



Paulownia's Potential Within The Lumber Market

World Tree presents:

**A brief overview of the global lumber market
and Paulownia's potential**



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01. Introduction

Projections for Future Opportunities



Image by World Tree: Paulownia harvest in Georgia, USA

World Tree is an agroforestry company focused on managing Paulownia-based tree farms. World Tree's farms are focused on the cultivation of Paulownia because of its fast growth rate and the high-quality lumber the tree produces. Paulownia is one of the top three species of trees grown in China but it is relatively new to the Americas. World Tree aims to change that through its expanding network of Paulownia-based farms in North and Latin America.

For investors who are new to investing in the lumber market and new to Paulownia, the following research is intended to provide you with an overview of the global lumber market and Paulownia's position within it. We walk you through the drivers of supply and demand for lumber from global population and income growth to the environmental necessity to reduce carbon emissions and forest

loss. We then discuss the global wood market characteristics from roundwood to sawlogs and veneer logs to sawnwood for both softwood and hardwood.

We then provide an in-depth description of Paulownia. Because the market for Paulownia lumber is in a nascent stage, the report focuses on the anticipated demand for Paulownia as indicated by the demand for comparable species and wood product market segments into which Paulownia may be sold. We start by reviewing the technical specifications of comparable species, wood product segments that lumber is being used for and pricing and then look at the competitive wood product market segments for Paulownia lumber and find that Paulownia is well-positioned to enter and acquire market share within these markets.

02. Overview of the Global Lumber Market

Drivers of Demand and Supply

The lumber market received heightened attention over the last year as COVID-related shortages led to price surges. While most commodity prices were falling due to the pandemic, the price of lumber increased by over 400%.¹ After reaching an all-time high in May 2021, prices have begun to decline as COVID-related supply and demand disruptions have begun to normalize.² Even as prices settle, the forecast demand and supply dynamics project entry into the global lumber market to be an appealing prospect. According to some estimates, global demand for timber products could more than triple over the next three decades.³ The World Wide Fund for Nature (WWF) Living Forests Model anticipates that due to this growth in demand, annual timber removals in 2050 will be 3 times the volume removed in 2010.⁴

Global lumber demand is forecast to grow for a myriad of reasons. One of the main reasons is growing populations and incomes globally, and especially in developing countries. In past decades, increases in wood consumption have matched increases in the global population with global roundwood consumption increasing by more than 50% between 1960 and 2010 (in line with global population growth).⁵ With the global population anticipated to increase by 24% between 2021 and 2050, it follows that lumber demand will also grow rapidly in the coming decades.⁶

Another source of future demand is related to the sustainable nature of wood products (when produced from sustainably managed farms or forests). This is because wood is renewable, recyclable and biodegradable and can be produced with less energy and carbon emissions than artificial materials such as steel and plastic.⁴ Wood products make up 47% of all industrial raw materials manufactured in the US and only consume 4% of the energy required to manufacture those materials.⁷ Most other materials used are far more energy intensive. **Figure 1.0 shows the amount of energy necessary to produce one ton of cement, glass, steel or aluminum in comparison to producing one ton of wood.**⁷ Many wood products also result in a net reduction in carbon when carbon storage is taken into account including framing lumber while other products produce high quantities of carbon (see Figure 2.0). Due to the characteristics of wood, sustainable forestry is likely to play a significant role in sustainable economic development in the coming decades.⁸

FIGURE 1.0⁷

Aluminum	Steel	Glass	Cement
126x more energy	24x more energy	14x more energy	5x more energy

02. Overview of the Global Lumber Market

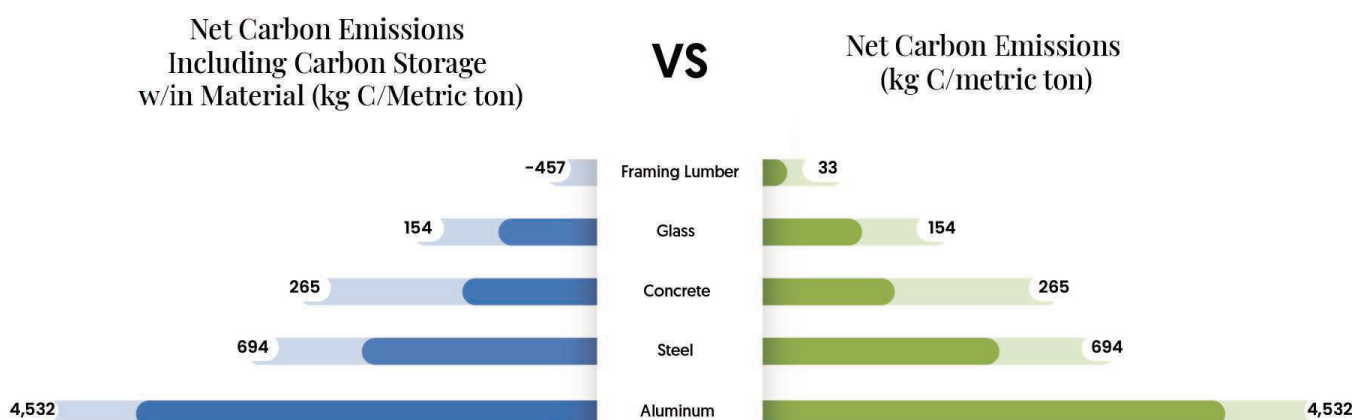
Reducing Carbon Emissions

In the face of growing demand and declining supply, tree farms will likely play a key role in the lumber market in the future.

While demand for lumber is rising, the lumber market is increasingly facing supply shortages due in part to deforestation. According to Food and Agriculture Organization of the United Nations' (FAO) forestry data, an estimated 10M hectares globally are being removed every year, while only 5M hectares are being replanted leading to an overall reduction in 5M hectares of forests annually.⁹ The main driver of deforestation is agricultural expansion but climate change is also leading to a reduction in harvests, especially for certain types of trees.¹⁰ Climate-related risks include higher temperatures, draughts, fires, flooding and other types of extreme weather, as well as invasive pests and pathogens. More than 100M hectares of forests are adversely affected by these types of climate-related

issues.¹⁰ Climate-related supply reductions are likely to become exacerbated over the next few decades. In the face of growing demand and declining supply, tree farms will likely play a key role in the lumber market in the future. Not only will they be necessary to meet market demand, they will also be important for reducing deforestation and degradation especially in old growth forests. Furthermore, when part of an agroforestry system, these farms help support agricultural production, water and air quality, soil health and wildlife habitat and can also create job opportunities.¹¹ Already, tree farms make up a significant portion of the timber market. In 2006, for example, although tree farms made up only 7% of total forest cover, they provided 50% of the industrial roundwood.¹²

