and affordable to a wider range of wood workers. For example, thin kerf band saws are a new breed of affordable and portable saw mills that allow small operators to establish lumber milling businesses with minimal staff and infrastructure. These sawmills can be easily moved about to process just one or a few trees before being moved to another location. Because of their simplicity, they can be used to process lumber to traditional standards or to produce specialized products such as matched slabs (Figure 2). The cost of saw-blade



Figure 2. Book-matched walnut slabs (left) and also several pieces of figured walnut from a large crotch produced by a portable thin kerf band mill. Due to production costs, especially labor, most traditional mills will not produce these types of products.

damage from objects occasionally found embedded in trees, especially from trees in urban areas, is far less than in traditional mills. These important innovations can facilitate use of urban timber.

Drying lumber is also an important part of the manufacturing process. Green lumber can mold, stain, and even decay quickly in warm weather. However, in many applications such as pallets, blocking, or other industrial low-grade uses, the stock is shipped and used green.

Hardwood lumber used in general construction and exterior applications is usually air-dried. If the lumber is to be used in secondary manufacturing such as furniture, cabinets, and millwork, it must also be kiln-dried or otherwise conditioned to about 6 to 8 percent moisture content for most regions of North America. In air drying, stacks from 4 to 8 feet wide and the length of the lumber are constructed over large timbers or blocking placed directly on a firm footing to allow air to circulate under the stack. Each course of lumber is separated by stickers or strips of lumber usually $\frac{3}{4}$ -inch thick by $1\frac{1}{2}$ -inches wide and the width of the stack. These stickers are placed directly above each other and no more than 2 feet apart and over the timbers used for the footing. For tall stacks of lumber about 4 by 4 inches, bolsters are placed every 4 to 6 feet in height and directly under the stickers to

allow room for a forklift to pick up the individual lumber packages. A cover and often a weight are placed on top of the stack. Depending on the weather, species, and lumber thickness, it will take about one to three months for 1-inch thick lumber to dry to 15- to 20-percent moisture content. Next, the lumber is placed in a dry kiln where the temperature, relative humidity, and air movement are precisely controlled. Some easy-to-dry hardwoods and most softwoods are not air-dried and go directly to a dry kiln. Hardwoods for secondary manufacturing are usually dried to 6- to 8-percent moisture content while softwoods for construction are dried to 15- to 19-percent.

Commercial kilns are designed and engineered to dry lumber as rapidly as possible without excessive degradation. They are equipped with a heat source (often steam for heat and humidity when needed), powerful fans for air movement, a venting system to allow excess moisture to escape, and a monitoring system to determine the rate of drying and thus provide information on kiln settings for temperature and humidity. Small milling operations often build kilns from available lumber or even from truck trailers or shipping containers by adding a source of heat or dehumidification equipment, fans, ventilation, and monitoring equipment. These operations often dry lumber at a slower rate but, none-the-less, achieve acceptable results. Solar kilns are also an option.

Lumber Markets

Lumber Standards

Before comparing the lumber produced by urban and timber trees, it is worth understanding the nature of traditional wood manufacturing. The primary wood manufacturing industry is composed of sawmills and veneer mills that seek out traditional forest trees, which tend to be tall and straight and, when mature, produce large quantities of relatively uniform lumber and veneer. Few urban trees match their needs (Figure 3).



Figure 3. Well-formed and large timber trees (top) as compared to an open-grown landscape tree. (bottom)

This material is separated by grades and sometimes even color, and kiln-dried to facilitate an efficient economic exchange between producers and buyers. This uniform lumber is then used by secondary manufacturers to mass-produce furniture, cabinets, millwork, and other products. Because wood is a natural material, tree health, growing conditions, and lumber-processing techniques can affect its appearance, causing variation even within the same species of wood. Some variation from piece to piece is acceptable, but this is controlled within limits established by lumber grades and industry custom.

