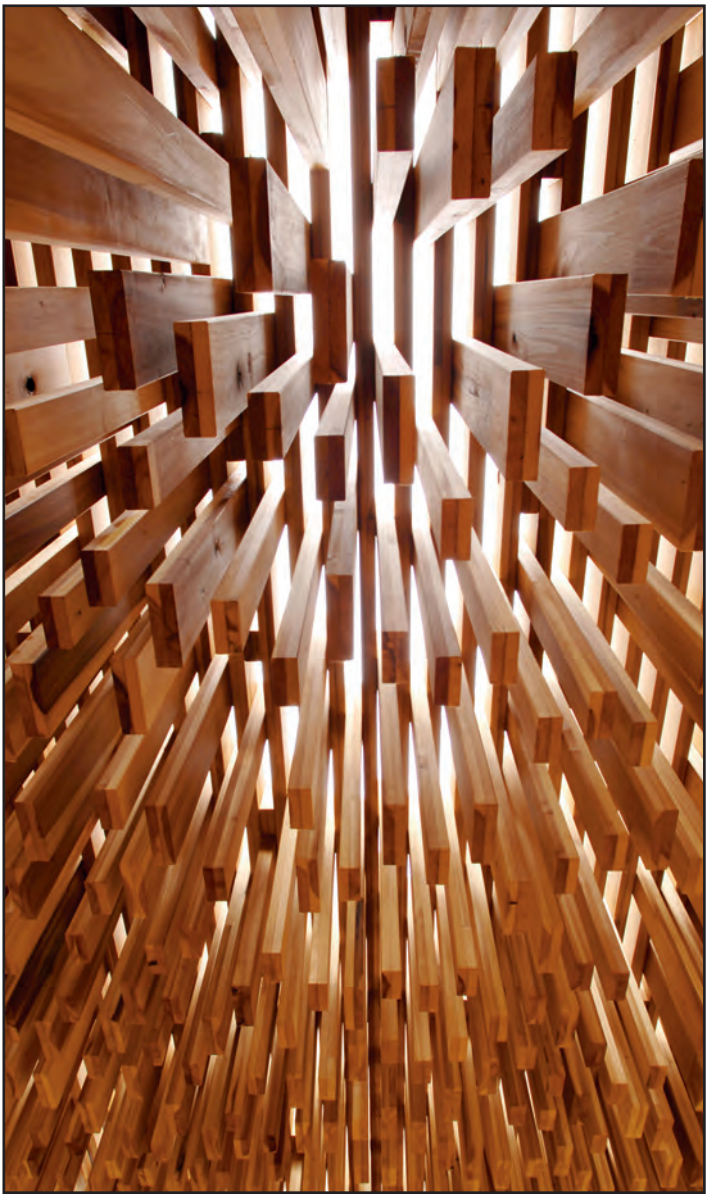
Sustainable American Hardwoods

A guide to species



alder
ash
aspen
basswood
beech
birch
cherry
cottonwood
elm
gum
hackberry
hickory & pecan
hard maple
soft maple
red oak
white oak
sycamore
tulipwood
walnut
willow

AMERICAN HARDWOOD EXPORT COUNCIL

Front page: 'Sclera', an American tulipwood pavilion designed by David Adjaye for the London Design Festival 2008. For more information visit www.americanhardwood.org

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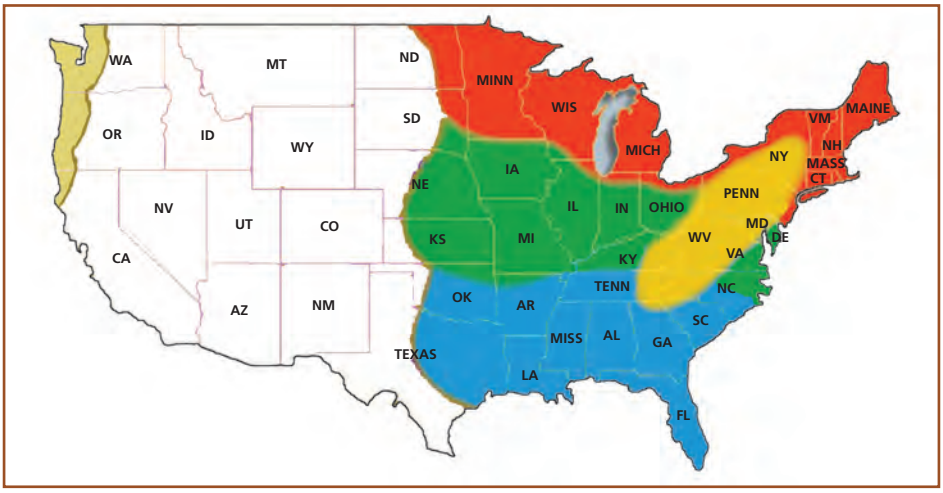
Introduction

The hardwood forests of the eastern United States contain a wide range of temperate hardwood species, which have been managed for commercial and non-commercial purposes since the turn of the 20th Century.

Hardwoods from America offer specifiers, manufacturers and end-users around the world a great variety of colour, grain and character; from the warm, darker tones of walnut, red alder, elm, cherry and red oak to the lighter hues of white oak, maple and ash. Many of these species also have interesting colour contrasts between the sapwood and heartwood, with species such as hickory, sapgum and tulipwood displaying exciting colour variation within their heartwood as well. Most of the species featured in this publication can be used for a wide range of applications, from fine furniture and cabinets to internal joinery such as doors, stairs and panelling. The physical properties of some species, such as the oaks, hard maple, ash, walnut and hickory make them ideal for flooring. An important factor for manufacturers is that both veneer and solid lumber are available in most species, ensuring a good match for any project.

The availability and characteristics of American hardwood species vary according to growing regions and the map below may be useful as a guide to provenance.



Northern region	Long winters, short summers. Particularly suited to slow grown, tight grained hardwoods such as maple and birch.
Central region	Hot summers, cold winters. Particularly suited to species such as walnut and hickory.
Appalachian region	Variable climate, due to differences in both elevation and latitude. Most hardwood species thrive here.
Southern region	Short winters, long hot summers. Producing fast grown large dimension species such as tulipwood and sapgum.
Pacific Northwest region	Maritime climate. Separated geographically from the main hardwood growing regions in the East. Red alder and Pacific Coast / Bigleaf maple grow exclusively here.

Note – Many American hardwood species such as ash, tulipwood, soft maple and the red and white oaks, will grow across the Northern, Central, Southern and Appalachian regions. But, because of the variation in climate, soil type and elevation, the wood produced can vary significantly in colour, grain and other physical properties.

The Sustainable Resource

The American hardwood industry, which dates back to the first European settlers, has a wealth of experience in processing the native hardwoods of North America. The U.S. hardwood resource is mainly located in the east from Maine in the North to the Gulf of Mexico in the South, and westwards across to the Mississippi valley. The USA has more temperate hardwood species than any other region of the world.

Few other countries can boast the success America has had in the sustainability of its hardwood forests. Due to the intensive application of Best Management Practices (BMP), the hardwood forests of America support a vibrant healthy stand of timber, as well as a large and diverse wildlife population, clean rivers and streams, and a host of recreational activities. The last 80 years of improved forest management and state and federal regulations, together with greater silvicultural understanding and public desire to conserve forests, have resulted in a dramatic recovery and renewal of the American hardwood resource.

The hardwood sawmilling and processing industry, which depends upon this resource, is the largest producer of sawn hardwood in the world. In recent years, the U.S. has substantially increased exports and through careful management of its forests, the United States is growing more hardwood each year than it harvests, ensuring reliable and long term supplies. As the world faces up to environmental change, with sustainability the watchword for natural materials, the good news is that the net volume of hardwood growing stock in the USA has increased from 184,090 million cubic feet in 1953 to just under 400,000 million cubic feet in 2007 (Resource Planning Act Assessment 2007).

Responding to increasing demands for independent assurances that U.S. hardwoods derive from legal and sustainable sources, the American Hardwood Export Council (AHEC) has published an *Assessment of Lawful Harvesting and Sustainability of U.S. Hardwood Exports*. This report was prepared by independent consultants and peer reviewed. The research provides confirmation of the legal and sustainable status of U.S. hardwood forest management. To review report and for more information visit www.americanhardwood.org.

About This Publication

This publication is designed to help specifiers, manufacturers and end users to understand the physical and mechanical properties and potential applications of the main commercial American hardwood species, thereby providing the necessary tools to make an informed choice. The physical and mechanical properties listed for all species in this publication are sourced from *Hardwoods of North America* by H. A. Alden. Sampling and testing procedures may have varied considerably in obtaining these values and due to the geographical size and diversity within the U.S. forest resource, they are offered as guidance only.