FIGURE 2.0⁷



02. Overview of the Global Lumber Market

Combating Deforestation

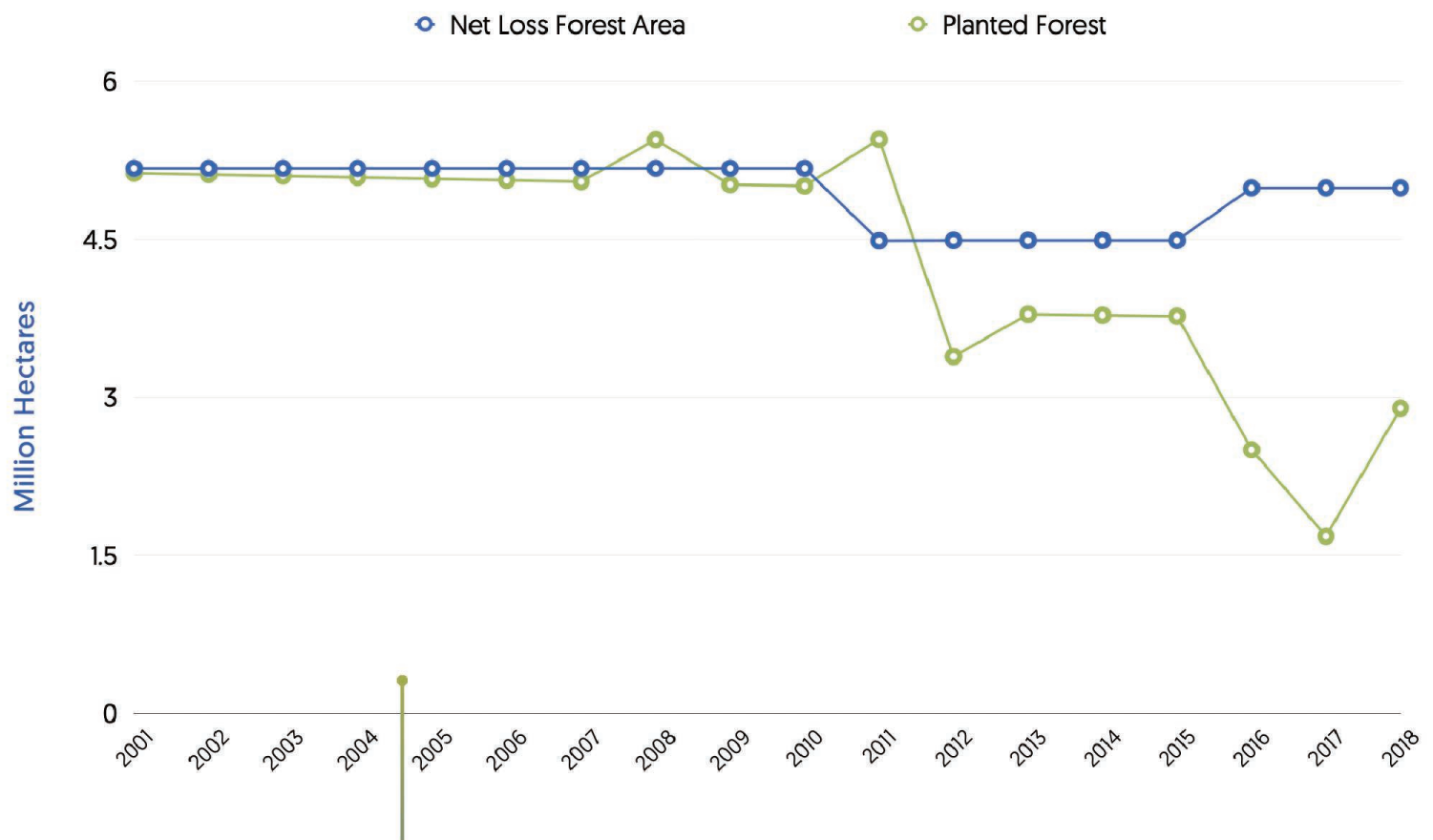


Figure 3.0 shows the net loss in forested area year over year versus the increase year over year in hectares planted.

FIGURE 3.0¹³

The decline in net forested area has averaged about 5M hectares per year since 2000, equating to a net loss of nearly 90M hectares between 2000 and 2018. In that same time, around 78.3M hectares have been planted meaning that closer to 170M gross hectares have been lost.⁹ Planted forests, and specifically sustainably managed tree farms, will continue to play an important role in reducing deforestation and making the lumber market more sustainable.