A customer outfitting an office in a particular style of furniture would naturally expect additional items from the same line of office furniture, purchased at a later date, to look like the first ones. In reality, the wood used to make the furniture will be from different sources grown under different conditions. Grading helps assure consistency in the mass manufactured product. While traditional forest-product streams are aligned to this system of grading and these markets, opportunities have developed for custom woodworkers to use more unique wood materials to satisfy customers wanting something different. Much of the urban wood, which will vary greatly in character, quality, and species, could fill this niche market.

Hardwood generally refers to those temperate trees that shed their leaves during the fall. In the lumber industry, the term has nothing to do with the actual hardness of the wood. Hardwoods are generally used for decorative applications such as molding, trim, furniture, and cabinets. Lower-grade material is used for industrial applications, such as pallets, blocking, crane mats, and railroad ties.

Softwood generally refers to those trees that have needles and retain them throughout the winter season. Softwoods are most commonly used for building construction and painted millwork.

Grade lumber is the general term used to describe the category of hardwoods used in furniture, cabinets, millwork, flooring, and similar applications. Grading is a complicated process that sorts lumber into about five different categories with an understanding that the boards will eventually be cut up into smaller pieces or parts. The grader looks for the amount of clear material in each board. The more clear material, the higher the grade. It is not essential that lumber be graded to be sold, but grading assures consistency in quality and price. Lumber harvested from traditional forests best fulfills grade lumber markets. Smaller lots of unusual-character lumber, such as might be supplied by urban forests, may be considered low-grade by the traditional market place, but yet be highly prized for a more custom application.

Industrial wood is a broad category that consumes nearly half of the entire hardwood lumber produced. It is mostly low-grade and not kiln-dried. This category includes pallets, blocking, railroad ties, trenching lumber, crane mats often used in oil and gas drilling, and similar items. There are specifications for the different items, but in most cases, all that is needed is a sound piece of wood capable of withstanding the loads that will be applied. Most urban wood could be used for at least one of these applications. Unfortunately, industrial wood is also one of the lowest valued categories.

Construction lumber is another category that usually pertains to the various softwood lumber species, such as pine, fir, hemlock, spruce, etc. This material is used for general construction. When it is used for residential or commercial construction it is generally required to be graded and marked with a grade stamp to meet local building code performance standards. However, enforcement of these standards varies greatly depending on location.

Softwood construction lumber is often pressure-treated with wood preservatives when it is to be used in applications where decay or insect attack can occur. Some hardwood and softwood species have natural decay resistance and may be substituted for preservative-treated wood, subject to building codes. Construction lumber is produced in large, highly efficient sawmills. The inconsistency in the supply of urban wood and costs associated with harvesting and transport will likely make it hard to compete economically with traditional lumber in this commodity market. However, there are cases where urban wood is used.

Character Wood is a loosely defined term that simply implies that the wood contains various natural characteristics such as knots, insect damage, stain, distorted grain, rot, and others that are not generally acceptable, at least in the higher grades of traditional lumber. However, this material can be quite distinctive and used to produce unique and one-of-a-kind consumer wood products. Urban wood sources offer an abundance of character wood (Figure 4).

Consumer Preferences

Increasing consumer demand for environmentally green and sustainable products offers opportunities for locally harvested and manufactured wood products. Consumers value local agricultural goods that can reconnect them with the land, as evidenced by the resounding popularity of farmers' markets. People develop attachments to landscape trees that are integrated into their community values and personal experiences. The devastation caused