American alder *Alnus rubra*

Other names: Red alder, Western red alder, Western alder

Distribution & Availability

West coast USA, principally the Pacific Northwest, where it is the most common commercial hardwood. Available in a range of grades and specifications as both rough lumber and dimension stock, although veneer production is more limited.

General Description

Red alder is almost white when freshly cut, but quickly changes on exposure to air to light brown with a yellow or reddish tinge. Heartwood is formed only in trees of advanced age and there is no visible definition between sap and heartwood. The wood is fairly straight grained with a uniform texture.

Physical & Mechanical Properties

Red alder is a relatively soft hardwood of medium density that has low bending strength, shock resistance and stiffness.

Specific gravity (12% MC)	0.41
Average weight (12% MC)	449 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	10.1%
Modulus of Rupture	67.571 MPa
Modulus of Elasticity	9515 MPa
Compressive strength (parallel to grain)	40.129 MPa
Hardness	2624 N

Working Properties

Red alder machines well and is excellent for turning and polishing. It nails, screws and glues well, and can be sanded, painted, or stained to a very good finish. It dries easily with little degrade and has good dimensional stability after drying.

	Poor	Fair	Good	Excellent
Sawing			■	
Planing			■	
Drilling			■	
Boring			■	
Turning				■
Carving			■	
Moulding			■	
Nailing			■	
Screwing			■	
Gluing			■	
Finishing				■

Durability

The wood is non-resistant to heartwood decay, but is permeable to preservative treatment.

Main Uses

Furniture, kitchen cabinets, doors, interior mouldings, turning, carving and kitchen utensils. Widely used by furniture industries around the world, its colour makes it an ideal substitute for cherry.

End use applications	Main uses
Doors	✓
Flooring	
Furniture	✓
Joinery	✓
Kitchen cabinets	✓
Mouldings and turnings	✓
Veneered panels	
Sports goods	
Tool handles	

Other Information

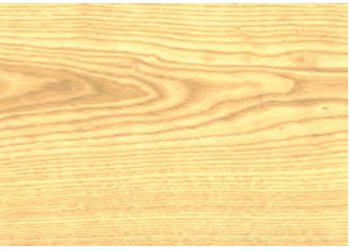
The grading rules are unique for this western USA hardwood. Key points include the following: The lumber is kiln-dried, surfaced, and then inspected from the better face. Pin knots are a natural characteristic and are not considered as defects. The primary grades include Superior (Select & Better), Cabinet (No.1 Common), and Frame (No.2 Common), which adapt themselves to similar uses as the standard NHLA grades. When specifying red alder, it is best to work closely with the supplier to find the best grade for the end use.

American ash *Fraxinus* spp.

Other names: Northern ash, Southern ash

Distribution & Availability

Distributed throughout Eastern USA. Good availability as lumber and veneer. The lumber is often classified according to growing regions and marketed as Northern ash and Southern ash. It is sometimes separated for colour and sold as white ash (sapwood) or brown ash (heartwood). American ash can comprise a number of commercial sub species and is available in a wide range of grades and specifications as lumber and veneer. Note that white ash is the commercial name for *Fraxinus americana.*



General Description

American ash is similar in appearance to European ash. The sapwood is light coloured to nearly white and the heartwood varies from greyish brown to light brown, to pale yellow streaked with brown. The wood is generally straight grained with a coarse uniform texture. The degree and availability of light coloured sapwood, and other properties, will vary according to the growing regions. For example, Southern ash lumber will be faster grown and contain more sapwood and therefore, a higher percentage of white colour, but compared to Northern ash, it has a more open texture and grain.

Physical & Mechanical Properties

Ash has very good overall strength properties relative to its weight. It has excellent shock resistance and is good for steam bending. Additional strength information is available in the AHEC publication *Structural design in American hardwoods.*

Specific gravity (12% MC)	0.60
Average weight (12% MC)	673 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	6.2%
Modulus of Rupture	103.425 MPa
Modulus of Elasticity	11,997 MPa
Compressive strength (parallel to grain)	51.092 MPa
Hardness	5871 N

Values based on Fraxinus americana

Working Properties

Ash machines well, is good in nailing, screwing and gluing, and can be stained and polished to a very good finish. It dries fairly easily with minimal degrade, and good stability means there is little movement in performance.

	Poor	Fair	Good	Excellent
Sawing			■	
Planing			■	
Drilling			■	
Boring			■	
Turning				■
Carving			■	
Moulding			■	
Nailing			■	
Screwing			■	
Gluing			■	
Finishing				■

Durability

Non-resistant to heartwood decay. The heartwood is moderately resistant to preservative treatment, and the sapwood is permeable.

Main Uses

Furniture, flooring, doors, architectural interiors, high class joinery and moulding, kitchen cabinets, panelling, tool handles, sports goods and turning. A versatile, good-looking wood, offering great value for a wide range of joinery and furniture applications.

End use applications	Main uses
Doors	✓
Flooring	✓
Furniture	✓
Joinery	✓
Kitchen cabinets	✓
Mouldings and turnings	✓
Veneered panels	✓
Sports goods	✓
Tool handles	✓

Other Information

Light brown flecks or mineral streaks, sometimes referred to as glassworm, are common and are treated as a natural characteristic and not considered as defects.

American cherry *Prunus serotina*

Other names: American black cherry

Distribution & Availability

Found throughout Eastern USA, but main commercial areas are Pennsylvania, Virginia, West Virginia and New York State. Although cherry accounts for less than 2% of the growing hardwood resource, it is widely available in a full range of specifications and grades as both lumber and veneer.

General Description

The heartwood of American cherry varies from rich red to reddish brown and will darken on exposure to light. In contrast the sapwood is creamy white. Cherry can be supplied steamed, to darken sapwood or left unsteamed. The wood has a fine uniform straight grain, smooth texture, and may naturally contain brown pith flecks and small gum pockets.

Physical & Mechanical Properties

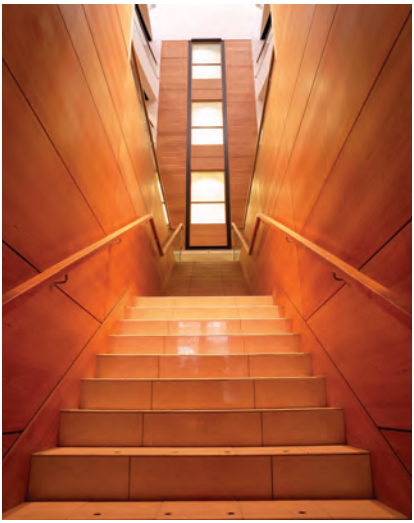
The wood is of medium density with good wood bending properties. It has low stiffness, medium strength and shock resistance.

Specific gravity (12% MC)	0.50
Average weight (12% MC)	561 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	9.2%
Modulus of Rupture	84.809 MPa
Modulus of Elasticity	10,274 MPa
Compressive strength (parallel to grain)	49.023 MPa
Hardness	4226 N

Working Properties

Cherry is easy to machine. It nails and glues well and when sanded, stained and polished, it produces an excellent smooth finish. It dries fairly quickly with moderately large shrinkage, but is dimensionally stable after kilning.

	Poor	Fair	Good	Excellent
Sawing			■	
Planing				■
Drilling				■
Boring				■
Turning				■
Carving				■
Moulding				■
Nailing			■	
Screwing			■	
Gluing			■	
Finishing				■



Durability

Rated as resistant to heartwood decay and the heartwood is moderately resistant to preservative treatment.

Main Uses

Furniture and cabinet making, high-class joinery, kitchen cabinets, mouldings, panelling, flooring, doors, boat interiors, musical instruments, turning and carving. The subtle range of red tones found in the heartwood have made this species very fashionable for many high end applications.

End use applications	Main uses
Doors	✓
Flooring	✓
Furniture	✓
Joinery	✓
Kitchen cabinets	✓
Mouldings and turnings	✓
Veneered panels	✓
Sports goods	
Tool handles	

Other Information

On exposure to UV light, cherry products with a natural finish will generally darken in colour over time. This premium wood has naturally occurring pin knots and gum streaks which are not considered defects. Sapwood is admitted without limit. Because of this NHLA rule, cherry lumber is often sold with a heartwood specification such as 90/50, which means one face will be 90% heartwood and not less than 50% heartwood on the reverse face. Consult your supplier about how their cherry is being sold.