02. Overview of the Global Lumber Market

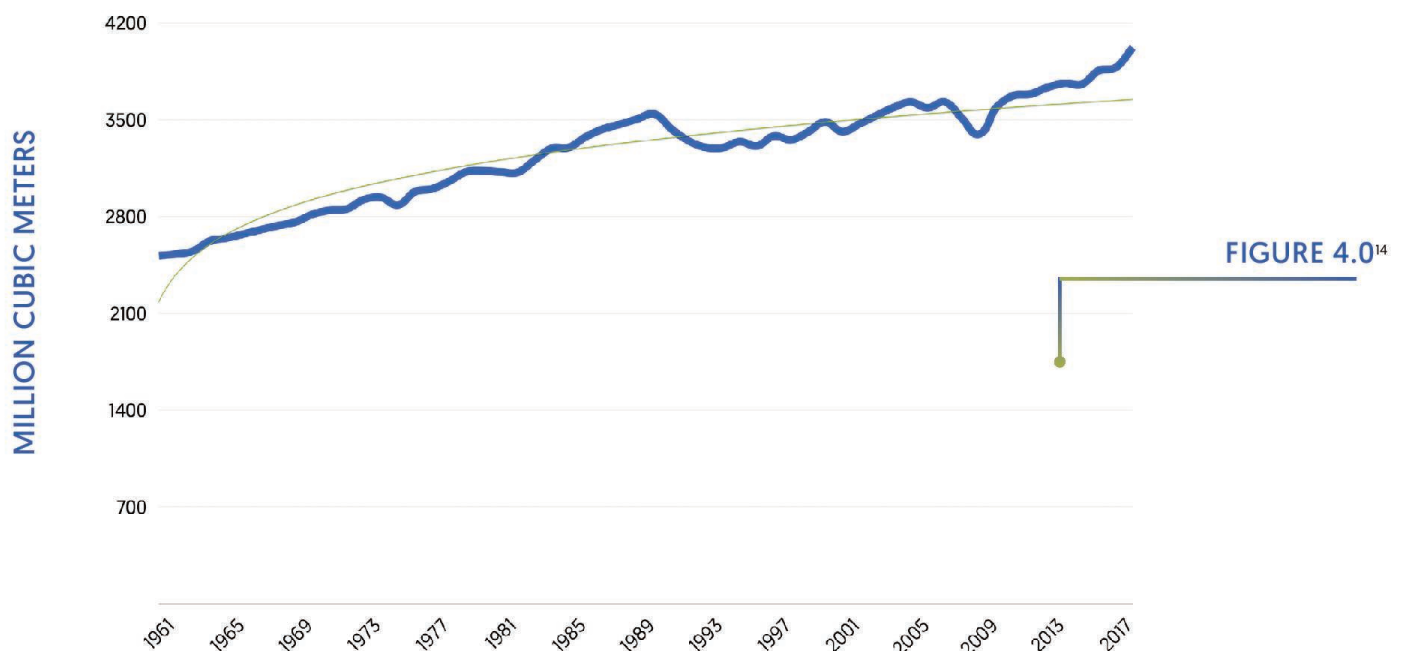
Global Lumber Market Characteristics

According to FAO data, global consumption of roundwood has steadily increased over the last half century with an increase of 17% since 2009.¹⁴ A **Figure 4.0 shows the growth in roundwood consumption since 1961**. During the Global Financial Crisis, roundwood consumption declined over 3% year over year in both 2008 and 2009 but then rebounded in 2010 with consumption growing by 5.6% in that year.¹⁴

As of 2017, the global unfinished wood/lumber manufacturing market was valued at \$223.1B.¹⁵ The global wood products market

was valued at \$624B in 2020 and it is expected to exceed \$866B in 2025, equating to a compound annual growth rate (CAGR) of 7%.¹⁶ In 2020, the Asia Pacific region constituted the largest portion of the market, accounting for 39% while North America represented the second largest portion at 27% or \$169B. South America is expected to witness the highest market growth of close to 6% CAGR due to increased demand in residential construction and home improvement projects. Within the US, the lumber wholesaling market is valued at \$97.8B in 2021 equating to a CAGR of 1.4% in 2021.¹⁷

Figure 4.0 below shows the steady growth in consumption of roundwood over the last half century. The United States was both the largest producer and consumer of roundwood in 2019.



A. Consumption was calculated based on FAOSTAT data using apparent consumption [production plus imports minus exports]

02. Overview of the Global Lumber Market

Roundwood Production

The United States led both production and consumption of roundwood in 2019 while India and China followed close behind.

Roundwood is wood in the rough and therefore includes all wood products (see definitions section). Timber generally refers to wood that has not yet been harvested while lumber refers to processed wood products, especially those commonly used in home construction and other finished wood products.¹⁸ As timber is processed it becomes roundwood. Then, as it is further processed it may be classified as industrial roundwood, sawlogs and veneer logs, sawnwood and then ultimately end use lumber products such as plywood or veneers.

Wood products are often classified according to whether the trees they are sourced from are softwood or hardwood. These terms are not necessarily an indicator of the hardness of the wood itself, but rather whether the wood is obtained from coniferous or deciduous trees. Softwood (coniferous) trees usually have needles or cones while hardwood (deciduous) have leaves. Common softwood tree species used for lumber products include Pine, Cedar, Fir, Redwood and Spruce while common hardwood trees used include Ash, Cherry, Maple, Oak, Walnut, Birch, Poplar and Teak.

FIGURE 5.0¹⁴

2019 Production and Consumption of Roundwood in Million Cubic Meters

Country	Production	Consumption
United States	459	453
India	352	356
China	340	404
Brazil	266	265
Russia	218	202
Canada	145	142
Indonesia	124	125
Ethiopia	116	116
DRC	91	91
Nigeria	77	76

02. Overview of the Global Lumber Market

Sawlog and Veneer Log Production

North America leads in the production of sawlogs and veneer logs with 314M m³ in 2019 (hardwood and softwood combined) or 31% of total production. It produced 38% of all softwood and 18% of all hardwood sawlogs and veneer logs.

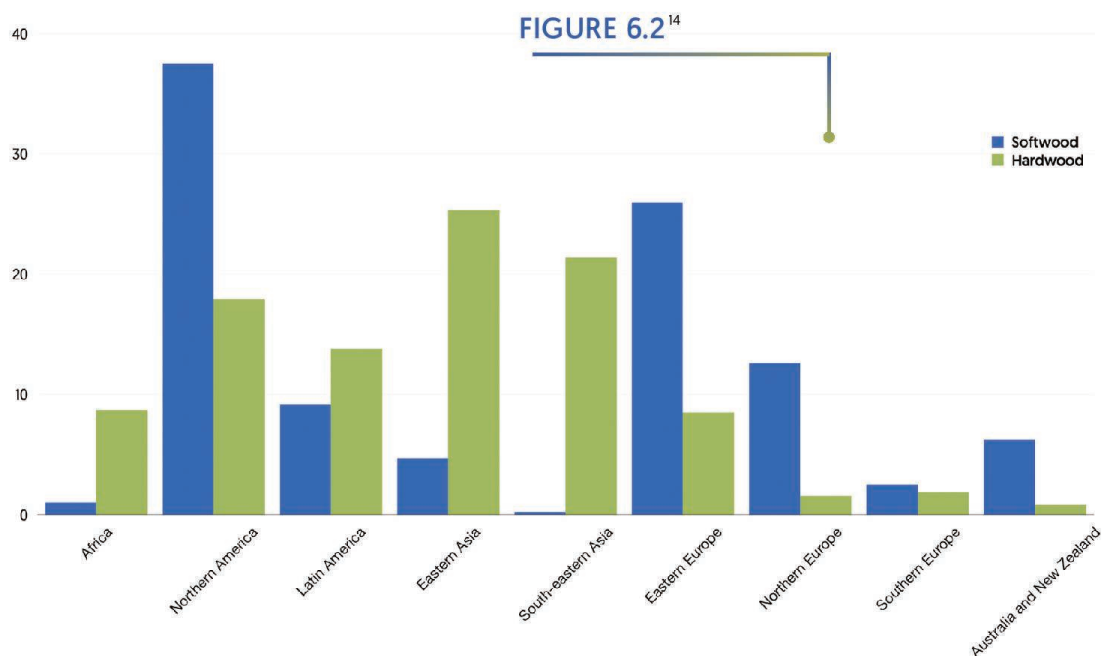


Figure 6.2 shows the 2019 share of global production of sawlogs and veneer logs for each major region by percent. North America leads in the production of sawlogs and veneer logs with 314M m³ in 2019 (hardwood and softwood combined) or 31% of total production. It produced 38% of all softwood and 18% of all hardwood sawlogs and veneer logs. The next highest producers were Eastern Europe with 204M m³ of sawlogs and veneer logs and Eastern Asia with 116M m³. Eastern Asia produces the most hardwood sawlogs and veneer logs, at 84M m³ in 2019.

02. Overview of the Global Lumber Market

Sawnwood Production

North America was the largest producer of softwood and second largest producer of hardwood sawnwood in 2019.