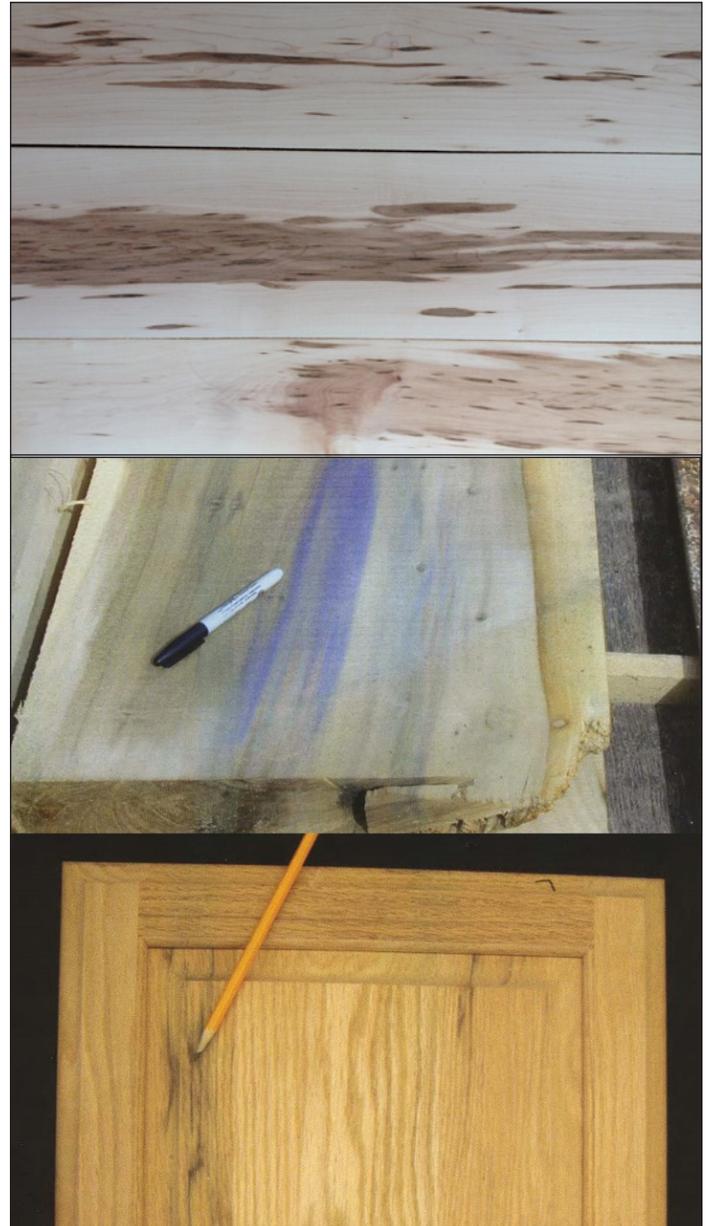


Figure 4. Mineral stain in hard maple (top), yellow poplar (middle) and in red oak (bottom). The white sapwood and brown heartwood of spalted maple is shown in Figure 9.

by the emerald ash borer, other invasive pests, and large-scale storms scar the urban landscapes—and residents mourn these losses. Reclaiming wood products from these felled trees can help residents reconcile these losses and reconnect with the sustainable cycle of forest products. Products made from treasured community trees, like the “Wilmette Wonder-Boy” baseball bats made from EAB-killed ash trees in Wilmette, Illinois, honor the relationships people have with their landscape trees (Figure 5).



Figure 5. “Wilmette Wonder-Boy” baseball bat made from EAB-killed ash. Used with permission.

Urban wood can be described as “lumber with a zip code.” The proximity to markets and the cultural values embodied in urban wood add value. On the other hand, variety in type and quality of urban lumber, the inconsistency in supply, and greater costs inherent in the harvesting and processing will likely keep urban lumber confined to specialty markets.

Wood Properties

Growth Rates

Forest trees naturally grow in close competition with one another and develop tall, straight trunks with little side branching. Urban trees usually mature in open environments where they do not compete with other trees for light and growing space. As a result, their crowns are fuller with more lateral branches and shorter main trunks (Figure 3).