American hard maple *Acer saccharum, Acer nigrum*

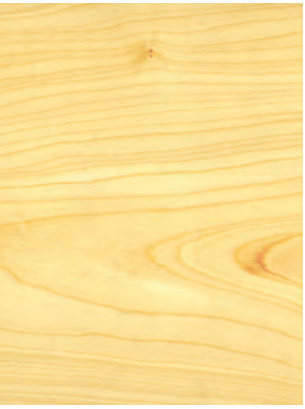
Other names: Sugar maple, black maple

Distribution & Availability

Eastern USA, principally Northeastern and Lake States. A cold weather tree favouring a more northerly climate. Widely available as lumber and veneer. The higher quality grades of lumber are available selected for white colour (sapwood), although this can limit availability. Figured maple (birdseye, curly, fiddleback) is generally only available in commercial volumes as veneer.

General Description

The sapwood is creamy white with a slight reddish brown tinge and the heartwood varies from light to dark reddish brown. The amount of darker brown heartwood can vary significantly according to growing region. Both sapwood and heartwood can contain pith fleck. The wood has a close fine texture and is generally straight grained, but it can also occur as “curly”, “fiddleback”, and “birdseye” figure.



Physical & Mechanical Properties

The wood is hard and heavy with good strength properties, in particular its high resistance to abrasion and wear. It also has good steam bending properties.

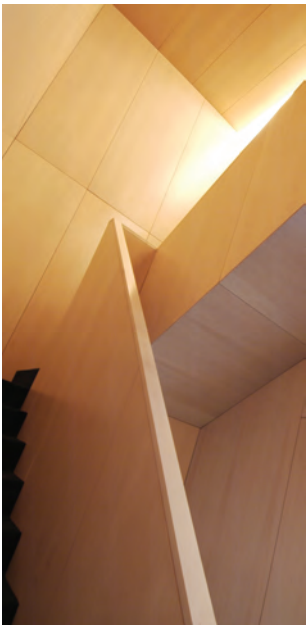
Specific gravity (12% MC)	0.63
Average weight (12% MC)	705 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	11.9%
Modulus of Rupture	108.941 MPa
Modulus of Elasticity	12,618 MPa
Compressive strength (parallel to grain)	53.998 MPa
Hardness	6450 N

Values based on Acer saccharum

Working Properties

Hard maple dries slowly with a large shrinkage, so it can be susceptible to movement in performance. Pre-boring is recommended when nailing and screwing. With care it machines well, turns well, glues satisfactorily, and can be stained and polished to an outstanding finish.

	Poor	Fair	Good	Excellent
Sawing				■
Planing			■	
Drilling			■	
Boring				■
Turning				■
Carving			■	
Moulding			■	
Nailing		■		
Screwing		■		
Gluing			■	
Finishing				■



Durability

Rated as slightly or non-resistant to heartwood decay. The heartwood is resistant to preservative treatment, but the sapwood is permeable.

Main Uses

Flooring, furniture, panelling, kitchen cabinets, worktops and table tops, interior joinery: stairs, handrails, mouldings, and doors. The hard wearing properties and tight smooth grain make this species ideal for high traffic flooring applications, such as theatres, concert halls, gymnasiums and basketball courts.

End use applications	Main uses
Doors	✓
Flooring	✓
Furniture	✓
Joinery	✓
Kitchen cabinets	✓
Mouldings and turnings	✓
Veneered panels	✓
Sports goods	✓
Tool handles	✓

Other Information

The lighter coloured sapwood will tend to darken over time on exposure to UV light. Hard maple lumber is often sorted for the white (sapwood) colour, which the NHLA grading rules define as White maple or Sap maple. For more information, refer to AHEC's publication *The Illustrated Guide to American Hardwood Lumber Grades.*

American soft maple

Acer rubrum, Acer saccharinum

Other names: Red maple, silver maple

Distribution & Availability

Wide distribution throughout Eastern USA, however, Pacific coast/big leaf maple (*Acer macrophyllum*) grows exclusively in the Pacific Northwest. Availability is improving as demand increases in export markets.

General Description

In most respects the wood of soft maple is very similar to that of hard maple, although due to its widespread growth it may be more susceptible to regional colour variations. Generally the sapwood is greyish white, sometimes with darker coloured pith flecks, and the heartwood varies from light to dark reddish brown. The wood is usually straight grained. The lumber is generally sold unselected for colour.

Physical & Mechanical Properties

Soft maple is about 25% less hard than hard maple, has medium bending and crushing strength, and is low in stiffness and shock resistance. It has good steam bending properties.

	Acer rubrum (red)	*Acer macrophyllum (Pacific coast / big leaf)*
Specific gravity (12% MC)	0.49	0.44
Average weight (12% MC)	801 Kg/m^3	753 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	10.5%	9.3%
Modulus of Rupture	92.393 MPa	73.777 MPa
Modulus of Elasticity	11,308 MPa	9,998 MPa
Compressive strength (parallel to grain)	45.093 MPa	41.025 MPa
Hardness	4225 N	3780 N

Working Properties

Soft maple machines well and can be stained and polished to an excellent finish. It glues, screws, and nails satisfactorily. It dries slowly with minimal degrade and has good stability which means there is little movement in performance.

	Poor	Fair	Good	Excellent
Sawing				■
Planing				■
Drilling			■	
Boring				■
Turning			■	
Carving			■	
Moulding			■	
Nailing			■	
Screwing			■	
Gluing			■	
Finishing				■

Durability

Non-resistant to decay. The heartwood is moderately resistant to preservative treatment but the sapwood is permeable.

Main Uses

Furniture, panelling, interior joinery, kitchen cabinets, mouldings, doors, musical instruments, and turning. Soft maple is often used as a substitute for hard maple or stained to resemble other species such as cherry. Its physical and working properties also make it a possible substitute for beech.

End use applications	Main uses
Doors	✓
Flooring	✓
Furniture	✓
Joinery	✓
Kitchen cabinets	✓
Mouldings and turnings	✓
Veneered panels	✓
Sports goods	
Tool handles	

Other Information

Eastern soft maple: Typically red maple in the North and silver maple through the Midwest and Southern USA. It is essential to discuss this with your supplier, as they are very different in appearance. The red maple tends to resemble hard maple and is much more consistent in colour, while the silver maple has a wide range of colours and can have a slightly softer texture. Both species can produce a highly figured wormy variety which is sold WHND or Worm Holes No Defect. All soft maple varieties can be sorted for colour according to the NHLA specifications in *The Illustrated Guide to American Hardwood Lumber Grades*.

Pacific coast / big leaf maple: This Pacific Northwest species follows the grading guidelines for red alder. The main lumber grades are Select & Better, No.1 Common, and Frame. It is sold kiln-dried, surfaced, and graded from the better face with naturally occurring pin knots, which are not considered a defect. For best results, consult your supplier for the grade that will suit your needs.

American red oak *Quercus* spp.

Other names: Northern red oak, Southern red oak

Distribution & Availability

Widespread throughout Eastern USA. The oaks are by far the largest species group growing in the Eastern hardwood forests. Red oaks grow more abundantly than the white oaks. The red oak group comprises many species, of which about eight are commercial. Excellent availability as lumber or veneer in a wide range of grades and specifications. Red oak is often classified according to growing regions and marketed as Northern red oak and Southern red oak.

General Description

The sapwood of red oak is white to light brown and the heartwood is often a pinkish reddish brown. The wood is similar in general appearance to white oak, but with a slightly less pronounced figure due to the smaller rays and a more porous end grain structure. The wood is mostly straight grained with a coarse texture.

Physical & Mechanical Properties

The wood is hard and heavy, with medium bending strength and stiffness and high crushing strength. It is very good for steam bending. More detailed strength information is available in AHEC's publication *Structural design in American hardwoods.*

	Quercus rubra (Northern)	*Quercus falcata* (Southern)
Specific gravity (12% MC)	0.63	0.68
Average weight (12% MC)	705 Kg/m^3	753 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	6.6%	N/A
Modulus of Rupture	98.599 MPa	75.156 MPa
Modulus of Elasticity	12,549 MPa	10,274 MPa
Compressive strength (parallel to grain)	46.610 MPa	41.991 MPa
Hardness	5738 N	4715 N

Working Properties

Red oak machines well; nailing and screwing is good although pre-boring is recommended, and it can be stained and polished to a very good finish. It performs best when dried slowly, reducing the opportunity for degrade such as splits and warp. It has a high shrinkage and can be susceptible to movement in performance under variable moisture conditions.