The lumber produced from softwood and hardwood trees differs as softwood is often lighter and has a lower density than hardwood. There is a larger supply of softwood trees and most processed lumber is softwood. In 2019, for example, on a global level, 72% (or 352M m3) of sawnwood production came from softwood trees.¹⁴ Hardwood lumber is generally higher density and more durable. It is commonly used in furniture-making, flooring, cabinetry and other uses where durability and longevity are important.¹⁹

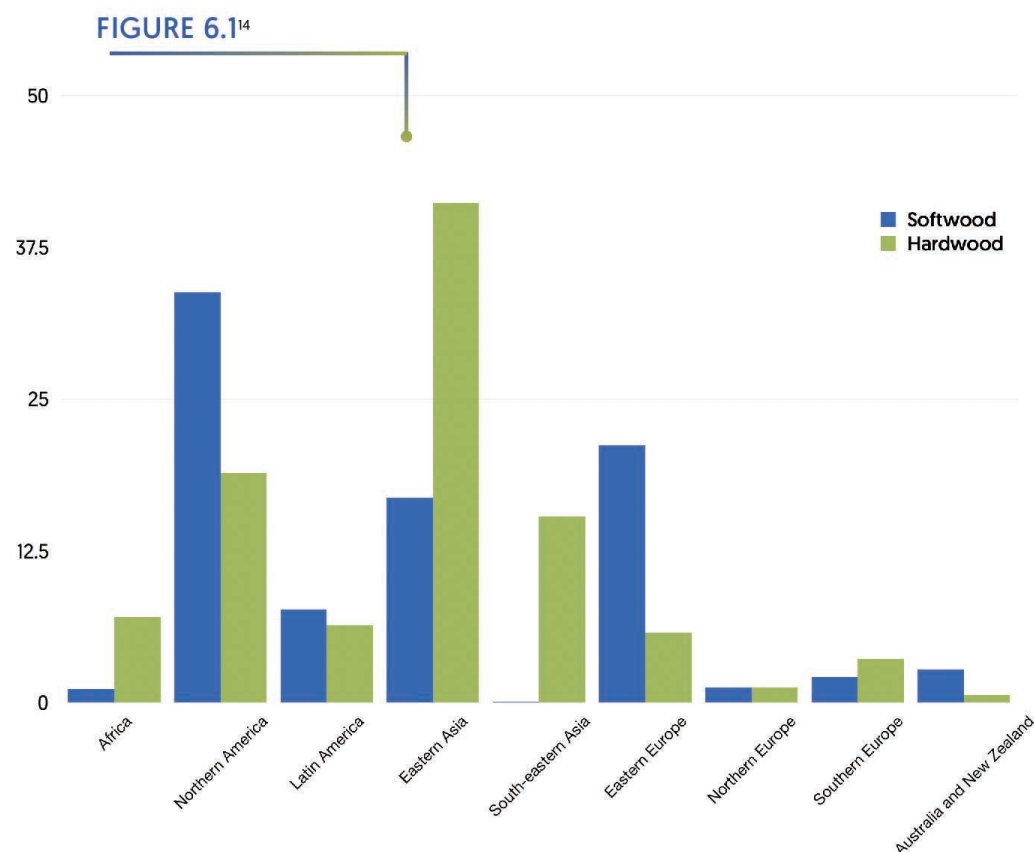


Figure 6.1 shows the 2019 share of global production of sawnwood for each major region by percent. North America (which excludes Mexico) and Eastern Europe (which includes Russia) were the largest producers of softwood sawnwood at 102M m3 and 64M m3 respectively, while Eastern Asia leads in the production of hardwood sawnwood with 51M m3, followed by North America (23M m3) and South-Eastern Asia (19M m3).

02. Overview of the Global Lumber Market

Production Levels by Country

FIGURE 7.1¹⁴

2019 Production in Million Cubic Meters

Country	Roundwood, softwood	Roundwood, hardwood	Sawlogs and veneer logs, softwood	Sawlogs and veneer logs, hardwood	Sawnwood, softwood	Sawnwood, hardwood
United States	326	133	143	45	60	22
Russia	173	46	121	15	41	3
Canada	117	28	112	15	42	1
China	93	247	13	83	40	50
Brazil	45	221	26	29	8	2
India	15	337	6	42	2	5

At the country level, the United States generally leads in the production of softwoods (including for roundwood, sawlogs and veneer logs and sawnwood) [See Figure 7.1]. India is the largest producer of hardwood roundwood at 337M m³ in 2019, while China leads production in hardwood sawlogs and veneers logs [83M m³] and sawnwood [50M m³].

FIGURE 7.2¹⁴

Sawnwood 2019 in Cubic Meters

Country	Production		Imports		Exports		Consumption		
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Total
China	40	50	29	9	0	0	69	59	128
United States	60	22	25	1	2	4	82	19	102
Germany	23	1	5	0	9	1	19	1	20
Canada	42	1	1	1	28	1	14	1	16
Japan	8	1	6	0	0	0	14	1	15
Russia	41	3	0	0	31	2	10	1	11

In addition to being the largest producer of softwood sawnwood, the US also imported 25M m³ in 2019. With exports of only around 2M m³, its apparent consumption (production plus imports minus exports) of softwood sawnwood was 82M m³ (see Figure 7.2). China has the largest hardwood sawnwood consumption at 59M m³ in 2019 followed by the US at 19M m³.

03. Paulownia Lumber and Comparable Species

Description of Paulownia

The fast growth rate of Paulownia, reaching maturity between 8-12 years, makes Paulownia a highly sustainable option within the lumber market.

The above-described market conditions, including anticipated growth in lumber demand, climate change-induced shortages and growing demand for sustainably sourced timber, will make Paulownia lumber sourced from sustainable tree farms well-positioned to acquire market share within the global lumber market. Because the market for Paulownia in North America is currently small (due largely to limited supply) the subsequent sections will focus on comparable species to Paulownia in the North American market (including their end uses and pricing) and finished wood product markets into which Paulownia lumber is likely to be sold.

Paulownia has many common names including Kiri, Empress tree, Princess tree and Foxglove tree and certain species of Paulownia are sold under the name Empress Splendor by World Tree.²⁰ The trees are native to China and East-Asia and have been introduced to North America, Australia, Europe and Japan.²¹ Paulownia is a fast-growing hardwood. It can grow 10-20 feet in its first year and generally reaches maturity within 10 years.^{22 23 24} Paulownia also regrows after harvesting and can be harvested up to 7 times without replanting. Its fast growth rate and regeneration capacity make Paulownia a highly sustainable option within the lumber market.