Fast-growth, *ring-porous* types of wood such as oak, ash, elm, and others will have a more distinctive grain pattern when grown in open landscapes than will their slower-growth forest counterparts (Figure 6). The fast-growth material in ring-porous wood is denser, stronger, and



Figure 6. Slow, medium, and fast growth rates in the cross section of three different red oak boards (top). Flat sawn surfaces of the same three red oak boards. The bottom left piece shows a fine textured board and the right shows a more distinctive grain pattern due to wide growth rings.

maybe a little more difficult to work, especially with hand tools. In the case of oak, it is likely slower to dry. The appearance and mechanical properties of *semi-ring-porous* wood, such as walnut, or diffuse-porous wood, such as maple and yellow poplar, are not significantly impacted by growth rates. None of these factors should deter most people from the use of fast-growth material, however. Very slow-growth, ring-porous wood can be brash, because it is composed mostly of thin-walled, earlywood cells. The more dense and strong, latewood cells do not develop.

Growth rates can also affect the amount of sapwood and heartwood in a particular tree (Figure 7). Heartwood is the dark, central core that structurally supports the tree, but it is not living tissue. The heartwood in certain species, such as walnut and cherry, is preferred because of its richer color. In commercial lumber operations, green or freshly cut walnut lumber is steamed to darken the sapwood so it resembles the heartwood.

The sapwood is the light-colored outer part of a tree. This tissue is living and used by the tree for nutrient storage and transport. In species such as hard maple and ash, sapwood is usually preferred because of its light color. Young, vigorous, fast-growth trees will tend to have wider bands of sapwood. In the case of fast-growth walnut, the sapwood may be two to three inches wide, thus severely limiting the amount of dark heartwood available, particularly in smaller trees. On the other hand, in fast-growth, vigorous hard maple, a large band of more valuable sapwood should be available, providing the tree has not been wounded. Darker colored wood is generally found where a tree is wounded. Both faster growth rates and periodic wounding are to be expected more commonly in urban trees.



Figure 7. Very narrow sapwood in a walnut veneer log (right) as compared to a wide band in a more vigorous, fast-growth tree (left).

Once dried, sapwood and heartwood have the same mechanical properties. It is only the color differences that are significant. The traditional industry does not care for these distinct color differences. In specialized, custom applications such as tabletops made from naturally alternating dark (heartwood) and light-colored (sapwood) walnut or cherry, these differences may be striking and used to advantage in design.

Tree Health and Wood Properties

Traditional markets for grade lumber or veneer prefer somewhat vigorous growth timber that has not been impacted by fire, mineral staining, grazing, insect defoliation, mechanical damage, or other factors. Any of these factors can impact wood quality, and, therefore, lumber grade. Urban and forest trees will all be impacted by similar pests and climate extremes. Serious invasive pest infestations will affect lumber supply and wood processing.

Currently spreading in the Midwest, East, and beyond, the emerald ash borer kills all untreated ash trees by destroying the vascular system. Damage caused by feeding insect larva is contained to the phloem tissue, just under the bark. This tissue is easily removed in standard milling operations; the log and lumber quality is unaffected as long as the trees are harvested before they are about one-half dead.

In the West, the mountain pine beetle is killing millions of acres of lodgepole pine, and other beetles are attacking conifers compromised by drought and climate conditions. This sapwood is then marred by blue stain fungus, which does not impact industrial uses or its use for construction lumber. Wood products salvaged from infested trees may have some added value in specialty markets that favor sustainability, especially urban markets.

Whereas managed forest trees are harvested in prime condition, urban trees are often harvested because they are in poor condition. As urban trees endure difficult growing conditions and various conflicts in the landscape—such as injury from construction impacts, maintenance equipment, vehicles, and infrastructure—they respond to wounding and die slowly. A landscape tree is also pruned over its lifetime, creating callus and wound-response tissue that is not as common in forest-grown trees. If some portions of living trees die, the wood in those limbs will change color and start to decay. As a result, color variation and streaking is probably more common than in forest trees. Depending on the extent of deterioration and intended end use, the material may still have some use, especially for character wood.