	Poor	Fair	Good	Excellent
Sawing			■	
Planing				■
Drilling				■
Boring			■	
Turning			■	
Carving			■	
Moulding				■
Nailing			■	
Screwing			■	
Gluing			■	
Finishing				■

Durability

Rated slightly non-resistant to heartwood decay, moderately easy to treat with preservatives.

Main Uses

Construction, furniture, flooring, architectural interiors, internal joinery, stairs and mouldings, doors, kitchen cabinets, panelling and coffins. Not suitable for tight cooperage. Red oak can vary in colour, texture, characteristics and properties according to the growing region. It is therefore recommended that users and specifiers work closely with their suppliers to make sure the wood they order is suited to their specific needs.

End use applications	Main uses
Doors	✓
Flooring	✓
Furniture	✓
Joinery	✓
Kitchen cabinets	✓
Mouldings and turnings	✓
Veneered panels	✓
Sports goods	
Tool handles	✓

Other Information

This attractive looking oak, that is widely available, is increasingly being chosen by designers and architects for furniture, joinery and flooring in export markets around the world. While some red oak can have a distinct pink or red colour, other supplies can appear very similar to white oak. This is especially true once a finish is applied, which results in more ‘mixed oak’ products.

The large volume of red oak production ensures that lumber availability is good and that a high proportion of long, wide boards with uniform grain can be obtained. For the same reason, red oak is increasingly available sorted to width and length for specific applications.

American white oak *Quercus* spp.

Other names: Northern white oak, Southern white oak

Distribution & Availability

Widespread throughout Eastern USA. The white oak group comprises many species, of which about eight are commercial. Very widely available in lumber and veneer, in a full range of grades and specifications.

General Description

White oak is similar in colour and appearance to European oak. The sapwood of American white oak is light coloured and the heartwood is light to dark brown. White oak is mostly straight grained with a medium to coarse texture, with longer rays than red oak. White oak, therefore, has more figure.

Physical & Mechanical Properties

A hard and heavy wood with medium bending and crushing strength, low in stiffness, but very good in steam bending. Its good overall strength means it is increasingly being used by architects and designers in structural applications. More detailed information can be obtained in the AHEC publication *Structural design in American hardwoods*.

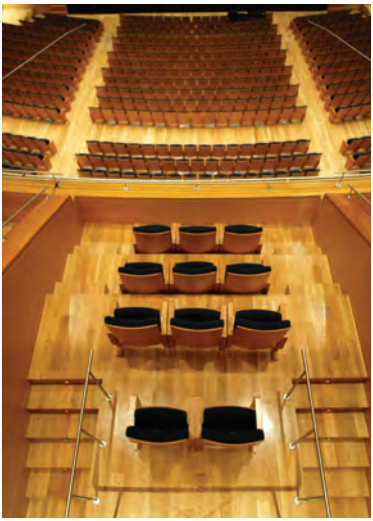
Specific gravity (12% MC)	0.68
Average weight (12% MC)	769 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	12.6%
Modulus of Rupture	104.804 MPa
Modulus of Elasticity	12,273 MPa
Compressive strength (parallel to grain)	44.955 MPa
Hardness	6049 N

Values based on Quercus alba

Working Properties

White oak machines well, nails and screws well, although pre-boring is advised. As it reacts with iron, galvanised or copper nails are recommended. Its adhesive properties are variable, but it stains and polishes to a good finish. The wood dries slowly and care is needed to avoid checking. Due to its high shrinkage, it can be susceptible to movement in performance under variable moisture conditions.

	Poor	Fair	Good	Excellent
Sawing			■	
Planing			■	
Drilling				■
Boring			■	
Turning			■	
Carving			■	
Moulding			■	
Nailing			■	
Screwing			■	
Gluing			■	
Finishing				■



Durability

The heartwood is resistant to decay, extremely resistant to preservative treatment, and the sapwood is moderately resistant to treatment. Its natural durability means that white oak heartwood can be used externally without preservative treatment, but localised climate and exposure conditions should be taken into account to determine its potential performance.

Main Uses

Construction, furniture, flooring, architectural joinery, exterior joinery, mouldings, doors, kitchen cabinets, panelling, railway sleepers, timber bridges, barrel staves and coffins.

White oak can vary in colour, texture, characteristics and properties according to the growing region. It is therefore recommended that users and specifiers work closely with their suppliers to make sure the wood they order is suited to their specific needs. Northern and Southern may be sold separately.

End use applications	Main uses
Doors	✓
Flooring	✓
Furniture	✓
Joinery	✓
Kitchen cabinets	✓
Mouldings and turnings	✓
Veneered panels	✓
Sports goods	
Tool handles	✓

Other Information

White oak tends to be consistent in colour throughout its wide Northern to Southern range. Certain areas of the Appalachian Mountains produce a highly figured wormy variety and this is sold as Sound Wormy. Sapwood is admitted without limit in the NHLA rules, but usually sorted with a minimum of one heartwood face for export. Consult your supplier about their grading standards for sapwood.

White oak is used around the world and complements European oak, although its colour consistency and the high volume of square edged lumber production make it first choice for many furniture, flooring and joinery manufacturers.

American tulipwood *Liriodendron tulipifera*

Other names: Yellow poplar, tulip poplar

Distribution & Availability

Widespread throughout Eastern USA. Widely available in a full range of standard lumber thicknesses. Excellent availability as lumber and veneer. Tulipwood is one of the largest trees in the U.S. forest and can produce very wide and long specifications, which are relatively knot free. It represents around 9% of the standing hardwood resource, which ensures continuity and volume supply to export markets.

General Description

The sapwood is creamy white and may be streaked, with the heartwood varying from pale yellowish brown to olive green. The green colour in the heartwood will tend to darken on exposure to UV light and turn brown. The wood has a medium to fine texture and is straight grained. The size of the sapwood and some physical characteristics will vary according to growing regions. The wood has many desirable characteristics and is suitable for a wide variety of important uses. Tulipwood is not a poplar (*Populus*) and has many superior properties. However the tree resembles the shape of the European poplar, hence its name in the USA.

Physical & Mechanical Properties

A medium density wood with low bending, shock resistance, stiffness and compression values, with a medium steam bending classification. Tulipwood is very strong for its weight and is ideal for laminated beams and structures. More detailed strength information is available in the AHEC publication *Structural design in American hardwoods*.

Specific gravity (12% MC)	0.42
Average weight (12% MC)	449 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	9.8%
Modulus of Rupture	69.640 MPa
Modulus of Elasticity	10,894 MPa
Compressive strength (parallel to grain)	38.198 MPa
Hardness	2402 N

Working Properties

A versatile timber that is easy to machine, plane, turn, glue and bore. It dries easily with minimal degrade. It has very good dimensional stability and has little tendency to split when nailed. It takes and holds paint, enamel and stain exceptionally well.

	Poor	Fair	Good	Excellent
Sawing			■	
Planing				■
Drilling			■	
Boring			■	
Turning			■	
Carving			■	
Moulding				■
Nailing			■	
Screwing			■	
Gluing			■	
Finishing				■

Durability

Non-resistant to decay. Heartwood is moderately resistant to preservative treatment, sapwood is permeable. The absorptive properties of tulipwood mean that it is potentially ideal for preservative treatment. Recent research in Europe confirms that tulipwood works effectively with traditional and new preservative treatment methods. For more information visit: www.americanhardwood.org.

Main Uses

Construction, furniture, interior joinery, kitchen cabinets, doors, panelling, mouldings, edged-glued panels, plywood (USA), turning and carving.

End use applications	Main uses
Doors	✓
Flooring	
Furniture	✓
Joinery	✓
Kitchen cabinets	✓
Mouldings and turnings	✓
Veneered panels	✓
Sports goods	
Tool handles	

Other Information

This very available, cost effective and versatile American hardwood is exported around the world and many designers and architects are exploring its exciting natural colour variegation.

Burls and swirls in the grain are a common occurrence and are not considered defects. A heavy purplish-blue mineral colour is limited in the upper lumber grades and unlimited in the Common lumber grades. Because the Common grades are generally stained or painted in finishing, a grey colour is allowed in the wood after surfacing. Tulipwood is becoming more readily available in fixed widths.

Note that tulipwood is widely known as yellow or tulip poplar in the USA.

American black walnut *Juglans nigra*

Other names: Black walnut, American walnut

Distribution & Availability

Throughout Eastern USA, but principal commercial region is the central United States. One of the few American species planted as well as naturally regenerated. Reasonable availability in both lumber and veneer.