03. Paulownia Lumber and Comparable Species

Comparable Species

Other attributes of the Paulownia tree which contribute to Paulownia's sustainability include that it will grow on fallow land, can be used for soil regeneration as its nitrogen-fixing leaves naturally fertilize and replenish the soil, as well as its flowers provide pollination benefits and attract honeybees.²⁵ Additionally, Paulownia is suitable for inter-cropping with other plant species.²⁶ Inter-cropping (versus a monoculture), has many environmental, economic and social benefits including improving agricultural productivity, improving air quality, water quality and soil health, reducing erosion, protecting crops from wind and more.^{26 27}

There are many species of Paulownia and the characteristics of each species differ slightly.^{26 B} This report therefore references ranges for characteristics or notes the specific species where applicable.

Paulownia lumber has many characteristics which will make it attractive to buyers in various segments of the lumber market. To begin with, Paulownia has a high strength to weight ratio [the dried weight ranges from 17-21lbs/ft³²⁸ and the crushing strength ranges from 2800-3560 psi].²⁹ This leads to a reduction in both transportation and building costs. It also has a relatively low density with a basic specific gravity ranging from .25 to .27.²⁹

The combination of low density/weight and high strength make Paulownia useful in construction of materials where a lightweight yet strong wood is needed [such as board sports, boating, musical instruments and more]. Another viable market segment for Paulownia is within the veneer market as it can be peeled at a thickness of less than 1mm, when most veneers are peeled at 2mm or above.³⁰ This makes Paulownia veneers far more cost-effective. Some additional characteristics of Paulownia include that it is fast-drying, taking weeks to dry in comparison to other woods which can take months, highly water-resistant, highly insulating, warp resistant, mold resistant, and takes on finishes well.^{26 31 32}

Of the lumber species in North America, many are comparable to Paulownia either due to the characteristics of the wood itself or their end use. The subsequent sections consider similar species or species for which Paulownia could act as a substitute focusing first on species grown within North America and then on tropical species imported into the US market. See Figure 8.0 below which outlines some basic characteristics of these various tree species and their uses.

FIGURE 8.0^{28 29 33}

Species	Type	Weight (lbs/ft ³)	Strength (psi)	Density (SG)	Common Uses
Paulownia	Hardwood	17-21	2,800-3,560	0.25-.27	Veneers, furniture, board sports, musical instruments, boating
Ash [Green]	Hardwood	30-33.6 ^C	7,080	0.53	Musical Instruments ^C , flooring
Redwood	Softwood	26	5,690	0.36	Veneers, construction lumber, beams, decking, musical instruments
Western Red Cedar	Softwood	23	4,560	0.31	Shingles, boating, musical instruments, decking, fencing
Teak	Hardwood	41	7,940	0.55	Boating, veneers, furniture, construction
Balsa	Hardwood	9	1,690	0.12	Buoys, rafts, surfboards, musical instruments

B. World Tree currently grows two non-invasive varieties, *fortunai* and *elongata*.

C. Swamp Ash specifically.

03. Paulownia Lumber and Comparable Species

North American Grown

Ash

Swamp Ash is the colloquial name for Ash (usually Green Ash specifically) which is a hardwood tree species typically found in wet or swampy areas of the southeastern US. The timber is usually submerged for a portion of the year and it is harvested when flooding recedes. Because it grows in standing water, Swamp Ash is lightweight and soft. It has an average dried weight of less than 30-33.6lbs/ft³ and a crushing strength of 7,080psi [Green Ash].³⁴ The wood has been used to make guitars since the 1950s due in part to the fact that at the time it was inexpensive and abundant but also due to its light weight. The Fender brand popularized the use of Swamp Ash lumber for guitars and people also became accustomed to the unique sound of a Swamp Ash guitar.

In recent years, climate change and an invasive bug have dramatically reduced the supply of Swamp Ash. High water levels in the Mississippi Delta driven by snowmelt and heavy rains have made Swamp Ash more difficult to harvest.³⁵ Additionally, the Emerald Ash Borer, which is native to East Asia, has killed tens of millions of Ash trees since it was first detected in the US in 2002. Although climate change-related flooding has primarily fueled the Swamp Ash shortages to date, the Emerald Ash Borer could lead to the extinction of the species.³⁵ As a result, Fender announced it would start phasing out making Swamp Ash guitars in April 2020, and therefore Fender and other manufacturers within the guitar industry that use Swamp Ash are actively seeking a replacement a lightweight and durable replacement. Although the industry average for a standard cut of Ash is just over \$2/bft,³⁶ Ash for veneer lumber sells for over \$100/bft³⁷ and due to its increasing scarcity and specific application, Swamp Ash also sells for a high price.

Redwood

Redwood, which is a softwood tree species grown in the coastal northwestern US, produces a soft and lightweight yet relatively durable wood that is resistant to shrinkage and decay. The average dried weight of Redwood is 26lbs/ft³ and it has a crushing strength of 5,690psi.³⁸ Significant shortages of Redwood are anticipated. This is due to an approximate 40% reduction in the species population in the last 3 generations caused by a decline in its natural range, and exploitation.³⁸ The wood is commonly used for veneers, construction lumber, beams, posts, decking, exterior furniture, trim and musical instruments. Redwood for veneer lumber can sell for over \$200/bft.³⁷

Western Red Cedar

Western Red Cedar is a softwood species known for its resistance to decay, warping, twisting and checking, and low shrinkage. The average dried weight for Western Red Cedar is 23lbs/ ft³ while its crushing strength is 4,560psi.³⁹ It is also considered to be a good thermal insulator due to its relatively low density [specific gravity of .31].⁴⁰ The wood is very easy to work with due to its softness but is also prone to denting and scratching. Some common uses for Western Red Cedar include shingles, exterior siding and lumber, boatbuilding, boxes, crates, musical instruments, fencing, decking, and canoes.

03. Paulownia Lumber and Comparable Species

Tropical/Imported



Image by World Tree: Paulownia lumber

Teak

Teak, which is native to Southern Asia but grown on farms in tropical regions of Africa, Asia and Latin America, is a hardwood known for being strong, highly decay resistant, very durable and easy to work with. Its average dried weight is 41lbs/ ft³ and its crushing strength is 7,940psi.⁴¹ The demand for teak has led to it becoming one of the most expensive lumbers on the market. It is commonly used in ship and boatbuilding, veneer, furniture, exterior construction, carving, turnings, and other small wood objects. Teak lumber can sell for a very high price with standard cuts used in furniture and other applications selling for \$15-\$20/bft and veneer lumber selling for \$187-\$479/bft.³⁷