Wood Color and Streaking

Wood color can vary tremendously within a species, and that variation is difficult to predict. Freshly cut cherry heartwood can vary from a very light pink to a darker red color. It also darkens quickly with exposure to light. Walnut heartwood, on the other hand, tends to lighten with exposure to light. Higher temperatures used in commercial steam dry kilns can also darken certain species such as maple sapwood. Freshly cut sapwood can also darken from molds and fungal infections such as blue stain. Sapwood is more likely to turn an off-grey color due to oxidation stain, if not processed promptly (Figure 8). These changes cause a loss of luster and life in the appearance of the finished wood, so they are not desirable in the traditional or custom industry.

Spalting of white woods is an exception. In this case, the fungus forms black, irregular-shaped zone lines, which are striking and often preferred by custom woodworkers (Figure 9). The wood is partially decayed and brash at this point.

Mineral stain, which results in olive to greenish-black or brown, blue, or purple discoloration in sapwood, is another factor to consider. The cause of mineral stain in other species is not well documented, but it is likely a response to mechanical damage, bird peck, or root damage to the tree. In commercial hardwood lumber, it is not considered a defect, but the amount is limited, depending on the grade. Yellow-poplar will sometimes turn a purplish-blue color that eventually, with exposure, turns the same brown color as aged heartwood. This discoloration has been related to wounding. The red oak lumber group can have excessive mineral stains (Figure 4). Some custom shops will prefer



Figure 8. Oxidation stain in yellow poplar sapwood due to poor or slow drying conditions. A drying sticker mark is shown on the left along with general graying of the left half of an unsurfaced board. The right part of the figure shows stain in the other half of the board after surfacing.



Figure 9. Spalted hard maple bowl.

this aberration. Because the development of mineral stain has been tied to wounding, in at least some cases, it seems intuitive that urban trees will likely show more of it.

The color of lumber produced from dead trees will be different than that produced from live trees. In addition, any number of different types of wood borers could be present or may have already damaged the wood and left. As a result, dead timber trees are usually used for industrial products.

Contaminants

Urban trees, as compared to forest trees, are more likely to contain contaminants such as nails or fence wire. Street trees are particularly prone, due to their use as “signposts.” People readily use convenient trees for backyard hammocks, bird feeders, dog stakes, or clothes line poles, and this may add to the sentimental attachment to the tree, but create problems when processing the tree into lumber. Metal contamination usually occurs at a location convenient for nailing or wiring. On occasion, contamination can occur higher up in the tree from old electrical or radio wires. Glass or porcelain insulators can be involved. These embedded contaminants can damage or break sawmill blades.

Because cutting equipment in traditional mills is expensive, as is the cost of downtime, these larger mills usually will not knowingly accept urban logs. Veneer mills often run commercial inline metal detectors. Sawmills may check suspect logs with handheld metal detectors. Hitting contaminants with smaller thin kerf band mills is not as serious as it is for larger, traditional mills. New blades for thin kerf band mills cost around \$20 each. Re-sharpening

these blades may cost about \$10, including shipping. Milling around metal contaminants requires extra time, skill, and luck, as well.

Trees occasionally contain lead from bullets. Lead does not damage cutting tools like iron, and sawing through a soft bullet, especially in an urban tree, could make for a conversation piece.

Simply using the contaminated material “as-is” presents opportunities for some crafts people (Figure 10).