General Description

The sapwood of walnut is creamy white, while the heartwood is light brown to dark chocolate brown, occasionally with a purplish cast and darker streaks. Walnut can be supplied steamed, to darken sapwood or left unsteamed. The wood is generally straight grained, but sometimes with wavy or curly grain that produces an attractive and decorative figure. The dark heartwood will lighten in colour as it ages overtime with exposure to UV light.

Physical & Mechanical Properties

Walnut is a tough, hard timber of medium density, with moderate bending and crushing strengths and low stiffness. It has a good steam bending classification.

Specific gravity (12% MC)	0.55
Average weight (12% MC)	609 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	10.2%
Modulus of Rupture	100.667 MPa
Modulus of Elasticity	11,584 MPa
Compressive strength (parallel to grain)	52.264 MPa
Hardness	4492 N

Working Properties

Walnut works easily with hand and machine tools, and nails, screws and glues well. It holds paints and stains very well and can be polished to an exceptional finish. It performs best when dried slowly, reducing the opportunity for degrade. Walnut has good dimensional stability.

	Poor	Fair	Good	Excellent
Sawing			■	
Planing				■
Drilling			■	
Boring			■	
Turning				■
Carving			■	
Moulding				■
Nailing			■	
Screwing			■	
Gluing			■	
Finishing				■

Durability

Rated as very resistant to heartwood decay, it is one of the most durable woods even under conditions favourable to decay.

Main Uses

Furniture, cabinet making, architectural interiors, high class joinery, doors, flooring, gunstocks and panelling. A favoured wood for using in contrast with lighter coloured timbers.

End use applications	Main uses
Doors	✓
Flooring	✓
Furniture	✓
Joinery	✓
Kitchen cabinets	✓
Mouldings and turnings	✓
Veneered panels	✓
Sports goods	
Tool handles	

Other Information

The NHLA grades have been altered for this species because of availability and nature of the timber growth (around 1% of the standing forest resource). The FAS lumber grade allows a 5 inch minimum width and 6 foot minimum length. When steamed, the sapwood, which is not considered a defect, will turn a darker colour to assist blending in the finishing process and is admitted without limit. Discuss with your supplier for more information.

American aspen *Populus tremuloides*

Other names: White poplar, popple

Distribution & Availability

Aspen is a true poplar and is harvested commercially in the North Eastern USA. Limited availability of volume lumber and veneer in a full range of sizes and grades.

General Description

Sapwood is white, blending into the light brown heartwood. The contrast between sap and heartwood is small. The wood has a fine uniform texture and is straight grained.

Physical & Mechanical Properties

The wood is light and soft, with low bending strength and stiffness, and medium shock resistance. It has a very low bending classification.

Specific gravity (12% MC)	0.38
Average weight (12% MC)	417 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	9.2%
Modulus of Rupture	57.918 MPa
Modulus of Elasticity	8,136 MPa
Compressive strength (parallel to grain)	29.304 MPa
Hardness	1557 N

Working Properties

Aspen does not split when nailed, it machines easily with a slightly fuzzy surface, and turns, bores, and sands well. It takes paint and stain well to produce a good finish, although care is required where the surface is fuzzy. It has low to moderate shrinkage and good dimensional stability. As a true poplar aspen has similar characteristics and properties to American cottonwood and European poplar.

Durability

Non-resistant to heartwood decay, and extremely resistant to preservative treatment.

Main Uses

Furniture parts (drawer sides), doors, mouldings, picture frames, interior joinery, toys, kitchen utensils. Matchsticks (USA). Important specialised uses include sauna laths because of lack of taste and odour.

Other Information

Regionally referred to as popple and is not to be confused with American tulipwood *(Liriodendron tulipifera)*, which is also known in the USA as yellow poplar. Light brown mineral streaks are naturally occurring and are not considered a defect.

American basswood *Tilia americana*

Other names: Linden

Distribution & Availability

Eastern USA, principally the Northern and Lake States, where there is reasonable availability as lumber and veneer. Lumber is produced in a range of thicknesses, specifications and grades, although volumes may be limited.

General Description

The sapwood of basswood is usually quite large and creamy white in colour, merging into the heartwood, which is pale to reddish brown, sometimes with darker streaks. The wood has a fine uniform texture and indistinct grain that is straight.

Physical & Mechanical Properties

The wood is light and soft with generally low strength properties and a poor steam bending classification.

Specific gravity (12% MC)	0.37
Average weight (12% MC)	417 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	12.6%
Modulus of Rupture	59.987 MPa
Modulus of Elasticity	10,067 MPa
Compressive strength (parallel to grain)	32.613 MPa
Hardness	1824 N

Working Properties

Basswood machines well and is easy to work with hand tools making it a premier carving wood. It nails, screws, and glues fairly well and can be sanded, stained, and polished to a good smooth finish. It dries fairly rapidly with little distortion or degrade. It has a fairly large shrinkage but good dimensional stability when dry.

Durability

Non-resistant to heartwood decay but the wood is permeable, so it can be suitable for preservative treatment.

Main Uses

Carving, turning, furniture, pattern-making, mouldings, interior joinery and musical instruments. An important specialised use is Venetian blinds or internal window shutters.

Other Information

Often produced in 9/4 (57.15mm) thickness for venetian blinds. Pin knots and light brown mineral streaks are a natural characteristic and not considered a defect.

American beech *Fagus grandifolia*

Other names:

Distribution & Availability

Grows throughout Eastern USA, although commercial concentration is in the Central and Middle Atlantic States. Production volumes of higher lumber grades and thicker stock may be limited.

General Description

The sapwood of American beech is white with a red tinge, while the heartwood is light to dark reddish brown. American beech tends to be slightly darker and less consistent than European beech. The wood is generally straight grained with a close uniform texture.

Physical & Mechanical Properties

American beech wood is classed as heavy, hard, and reasonably strong, high in resistance to shock and very suitable for steam bending.

Specific gravity (12% MC)	0.64
Average weight (12% MC)	741 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	13.0%
Modulus of Rupture	102.736MPa
Modulus of Elasticity	11,859 MPa
Compressive strength (parallel to grain)	50.334 MPa
Hardness	5782 N

Working Properties

American beech works readily with most hand and machine tools. It has good nailing and gluing properties and can be stained and polished to a good finish. The wood dries fairly rapidly but with a strong tendency to warp, split and surface check. It is subject to a large shrinkage and moderate movement in performance.

Durability

Rated as non-resistant to heartwood decay, but permeable for preservative treatment.

Main Uses

Furniture, doors, flooring, internal joinery, panelling, brush handles and turning. It is particularly suitable for food containers as there is no odour or taste.

Other Information

Occasional brown streaks of mineral can be found in the heartwood and are not considered a defect. Commercially, production of beech is not on the scale of European production but there are U.S. companies specialising in steaming and export.

American yellow birch *Betula alleghaniensis*

Other names:

Distribution & Availability

Eastern USA, principally Northern and Lake States. Reasonable availability, but more limited if selected for colour, i.e. red birch (heartwood) or white birch (sapwood). Increasingly found in export markets, although volumes produced may limit sizes and grades available.

General Description

Yellow birch has a white sapwood and light reddish brown heartwood. The wood is generally straight grained with a fine uniform texture.

Physical & Mechanical Properties

The wood of yellow birch is heavy, hard and strong. It has very good wood bending properties, with good crushing strength and shock resistance.

Specific gravity (12% MC)	0.62
Average weight (12% MC)	689 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	13.4%
Modulus of Rupture	114.457 MPa
Modulus of Elasticity	13,859 MPa
Compressive strength (parallel to grain)	56.332 MPa
Hardness	5604 N

Working Properties

The wood works fairly easily, glues well with care, takes stain and polish extremely well, and nails and screws satisfactorily where pre-boring is advised. It dries rather slowly with little degrade, but it has moderately high shrinkage, so can be susceptible to movement in performance.

Durability

Non-resistant to heartwood decay. Moderately resistant to preservative treatment but sapwood is permeable.

Main Uses

Furniture, internal joinery and panelling, doors, flooring, kitchen cabinets, turning and toys.

Other Information

Often sorted for sap (sapwood) or red (heartwood). When sorted for colour, the FAS grade will allow a 5 inch minimum width. Refer to the NHLA's *Rules for the Measurement & Inspection of Hardwood & Cypress* for colour sorting specifications. Paper birch is a much softer textured birch species, which is lighter in colour, with scattered brown flecks and should not be confused with yellow birch.