Balsa

Balsa, which is grown in tropical regions in the Americas, is known for being the lightest and softest of all commercial woods, with an average dried weight of 9lbs/ft³ and a crushing strength of 1,690psi.⁴² In spite of its softness, Balsa is considered a hardwood. Balsa has very good sound, heat and vibration insulating properties and it is highly buoyant due to its low density [specific gravity of .12].⁴² It is commonly used for buoys, rafts, surfboards, model airplanes, and musical instruments. Balsa is also relatively fast-growing with trees reaching maturity in 12-15 years.⁴³ There is evidence of balsa selling for about \$12.50/bft for a standard plank⁴⁴ and \$8-\$10/bft for use in a surfboard core.⁴⁵

03. Paulownia Lumber and Comparable Species

Paulownia Lumber Market

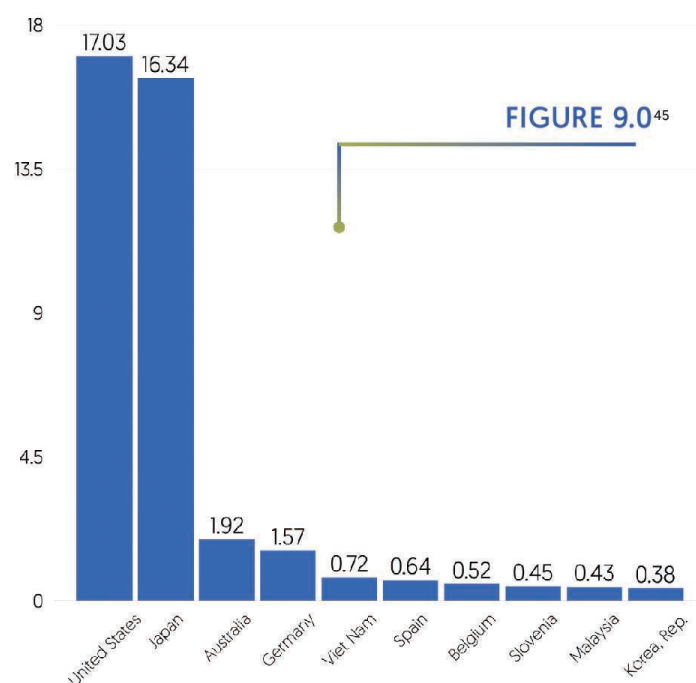
Because the Paulownia market is at a nascent stage, there is limited data on the size of the overall market. China is the largest producer and exporter of Paulownia lumber but it also appears to be grown and sold in small quantities in parts of Europe, Australia, the US and other parts of Asia. According to Chinese Customs, China exported \$42.9M of Paulownia wood in 2020 [specifically sawn lengthwise and greater than 6mm in thickness].⁴⁵ The largest importer of Chinese Paulownia according to these statistics was the US who imported \$17M in 2020 followed by Japan who imported \$16.3M. Germany and Japan are the next largest importers but each imported less than \$2M in 2020. US customs tracks trade data only for exports and imports of Paulownia in the rough and therefore the values it shows for imports and exports in 2020 are far smaller than is indicated by the Chinese statistics. The total value of exports of Paulownia in the rough from the US in 2020 was \$426K with Japan making up \$374K of that.⁴⁶ Between January and April of this year, China imported \$188K worth of Paulownia in the rough from the US which exceeds Japan during the same time period at \$177K. US imports of Paulownia in the rough in 2020 amounted to \$1.2M of which imports from China made up almost 100%.

Pricing

The various attributes of Paulownia lumber including the fact that it is light weight, has a high strength to weight ratio, is resistant to decay, has an even color, is stable [resistant to warping, twisting, etc.], is easy to work with and takes a stain well make it feasible that quality Paulownia could sell for a high price within the lumber market.^{24 26 47} The future pricing of Paulownia in the US market will be highly dependent on overall lumber demand, the quality of the Paulownia lumber being produced and the end use products for which Paulownia is being sold. For example, at present there is evidence of Paulownia being sold for \$18/bft for use in a surfboard core⁴⁰ and for \$31-\$40 per board foot for veneer lumber.⁴⁸

Pricing also depends significantly on the grade of lumber being produced. Lumber grades reflect the amount of clear wood (meaning wood free of knots, splits and other imperfections) in a piece of lumber. Higher grade lumber has a larger percentage of clear wood and therefore receives a higher price per board foot. Because tree farms allow for intensive maintenance of trees, they are more likely to produce high-grade, clear lumber and earn a higher price per board foot as a result.

Figure 9.0 shows Chinese exports of Paulownia in 2020 by receiving country in millions of USD



03. Paulownia Lumber and Comparable Species

Competitive Market Segments

Competitive Market Segments for Paulownia Lumber

Paulownia lumber is well-suited for a variety of applications including furniture, construction, musical instruments, shipbuilding, cabinetry, molding and more.²⁴⁻⁴⁹ At present, Paulownia is being sold to make furniture, musical instruments, veneers, plywood, and along with many other items. The following section describes the market size and characteristics of some of the top product segments into which Paulownia may be sold.

Veneers

The characteristics of Paulownia make it well-positioned to excel within the veneer market as it can be peeled at a thickness of less than 1mm when most veneers are peeled at 2mm or above.³⁰ As mentioned, there is evidence of Paulownia presently being sold for \$31-\$40/bft as veneer lumber.⁴⁸

The global veneer market was estimated to be valued at \$33B in 2020 and it is forecast to grow to over \$41B by 2030,⁵⁰ this equates to a CAGR of 2.3% between 2020 and 2030. This growth will primarily be driven by growth in residential and commercial building construction, urbanization, and an increase in woodworking projects. Veneers are also seen as a more sustainable option than full wood construction and are able to be combined with other eco-friendly building material which should lead to increased demand in the coming years. The largest markets for veneers are in East Asia (28.8% market share in 2020) and South Asia and the Pacific (27.2% market share in 2020).⁵⁰

The North American market constituted about 6.8% of the global market in 2020 equating to \$2.2B and this is estimated to grow to \$2.7B by 2030 CAGR of 4.3%. The average price is estimated to grow from \$1,846/m³ to \$1,968/m³ by 2030. This equates to approximately \$4.60/bft. This price represents the broad industry average for all types of lumber, however, higher end veneer lumber can sell for a

very high price per board foot. For example, there is evidence of teak veneer being sold for \$479/bft.³⁷

According to the FMI Global Veneer Sheets 2020 report, the US is considered a high opportunity country. The North American market is anticipated to grow 1.2 times between 2020 and 2030 equating to incremental dollar opportunity of \$524M and according to the FMI Global Veneer Sheets 2020 report, the US is considered a high opportunity country.⁵⁰

Figure 10.0 shows sample veneer pricing in dollars per board foot for Teak, Redwood and Ash.³⁷