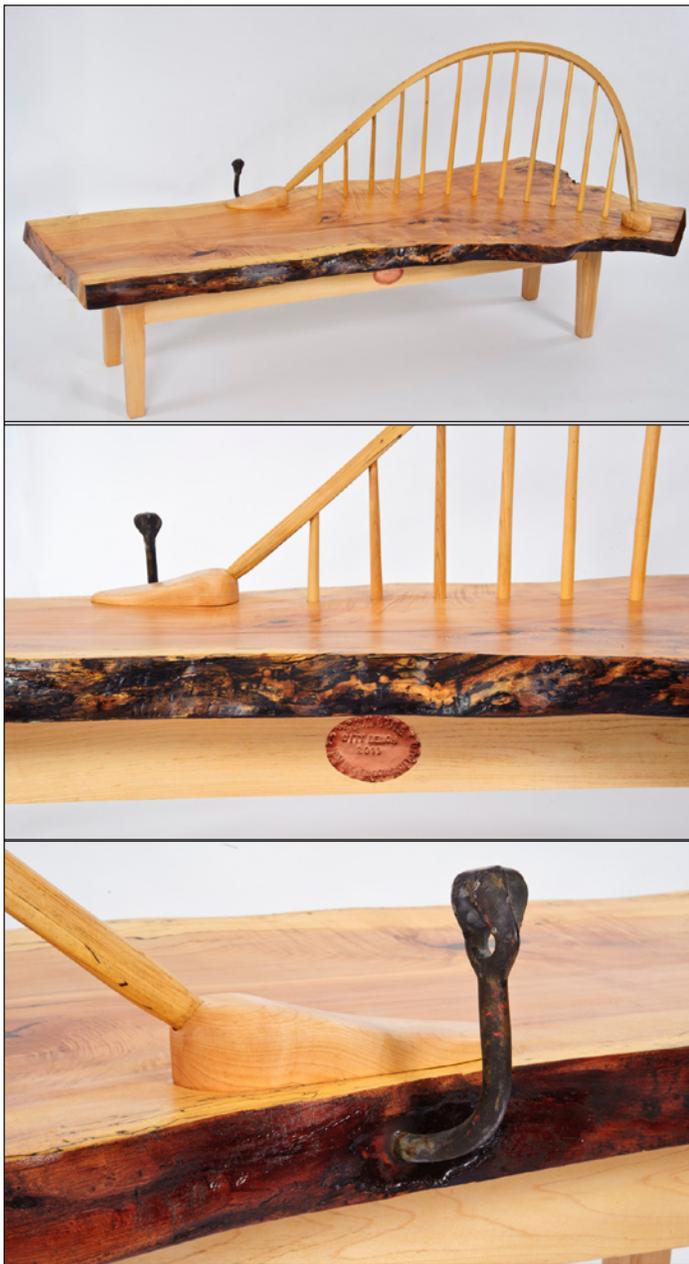


Figure 10. Metal contamination (a metal fastener) was cleverly incorporated into this unique bench. <http://www.city-bench.com/new-haven-electric-sugar-maple-rail-bench/>.

Species

Arborists deal with many different tree species, such as red oak, pin oak, black oak, etc. The traditional lumber industry groups some individual species into broader categories, because once sawn, the wood cannot be reliably separated by species. An example is Red Oak lumber. It may contain any of 18 distinct tree species in the Eastern United States. The lumber from other species such as walnut and cherry is unique and simply sold as walnut or cherry. The number of species, or species group for which prices are reported, has actually declined over the years due to changes in markets. Between the two hardwood lumber market reports (Hardwood Market Report <www.hmr.com>; Hardwood Review Weekly <www.hardwoodreview.com>) and all eastern hardwood regions, there are only 18 distinct species or species groups for which prices are reported. These are:

Aspen	Cottonwood	Sap gum (Sweet gum)
Ash	Hackberry	Sycamore
Basswood	Hard Maple	Walnut
Beech	Hickory/Pecan*	White Oak
Birch	Red Oak	Willow
Cherry	Soft Maple	Yellow-Poplar

* *Hickory is the category used in the north and east and Pecan/ Hickory is used in the south. A professional hardwood lumber grader will not separate hickory and pecan, and the ranges overlap.*

Native sassafras, honey locust, black locust, Kentucky coffeetree, osage orange, and others are unusual and beautiful woods (Figure 11). Except for an occasional offering, they are not listed in the market reports and not traded on the commercial market, but could be part of the urban wood offering.

In addition, numerous exotic species have been planted in the urban landscape and many develop into sawlog-size material. Examples include Siberian elm, ginkgo, and Chinese chestnut.



Figure 11. These are sample boards of several minor species that could be produced in small quantities from the urban forest.