American cottonwood *Populus deltoides*

Other names: Eastern cottonwood, Eastern poplar, Carolina poplar

Distribution & Availability

Cottonwood is a true poplar and grows commercially in the Central and Southern States, where it is widely available in lumber and veneer. This species may be limited in some export markets where demand is low.

General Description

The sapwood is white and may contain brown streaks while the heartwood may be pale to light brown. It is a diffuse porous timber with a coarse texture. The wood is generally straight grained and contains relatively few defects. As a true poplar cottonwood has similar characteristics and properties to American aspen and European poplar.

Physical & Mechanical Properties

Cottonwood is relatively light in weight. The wood is soft, and weak in bending and compression, and low in shock resistance. It has no odour or taste when dry.

Specific gravity (12% MC)	0.40
Average weight (12% MC)	449 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	11.3%
Modulus of Rupture	58.608 MPa
Modulus of Elasticity	9,466 MPa
Compressive strength (parallel to grain)	33.854 MPa
Hardness	1913 N

Working Properties

General machinability is fair, although tension wood is frequently present and can cause a fuzzy surface when cut, if machine blades are not very sharp or set at correct angles, which in turn will require additional care when finishing. The wood glues well and has good resistance to splitting when nailing and screwing. It dries easily but may still have a tendency to warp, with small movement in performance.

Durability

Non-resistant to decay.

Main Uses

Furniture, furniture parts, interior joinery and mouldings, toys and kitchen utensils. A specialised use in America is Venetian blinds and shutters. Some export markets in Asia and Europe, especially Italy, use this cost effective, light coloured species for dark staining in reproduction furniture.

Other Information

Occasionally referred to as white poplar and is not to be confused with American tulipwood which is known as yellow poplar in the USA. Sometimes sawn into 9/4 (57.15mm) thickness for Venetian blinds.

American red elm *Ulmus rubra*

Other names: Slippery elm, brown elm, grey elm

Distribution & Availability

The Eastern to Midwest USA. Limited availability in both lumber and veneer, due to the impact of Dutch elm disease[1]. Elm is now regenerating better in some regions and is still exported, but in relatively small volumes, therefore some grade qualities and specifications may be limited.

General Description

Red elm has a greyish white to light brown narrow sapwood, with heartwood that is reddish brown to dark brown in colour. The grain can be straight, but is often interlocked. The wood has a coarse texture.

Physical & Mechanical Properties

Elm is moderately heavy, hard and stiff with excellent bending and shock resistance. It is difficult to split because of its interlocked grain.

Specific gravity (12% MC)	0.53
Average weight (12% MC)	593 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	11.0%
Modulus of Rupture	89.635 MPa
Modulus of Elasticity	10,274 MPa
Compressive strength (parallel to grain)	43.852 MPa
Hardness	3825 N

Working Properties

The wood of red elm is fairly easy to work; it nails, screws and glues well and can be sanded, stained and polished to a good finish. It dries well with minimal degrade and little movement in performance.

Durability

Rated as non-resistant to heartwood decay, and classed as permeable to preservatives.

Main Uses

Furniture, cabinet making, flooring, internal joinery and panelling.

Other Information

Bird pecks are a natural characteristic in all the elm species and are not considered a defect when grading lumber to the NHLA standard.

[1]a fungal disease, which is spread by the elm bark beetle. Although believed to be originally native to Asia, the disease was accidentally introduced into America and Europe in the 1920s, where it has devastated native populations of elms which have not had the opportunity to evolve resistance to the disease

American gum *Liquidambar styraciflua*

Other names: redgum, sapgum, sweetgum

Distribution & Availability

The gums are an important part of the Eastern hardwood forests, and are found throughout the South Eastern USA. Excellent availability as lumber and veneer in a wide range of grades and specifications. When sorted for colour, redgum (majority heartwood) is more limited in its availability.

General Description

The sapwood of American gum tends to be wide and is white to light pink, while the heartwood is reddish brown, often with darker streaks. The wood has irregular grain, usually interlocked, which produces an attractive grain figure. It has a fine uniform texture.

Physical & Mechanical Properties

American gum is moderately hard, stiff and heavy and has a low steam bending classification.

Specific gravity (12% MC)	0.52
Average weight (12% MC)	545 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	12.0%
Modulus of Rupture	86.188 MPa
Modulus of Elasticity	11,308 MPa
Compressive strength (parallel to grain)	43.576 MPa
Hardness	3781 N

Working Properties

The wood is easy to work, with both hand and machine tools. It nails, screws and glues well, takes stain easily and can be sanded and polished to an excellent finish. It dries rapidly with a strong tendency to warp and twist. It has a large shrinkage, and is liable to movement in performance.

Durability

Rated as non-resistant to heartwood decay. The heartwood is moderately resistant to preservative treatment, but the sapwood is permeable.

Main Uses

Cabinet making, furniture parts, doors, internal joinery, strips and mouldings. Used in some export markets with stained finishes as a walnut or mahogany substitute.

Other Information

Lumber is often sold as sapgum and no colour specification is required. According to the NHLA grading standards, when sold as redgum, each clear cutting is required to have one red (heartwood) face.

American hackberry *Celtis occidentalis*

Other names: Common hackberry, sugarberry

Distribution & Availability

Throughout Eastern USA, although not available in large commercial volumes. There is some export of lumber, mainly in thinner stock and availability of higher grades may be limited.

General Description

Hackberry is closely related to sugarberry *(Celtis laevigata)* and is a member of the elm family. There is little difference between sapwood and heartwood, which is yellowish grey to light brown with yellow streaks. The wood has irregular grain, occasionally straight and sometimes interlocked, with a fine uniform texture.

Physical & Mechanical Properties

Hackberry is moderately hard, heavy and has medium bending strength, high shock resistance but is low in stiffness. It has a good steam bending classification.

Specific gravity (12% MC)	0.53
Average weight (12% MC)	593 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	13.5%
Modulus of Rupture	76.535 MPa
Modulus of Elasticity	8,205 MPa
Compressive strength (parallel to grain)	37.509 MPa
Hardness	3914 N

Working Properties

The wood planes and turns well and is intermediate in its ability to hold nails and screws, and stains and polishes satisfactorily. Hackberry dries readily with minimal degrade. It has a fairly high shrinkage and may be susceptible to movement in performance.

Durability

Non-resistant to heartwood decay. The heartwood is moderately resistant to preservative treatment, but the sapwood is permeable.

Main Uses

Furniture and kitchen cabinets, joinery, doors and mouldings.

Other Information

Sometimes referred to as sugarberry and used as an ash substitute. Can be susceptible to blue stain before and after kilning, so lumber purchased in USA will tend to be surfaced (planed).

American hickory & pecan *Carya* spp.

Other names:

Distribution & Availability

Eastern USA, principal commercial areas are the Central and Southern states. Readily available, but more limited if sold selected for colour as either red or white hickory or pecan. For export, lumber may be limited in the higher grades and available mainly in thinner stock.

General Description

The hickories are an important group within the eastern hardwood forests. Botanically, they are split into two groups; the true hickories, and the pecan hickories (fruit bearing). The wood is virtually the same for both and is usually sold together. The sapwood of hickory and pecan is white, tinged with brown while the heartwood is pale to reddish brown. Both are coarse textured and the grain is usually straight but can be wavy or irregular.

Physical & Mechanical Properties

The density and strength of the hickories will vary according to the rate of growth, with the true hickories generally showing higher values than the pecan hickories. The wood is well known for its very good strength and shock resistance and it also has excellent steam bending properties.

	Hickory *(Carya glabra)*	Pecan *(Carya illinoinensis* or *illinoensis*)
Specific gravity (12% MC)	0.75	0.66
Average weight (12% MC)	833 Kg/m^3	737 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	14.3%	N/A
Modulus of Rupture	138.590 MPa	94.462 MPa
Modulus of Elasticity	15,583 MPa	11,928 MPa
Compressive strength (parallel to grain)	63.365 MPa	54.126 MPa
Hardness	N/A	8095 N

Working Properties

The hickories are considered difficult to machine and glue, and are very hard to work with hand tools, so care is needed. They hold nails and screws well, but there is a tendency to split so pre-boring is advised. The wood can be sanded and polished to a good finish. It can be difficult to dry and has a large shrinkage, which may affect stability under variable moisture conditions.

Durability

Rated as non-resistant to heartwood decay. The wood is classed as resistant to preservative treatment.

Main Uses

Tool handles, furniture, cabinetry, flooring, wooden ladders, dowels and sporting goods. Hickory is increasingly being exported for flooring, for its attractive rustic look and hardwearing properties.