FIGURE 10.0³⁷

Teak

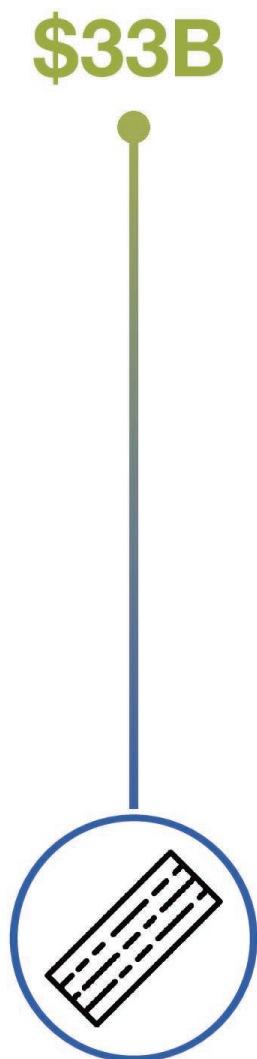
\$187-479/bft

Redwood

\$236-310/bft

Ash

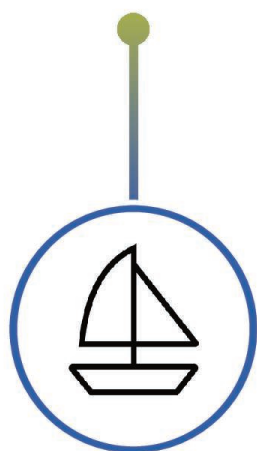
\$104-115/bft



03. Paulownia Lumber and Comparable Species

Competitive Market Segments

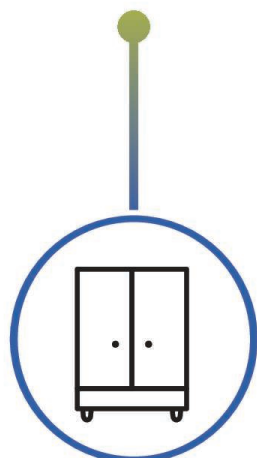
\$18.5B



Marine applications

Paulownia's high strength to weight ratio and low density also make it good for use in boat construction. The global leisure boat market, which includes sailboats, jet boats, watercrafts, etc. was valued at \$41.1B in 2020.^{51 52} The market is expected to grow at a CAGR of 4.5% from 2021 to 2028. The North American market constitutes 45% of the global market equating to \$18.5B in 2020. Used leisure boats account for 76% of the global revenue with new leisure boats and monitoring equipment making up the remaining 24%. The new leisure boat segment is forecast to experience significant growth between 2021 and 2028 due to new technologies being incorporated into boats such as artificial intelligence and the internet of things.

\$14.9B



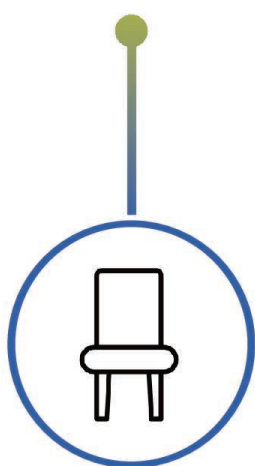
Cabinetry

As of 2018, the global market for cabinets was valued at \$64 billion.⁵³ The US market value for cabinets and vanity manufacturing is estimated at \$14.9B in 2021⁵⁴ which indicates growth in 2021 will be 1.7%. The cabinetry market is highly linked to residential construction and spending on single and multi-family homes, therefore the short-term anticipated growth in residential home construction and more people taking on home-improvement projects due to an increase in the number of people working from home, should positively influence the cabinetry market.⁵⁵

03. Paulownia Lumber and Comparable Species

Competitive Market Segments

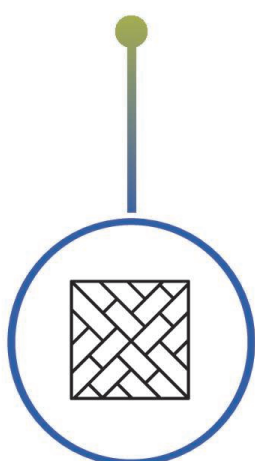
\$5.8B



Furniture

The global home furniture market is forecast to grow by over \$8B dollars between 2020 and 2024 equating to a CAGR of 2%.⁵⁶ As a subset of that market, the global outdoor furniture market was valued at around \$18B in 2019 and at the time was expected to grow at a CAGR of 4.8% between 2020 and 2026.⁵⁷ Wood makes up the majority of the outdoor furniture market and the residential segment is also dominant. As of 2018, the outdoor furniture market size in the North America was worth roughly \$5.8B.⁵⁸ The global outdoor furniture market was valued at around \$18B in 2019 and at the time was expected to grow at a CAGR of 4.8% between 2020 and 2026.⁵⁷ Wood makes up the majority of the outdoor furniture market and the residential segment is also dominant.

\$5.3B



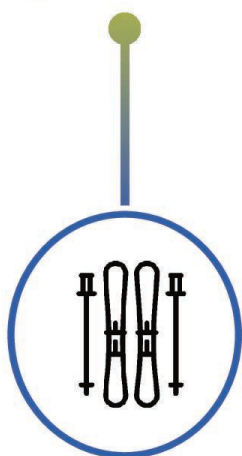
Decking

The global wooden decking market was valued at \$15B in 2020 and is expected to grow at a CAGR of 2.7% 2021 to 2027.⁵⁹ The North American market constituted 35% of the global market or around \$5.3B in 2020. The market for redwood and cedar are expected to grow significantly. Of the global market, redwood had greater than 17% market share in 2020. It is anticipated that increasing energy costs and a shift toward greener construction will boost the demand for wooden products. The market will also be supported by increases in refurbishment and remodeling activities alongside an increased interest in outdoor living.⁶⁰

03. Paulownia Lumber and Comparable Species

Competitive Market Segments

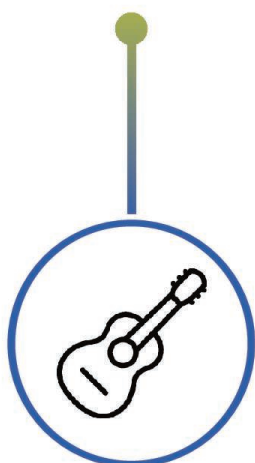
\$5.2B



Board Sports

Paulownia's high strength to weight ratio makes it ideal for the board sports market which includes skis, surfboards, snowboards and more. There is evidence of Paulownia presently being sold for \$18/bft for use as a surfboard core.⁴⁵ The global market for board sports was valued at \$17.1B in 2020 and is estimated to grow to \$22.1B by 2027 equating to a CAGR of 3.4%. The US makes up the largest portion of market share at an estimated \$5.2B in 2020 and the market is forecast to grow at CAGR of 4.1% between 2021 and 2027.⁶¹

\$4.5B



Musical Instruments

The global market for musical instruments is forecast to grow by nearly \$808M between 2021 and 2025 representing a CAGR of 2%. The North American market constitutes 40% of that growth or around \$323M.⁶² The musical instruments and supplies stores market within the US is estimated at \$4.5B in 2021 and growth is estimated at 1.4% in 2021.⁶²

04. Conclusion

As a fast-growing hardwood which produces quality lumber, Paulownia can help meet the demand for sustainably-grown lumber.