Naturally Durable Woods

Table 1 lists the natural durability of both softwood and hardwood species. Natural durability can vary from tree to tree. It has been demonstrated for some species that young-growth stock is not as durable as old-growth stock. However, naturally durable woods will last longer than non-durable woods when placed in a high-decay, hazard application or if exposed to insects. Black locust and osage orange are particularly durable and are somewhat common in the urban landscape in the Midwest. These dark woods could be used in outdoor furnishings where tropical hardwoods have been popular.

It is only the darker heartwood as compared to the outer, light-colored band of sapwood that is durable. As mentioned above, urban trees tend to be open and fast-grown, so they may contain a wide band of sapwood, which will not be durable. Figure 12 shows tongue-and-groove cypress boards used for ceiling decking on a walkway. The



Figure 12. The decayed board ends are cypress sapwood while the sound end is heartwood. The joist is southern yellow pine sapwood.

flat roof developed a leak, and all of the exposed cypress in the vicinity of the leak decayed, except the end of one board. The decayed wood is sapwood, whereas the sound end is heartwood.

Resistant or very resistant	Moderately resistant	Slightly or nonresistant
Baldcypress, old growth	Baldcypress, young growth	Alder, red
Catalpa	Douglas-fir	Ash
Cedar	Larch, western	Aspen
Atlantic white	Pine, longleaf, old growth	Beech
Eastern redcedar	Pine, slash, old growth	Birch
Incense	Pine, eastern white, old growth	Blackgum and tupelo
Northern white	Redwood, young growth	Buckeye
Port-Orford	Tamarack	Butternut
Western redcedar		Cottonwood
Yellow		Elm
Cherry		Basswood
Chestnut		Firs, true
Cypress, Arizona		Hackberry and sugarberry
Honeylocust		Hemlock
Juniper		Hickory and pecan
Locust, black ¹		Magnolia
Mesquite		Maples (all)
Mulberry, red ¹		Pines (other than those listed) ²
Oaks, white ²		Spruce
Osage-orange ¹		Sweetgum
Redwood, old growth		Sycamore
Sassafras		Tanoak
Walnut		Willow
Yew, Pacific ¹		Yellow-poplar

Table 1. Natural decay resistance of common hardwood and softwood lumber species. *Wood Handbook, Wood as an Engineering Material*. USDA General Technical Rep. FPL-GTR-190. Madison, WI.

¹ Exceptionally high decay resistance.

² More than one species included, some of which may vary in resistance from that indicated.

Abnormal Wood Properties

In both hardwoods and softwoods, depending on age and location in the tree, wood can be found that is not representative of most wood for that species. This wood is called abnormal wood.

Juvenile Wood

One type of abnormal wood is juvenile wood. Juvenile wood is that material formed near the center or pith of the tree. It is prevalent in softwoods. It also occurs in hardwoods, but little information is available concerning it. Juvenile wood is characterized by wide growth rings with shorter, thin-walled cells, and fewer latewood cells, thus resulting in a lower density and reduced strength values. There is also a tendency toward greater spiral grain in juvenile wood. This spiral grain results in lumber with cross grain and diminished strength properties. The shrinkage characteristics of juvenile wood are different from the shrinkage of normal wood, thus increasing warp problems. The change from juvenile wood to normal wood is gradual, thus making identification of juvenile wood difficult.

Reaction Wood

Reaction wood is another type of abnormal wood. This wood often forms in leaning trees that are partially bent by a storm or other disturbance. Reaction wood is formed in an attempt by the tree to straighten itself. This abnormal wood may also be formed as a tree bends toward a light source. Reaction wood is particularly troublesome, because the board may otherwise be defect-free and appear as a desirable piece.