Other information

Typically referred to as hickory in the North and pecan in the South of the USA. Bird pecks are a common characteristic and are not considered as defects. Deep purple mineral streaks are also a natural characteristic and are not considered as defects. The FAS lumber grade permits a minimum width of 4 inches (101.6mm).

American sycamore *Platanus occidentalis*

Other names: Buttonwood, American plane

Distribution & Availability

Throughout the Eastern USA. Reasonable availability in a range of specifications and grades in lumber and veneer, although availability in export markets may vary and be quite limited where demand or interest is low.

General Description

The sapwood of sycamore is white to light yellow, while the heartwood is light to dark brown. The wood has a fine close texture with interlocked grain. It is not related in any way to European sycamore *(Acer pseudoplatanus)*, but it has the same family classification, and similar characteristics to European plane *(Platanus orientalis)*. Contrasts well with other species.

Physical & Mechanical Properties

The wood is classified as moderate in weight, hardness, stiffness and shock resistance. It turns well on the lathe and has good bending qualities.

Specific gravity (12% MC)	0.49
Average weight (12% MC)	545 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	11.4%
Modulus of Rupture	68.950 MPa
Modulus of Elasticity	9,791 MPa
Compressive strength (parallel to grain)	37.095 MPa
Hardness	3425 N

Working Properties

The wood machines well, but high speed cutters are needed to prevent chipping. It is resistant to splitting, due to the interlocked grain. The wood glues well and stains and polishes, with care, to an excellent finish. It dries fairly rapidly, with a tendency to warp. It has moderate shrinkage and little movement in performance.

Durability

Rated as non-resistant to heartwood decay, but is permeable to preservative treatment.

Main Uses

Furniture, furniture parts (drawer sides), internal joinery, panelling and mouldings, kitchen ware, butchers blocks and veneered panels.

Other Information

In some export regions, such as Europe, sycamore refers to a specific “maple” looking wood species, which can cause confusion. American sycamore produces the same wood as European plane with its distinct grain pattern, but is probably more commercially available and, therefore, has the potential to be more widely used.

American willow *Salix* spp.

Other names: Black willow, swamp willow

Distribution & Availability

Eastern USA. Principal commercial areas are the Middle and Southern States, along the Mississippi river. Reasonable availability on a regional basis as lumber and veneer, although availability in exports markets may vary and may be restricted to certain grades and thinner stock.

General Description

The sapwood of willow varies according to growing conditions and is light creamy brown in colour. In contrast, the heartwood is pale reddish brown to greyish brown. The wood has a fine even texture and, although generally straight grained, it can sometimes be interlocked, or display figure.

Physical & Mechanical Properties

The wood is weak in bending, compression, shock resistance and stiffness, with a poor steam bending classification.

Specific gravity (12% MC)	0.39
Average weight (12% MC)	417 Kg/m^3
Average volumetric shrinkage (Green to 6% MC)	11.5%
Modulus of Rupture	53.800 MPa
Modulus of Elasticity	6,960 MPa
Compressive strength (parallel to grain)	28.300 MPa
Hardness	N/A

Working Properties

Willow works fairly easily with hand and machine tools, but care is needed to avoid a fuzzy surface when interlocked grain is present. The wood nails and screws well, glues excellently, and can be sanded and polished to a very good finish. It dries fairly rapidly with minimal degrade, although may be susceptible to moisture pockets. Dimensional stability is good when dry.

Durability

Non-resistant to hardwood decay. The heartwood is resistant to preservative treatment and the sapwood is permeable.

Main Uses

Furniture, joinery, interior mouldings, panelling, doors, sports equipment, kitchen utensils and toys. In some European markets, such as Italy, willow is increasingly used with a stain to reproduce the lighter tones of European walnut.

Other Information

Burls and swirls in the grain are a natural characteristic and are not considered defects.

Other Species

The eastern forests of the United States also include a wide variety of hardwood species which are less available for commercial purposes, and produced in small volumes of sawn lumber on a regional basis. Due to location and end use, a few softwood species are also produced by the hardwood sawmilling industry. The following table includes eight of the better known species in these categories.

Name	General description & regional availability
Hardwoods	
White birch *Betula papyrifera*	Soft, yet moderately heavy, white wood with characteristic brown flecks. It is used for furniture parts, floors, and Oriented Strand Board (OSB). Regional availability: Northern
Butternut White walnut *Juglans cinerea*	From the walnut family, light creamy brown with a walnut grain pattern. Light in weight and takes polish well. Butternut is highly rot resistant, but is much softer than black walnut. It is used to make furniture, and is a favourite of woodcarvers. Butternut is threatened by an introduced fungus that has already reduced its availability in certain areas. Regional availability: Northern and Appalachian
Pacific coast maple Big leaf maple *Acer macrophyllum*	Botanically in the soft maple group of species, its off-white colour tends to be a little darker than the eastern maples and more consistent. This is due to its confinement to an isolated growing region in the Pacific Northwest. Used for a wide range of joinery and furniture applications. Regional availability: Northwest
Sassafras *Sassafras albidum*	A family of its own, sassafras heartwood is pale brown to orange brown, resembling ash or chestnut. The narrow sapwood is yellowish white. The wood has a coarse texture and is generally straight grained. Well known as an aromatic species. Used for furniture and joinery but rarely exported as lumber due to very limited availability. Regional availability: Central
Tupelo Black gum *Nyssa sylvatica*	From the gum family, pale yellow colour with white sapwood. The wood is hard and cross-grained. It is suitable for turning, children's toys and internal furniture parts. Regional availability: Southern
Softwoods	
Aromatic red cedar Eastern red cedar *Juniperus virginiana*	Soft, fine-grained and fragrant heartwood with pink, red and brown tones. The wood is very light and it repels moths so is often used for wardrobes and drawer linings. Regional availability: Central
Cypress Bald cypress *Taxodium distichum*	Sapwood is narrow and off-white whereas the heartwood varies widely, ranging from light yellowish brown to dark brownish red. The wood is moderately heavy, strong, and hard. Good natural durability and therefore can be used for exterior decking, cladding and garden furniture. Cypress is included within the NHLA grading standards for hardwood. Regional availability: Southern
Eastern white pine *Pinus strobus*	White pine has a creamy straw colour but will darken with age to a deep rich tan. The wood is soft and easy to cut and used for panelling, floors and furniture. Regional availability: Northern and Appalachian

Comparative Tables

For direct comparison, physical, mechanical and working properties are shown in the following tables:

Physical & Mechanical Properties

	Specific gravity (12% MC)	Average weight (12% MC), Kg/m³	Average volumetric shrinkage (Green to 6% MC), %	Modulus of Rupture MPa	Modulus of Elasticity, MPa	Compressive strength (parallel to grain), MP	Hardness, N
Alder	0.41	449	10.1%	67.571	9515	40.129	2624
Ash	0.60	673	6.2	103.425	11,997	51.092	5871
Aspen	0.38	417	9.2	57.918	8,136	29.304	1557
Basswood	0.37	417	12.6	59.987	10,067	32.613	1824
Beech	0.64	741	13.0	102.736	11,859	50.334	5782
Birch	0.62	689	13.4	114.457	13,859	56.332	5604
Cherry	0.50	561	9.2	84.809	10,274	49.023	4226
Cottonwood	0.40	449	11.3	58.608	9,466	33.854	1913
Elm	0.53	593	11.0	89.635	10,274	43.852	3825
Gum	0.52	545	12.0	86.188	11,308	43.576	3781
Hackberry	0.53	593	13.5	76.535	8,205	37.509	3914
Hickory	0.75	833	14.3	138.590	15,583	63.365	N/A
Pecan	0.66	737	N/A	94.462	11,928	54.126	8095
Hard maple	0.63	705	11.9	108.941	12,618	53.988	6450
Soft maple							
Acer rubrum	0.49	801	10.5	92.393	11,308	45.093	4225
Acer macrophyllum	0.44	753	9.3	73.777	9,998	41.025	3780
Red oak							
Quercus rubra	0.63	705	6.6	98.599	12,549	46.610	5738
Quercus falcata	0.68	753	N/A	75.156	10,274	41.991	4715
White oak	0.68	769	12.6	104.804	12,273	44.955	6049
Sycamore	0.49	545	11.4	68.950	9,791	37.095	3425
Tulipwood	0.42	449	9.8	69.640	10,894	38.198	2402
Walnut	0.55	609	10.2	100.677	11,584	52.264	4492
Willow	0.39	417	11.5	53.800	6,960	28.300	N/A

Working Properties

	Sawing	Planing	Drilling	Boring	Turning	Carving	Moulding	Nailing	Screwing	Gluing	Finishing
Alder	Good	Good	Good	Good	Excellent	Good	Good	Good	Good	Good	Excellent
Ash	Good	Good	Good	Good	Excellent	Good	Good	Good	Good	Good	Excellent
Aspen	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good
Basswood	Good	Good	Good	Good	Good	Excellent	Good	Fair	Fair	Fair	Excellent
Beech	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good
Birch	Good	Good	Good	Good	Good	Good	Good	Fair	Fair	Good	Excellent
Cherry	Good	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Good	Good	Good	Excellent
Cottonwood	Fair	Fair	Fair	Good	Good	Good	Good	Good	Good	Good	Good
Elm	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Excellent
Gum	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Excellent
Hackberry	Good	Good	Good	Good	Good	Good	Good	Fair	Fair	Good	Good
Hickory & Pecan	Fair	Good	Fair	Good	Good	Fair	Fair	Good	Good	Fair	Excellent
Hard maple	Excellent	Good	Good	Excellent	Excellent	Good	Good	Fair	Fair	Good	Excellent
Soft maple	Excellent	Excellent	Good	Excellent	Good	Good	Good	Good	Good	Good	Excellent
Red oak	Good	Excellent	Excellent	Good	Good	Good	Excellent	Good	Good	Good	Excellent
White oak	Good	Good	Excellent	Good	Good	Good	Good	Good	Good	Good	Excellent
Sycamore	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Excellent
Tulipwood	Good	Excellent	Good	Good	Good	Good	Excellent	Good	Good	Good	Excellent
Walnut	Good	Excellent	Good	Good	Excellent	Good	Excellent	Good	Good	Good	Excellent
Willow	Good	Good	Good	Good	Good	Good	Good	Good	Good	Excellent	Excellent

End Use Applications

Species	Doors	Flooring	Furniture	Joinery	Kitchen cabinets	Mouldings and turnings	Veneered panels	Sports goods	Tool handles
Alder	✓		✓	✓	✓	✓			
Ash	✓	✓	✓	✓	✓	✓	✓	✓	✓
Aspen	✓		✓	✓		✓	✓		
Basswood			✓	✓	✓	✓	✓		
Beech	✓	✓	✓	✓	✓	✓	✓		✓
Birch	✓	✓	✓	✓	✓	✓			
Cherry	✓	✓	✓	✓	✓	✓	✓		
Cottonwood	✓		✓	✓		✓	✓		
Elm	✓	✓	✓	✓	✓	✓	✓		
Gum	✓		✓	✓	✓	✓	✓		
Hackberry	✓	✓	✓	✓	✓	✓	✓		
Hickory & Pecan		✓	✓	✓	✓			✓	✓
Hard maple	✓	✓	✓	✓	✓	✓	✓	✓	✓
Soft maple	✓	✓	✓	✓	✓	✓	✓		
Red oak	✓	✓	✓	✓	✓	✓	✓		✓
White oak	✓	✓	✓	✓	✓	✓	✓		✓
Sycamore	✓		✓	✓	✓	✓	✓		
Tulipwood	✓		✓	✓	✓	✓	✓		
Walnut	✓	✓	✓	✓	✓	✓	✓		
Willow	✓		✓	✓	✓	✓	✓	✓	

Glossary of terms

Checks: Longitudinal separation of the fibres in wood that do not go through the whole cross section. Checks result from tension stresses during the drying process.

Compressive Strength: The ability to resist a force tending to shorten a structural member by crushing the fibres longitudinally.

Decay: The decomposition of wood substance by fungi (other terms: rot, dote)

Density: Weight per unit volume. Density of wood is varied by rate of growth, percentage of late wood and in individual pieces, the proportion of the heartwood.

Dimensional Stability: A term that describes whether a section of wood will resist changes in volume with variation in moisture content (other term: movement in performance).

Durability: The resistance of wood to attack by decay fungi, insects and marine borers.

FAS: Highest quality NHLA grade

Figure: The pattern produced in a wood surface by annual growth rings, rays, knots, deviations from regular grain, such as interlocked and wavy, and irregular colouration.

Grain: The direction, size, arrangement, appearance, or quality of the fibres in sawn wood. Straight grain is used to describe lumber where the fibres and other longitudinal elements run parallel to the axis of the piece.

Gum Pocket: An excessive local accumulation of resin or gum in the wood.

Hardness: The resistance of the wood against indentation and abrasion. Values are given in Newtons (N) and are a measure of the load required to embed an 11.3mm steel ball to one half its diameter in the wood.

Hardwood: A description applied to woods from deciduous and evergreen broadleaved trees (Angiosperms). The term has no reference to the actual hardness of the wood.

Heartwood: The inner layers of wood in growing trees that have ceased to contain living cells. Heartwood is generally darker than sapwood, but the two are not always clearly differentiated.

Kilning: The process of drying lumber artificially under scientifically controlled conditions. Kilns are the chambers used for this process.

Modulus of Elasticity: An imaginary stress necessary to stretch a piece of material to twice its length or compress it to half its length. Values for the individual species are given in megapascals (MPa – equivalent to N/mm^2), and are based on testing small clear pieces of dry wood.

Modulus of Rupture: The equivalent fibre stress at maximum load. A constant used in structural design and obtained by loading pieces of wood to destruction.

Moisture Content (MC): The weight of water contained in wood expressed as a percentage of the weight of the oven dry wood.

NHLA: National Hardwood Lumber Association

Pith Flecks: Pith-like irregular discoloured streaks of tissue in wood, due to insect attack on the growing tree.

Sapwood: The outer zone of wood in a tree, next to the bark. Sapwood is generally lighter than heartwood, and lacks resistance to decay.

Shrinkage: The contraction of wood fibres caused by drying below the fibre saturation point (usually around 25-27% MC). Values are expressed as a percentage of the dimension of the wood when green.

Specific Gravity: The relative weight of a substance compared with that of an equal volume of water. SG values given are based on wood volume at 12% MC and oven dry weight.

Split: Separation of the fibres in a piece of wood from face to face (other term: end-split).

Stain: A variation from the natural colour of the wood or a discolouration that may be caused by microorganisms, metal or chemicals. The term also applies to materials used to impart colour to wood.

Surfaced: The American term to describe lumber that has been planed.

Tensile Strength: The ability to resist a force acting on a member and tending to lengthen the member or pull the fibres apart lengthwise.

Texture: Determined by relative size and distribution of the wood elements. Described as coarse (large elements), fine (small elements), or even (uniform size of elements).

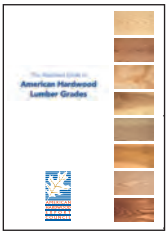
Warp: Distortion in lumber causing departure from its original plane, usually developed during drying. Warp includes cup, bow, crook and twist.

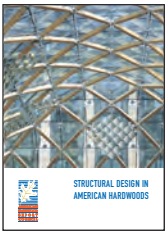
Weight: The weight of dry wood depends upon the cellular space, i.e. the proportion of wood substance to air space. Values are given for each species in Kg/m^3 at 12% MC.

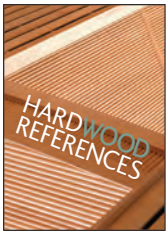
Contacts & Further Information

The American Hardwood Export Council (AHEC) is the leading international trade association of the U.S. hardwood industry, representing the committed exporters of U.S. hardwood companies and all the major U.S. hardwood product trade associations. From Washington, DC and five overseas offices, AHEC conducts a worldwide promotion programme with activities in more than 35 countries. AHEC offices in London, Osaka, Hong Kong, Mexico City and Shanghai are strategically located near key hardwood markets. AHEC's policy is to develop worldwide markets for all species and thereby balance exports with what is growing in the forest, now and in the future.

For office contact details and further detailed technical information on American hardwood species, products, grading & applications, please visit www.americanhardwood.org, where you can also download or order free hard copies of the following publications:







Other Technical Contacts

American Walnut Manufacturers Association (AWMA)
www.walnutassociation.org

Appalachian Hardwood Manufacturers, Inc. (AHMI)
www.appalachianwood.org

Hardwood Manufacturers Association (HMA)
www.hardwoodinfo.com

Hardwood Plywood & Veneer Association (HPVA)
www.hpva.org

National Hardwood Lumber Association (NHLA)
www.nhla.com

National Wood Flooring Association (NWFA)
www.woodfloors.org

Wood Component Manufacturers Association (WCMA)
www.woodcomponents.org

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