In hardwood trees, reaction wood is called tension wood and forms predominately toward the upper side of the leaning tree (Figure 13). It may form irregularly around the entire stem and, as a result, there is less tendency for the pith to be off-center. Tension wood is often difficult to detect. It may have a silvery appearance or, at other times, may not be visually detected. However, crooked and sweepy, or bowed logs and limb logs should be suspect. When machined, a fuzzy or woolly surface may result, particularly in green wood. During the finishing process, stain is sometimes absorbed irregularly by tension wood, leaving a blotchy appearance. Due to abnormal longitudinal shrinkage, warping is also a problem with tension wood. During drying, it may collapse. The mechanical properties of tension wood are generally less than those for normal wood. Tension wood can deform the work piece as it is being sawed, resulting in thick and thin lumber.

In softwood trees such as pines, reaction wood is called compression wood (Figure 13). It is formed on the lower side of leaning trees. The part of the growth ring with reaction wood is usually wider than the rest of the ring with a high proportion of latewood. As a result, the tree develops an eccentrically shaped stem, and the pith is not centered. Compression wood, especially the latewood, is usually dull and lifeless in appearance. It presents serious problems in wood manufacturing, since it is much lower in strength than normal wood of the same density and tends to shrink excessively in the longitudinal direction. Sometimes it's the cause of structural failures in critical applications, such as ladders. The softwood lumber grading rules restrict the extent of reaction wood in lumber.

In reality, neither tension wood nor compression wood is intentionally sorted or culled in the lumber industry. However, most of it probably ends up being scrap because of warping, machining, and finishing issues.

Because urban trees are open-grown, subject to conflicts with infrastructure and cultivated through fertilizing, pruning, and other arboricultural care, abnormal wood may be more common in urban lumber. This likely increases the amount of degradation during the drying operation and also makes some material more difficult to work.



Figure 13. Tension wood is found in the upper side of leaning hardwood trees and branches. This is an extreme example (top). Compression wood is found on the lower side of leaning softwood trees (bottom).

Summary

Traditional wood manufacturers who mass-produce lumber and furniture need large quantities of uniform, clear material. This material is best obtained from forest-grown trees that are harvested and processed in a traditional manner. Custom wood manufacturers and home woodworkers are capable of using smaller quantities of wood materials that have a variety of distinct characteristics. These characteristics and species often provide an element of uniqueness to the finished product. This material is often found in the urban forest.

Harvesting and processing systems in the urban forest are not well established. Secondary wood manufacturers and artisans seeking unique urban-forest products need to seek out commercial tree-care firms to procure urban saw logs. Arborists can then plan future tree removal work to set aside salvageable logs. Municipal arborists seem particularly interested in reclaiming lumber from publicly owned trees to satisfy community sustainability goals. In Michigan, the Urbanwood Project established three special urban lumber retail stores that sell a wide variety of dimensional and specialty lumber products (Figure 14). In most areas, urban lumber can be purchased through small portable saw mill operators. State forestry departments often maintain lists of sawyers.

Owners and managers of urban trees wishing to reclaim lumber products from landscape trees that must be removed should identify arborists, sawyers, and woodworkers before felling. State forestry agencies, urban foresters, arborist associations, county Extension offices, and sawmill suppliers can be helpful resources. If an invasive pest is involved, be certain to check any quarantine regulations.



Figure 14. Arborist Pat O'Connor examines lumber produced from logs that his company salvaged during tree care operations. His company sells reclaimed lumber at the Urbanwood marketplace in Recycle Ann Arbor's ReUse Center. Photo used with permission of Jessica Simons, Consultant/Project Manager, Verdant Stewardship, LLC. <http://verdantstewardship.com>

Additional Readings

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Resources

Urban Forest Products Alliance, <http://www.urbanforestproducts.org/Home.html>

Urban Forest Products Alliance Discussion Group, <http://www.linkedin.com/groups/Urban-Forest-Products-Alliance-2871768/about>

US Forest Service Northeastern Area Wood Education and Resource Center, <http://www.na.fs.fed.us/werc/>

Cassens, Dan. 2008. *Lumber from Hardwood Trees*. Purdue University, Purdue Extension CD-FNR-406. https://mdc.itap.purdue.edu/item.asp?Item_Number=CD-FNR-406. Shows wood characteristics of several species through 4x4-foot finished panels.

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