In summation, this report has shown that demand for lumber, especially from sustainably-grown timber, is expected to increase over time. Sustainable wood products are increasingly being seen as a viable alternative to more carbon-intensive materials with many wood products resulting in a net reduction in carbon emissions. While demand for wood products is increasing, supply is declining due to deforestation and climate-change related shortages.

As a fast-growing hardwood which produces quality lumber Paulownia can help meet the demand for sustainably-grown lumber. Paulownia is a fantastic lumber choice from a sustainability perspective as the trees sequester large amounts of carbon, help regenerate soils, are suitable for intercropping and regrow from the stump. Paulownia lumber also has many qualities which will make it ideal for an array of applications. For example, its high strength to weight ratio, low density, water and mold resistance, and insulating qualities will make it a viable player in many wood product

segments including veneers, musical instruments, furniture, marine applications and more.

The US will be an important market for the sale of Paulownia due to its overall demand for softwood and hardwood lumber and the size of the above-mentioned wood products segments. There is also evidence of existing demand for Paulownia lumber with it being the largest importer of Chinese Paulownia lumber in 2020. Altogether, the forecast supply and demand dynamics within the global and regional lumber market combined with the characteristics of farm-grown Paulownia and its application within high-end lumber products set the stage for Paulownia to be a successful player within the lumber market.

05. Definitions

Roundwood - Wood in the rough. Wood in its natural state as felled, or otherwise harvested, with or without bark, round, split, roughly squared or other forms [e.g. roots, stumps, burls, etc.]. It may also be impregnated [e.g. telegraph poles] or roughly shaped or pointed. It comprises all wood obtained from removals, i.e. the quantities removed from forests and from trees outside the forest, including wood recovered from natural, felling and logging losses during the period - calendar year or forest year. Commodities included are sawlogs and veneer logs, pulpwood, other industrial roundwood [including pitprops] and fuelwood. The statistics include recorded volumes, as well as estimated unrecorded volumes as indicated in the notes. Statistics for trade include, as well as roundwood from removals, the estimated roundwood equivalent of chips and particles, wood residues and charcoal.⁶³

Industrial Roundwood - The commodities included are sawlogs or veneer logs, pulpwood, other industrial roundwood and, in the case of trade, also chips and particles and wood residues.⁶³

Sawnwood - Sawnwood, unplaned, planed, grooved, tongued, etc., sawn lengthwise, or produced by a profile-chipping process [e.g. planks, beams, joists, boards, rafters, scantlings, laths, boxboards, "lumber", sleepers, etc.] and planed wood which may also be finger jointed, tongued or grooved, chamfered, rabbeted, V-jointed, beaded, etc. Wood flooring is excluded. With few exceptions, sawnwood exceeds 5 mm. in thickness.⁶³

Sawlogs and Veneer Logs - Sawlogs, veneer logs and logs for sleepers. Logs whether or not roughly squared, to be sawn (or chipped) lengthwise for the manufacture of sawnwood or railway sleepers (ties). Shingle bolts and stave bolts are included. Logs for production of veneer, mainly by peeling or slicing. Match billets

are included, as are special growth [burls, roots, etc.] used for veneers.⁶³

Veneer Sheets - Thin sheets of wood of uniform thickness, rotary cut, sliced or sawn, for use in plywood, laminated construction, furniture, veneer containers, etc. In production, the quantity given excludes veneer sheets used for plywood production within the country.⁶³

Plywood - Plywood, veneer plywood, core plywood including veneered wood, blockboard, laminboard and battenboard. Other plywood such as cellular board and composite plywood. Veneer plywood is plywood manufactured by bonding together more than two veneer sheets. The grain of alternate veneer sheets is crossed generally at right angles. Core plywood is plywood whose core [i.e. central layer, generally thicker than the other plies] is solid and consists of narrow boards, blocks or strips of wood placed side by side, which may or may not be glued together. [This item includes veneered wood in sheets or panels in which a thin veneer of wood is affixed to a base, usually of inferior wood, by glueing under pressure]. Cellular board is a plywood with a core of cellular construction while composite plywood is a plywood with core or certain layers made of material other than solid wood or veneers.⁶³

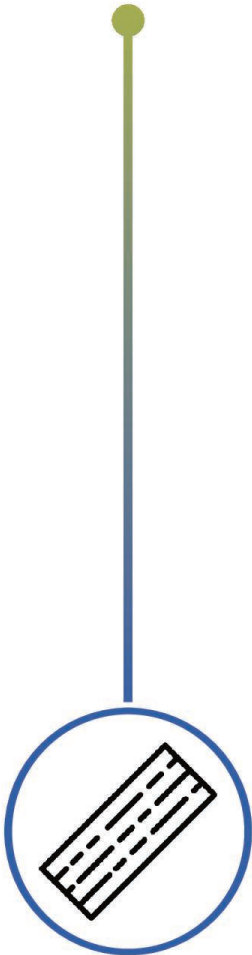
06. References

- 1 "Lumber," Trading Economics, accessed June 4, 2021, <https://tradingeconomics.com/commodity/lumber>.
- 2 "Lumber Enters a Bear Market with Prices down 20% from the Peak," Fortune, accessed June 18, 2021, <https://fortune.com/2021/06/16/lumber-prices-falling-2021-chart-update-price-of-lumber-going-down-wood-costs/>.
- 3 "Forests," World Wide Fund for Nature [WWF], accessed June 4, 2021, <https://explore.panda.org/forests>.
- 4 World Wide Fund for Nature [WWF], "WWF Living Forests Report: Chapter 4, Forests and Wood Products" [WWF, 2012].
- 5 Indufor, "Strategic Review on the Future of Forest Plantations" [Forest Stewardship Council [FSC], October 4, 2012].
- 6 United Nations, Department of Economic and Social Affairs, Population Division, "World Population Prospects 2019," Online Edition, Rev. 1, 2019.
- 7 American Hardwoods, "American Hardwoods Collection," accessed June 4, 2021, <https://www.hardwoodinfo.com/wp-content/uploads/professional/species-guide/Hardwood-Collection-Species-Guide.pdf>.
- 8 IISD's SDG Knowledge Hub, "FAO, Partners Call for Strengthening Sustainable Wood Value Chains to Achieve SDGs," December 3, 2019, <https://sdg.iisd.org/443/news/fao-partners-call-for-strengthening-sustainable-wood-value-chains-to-achieve-sdgs-paris-agreement/>.
- 9 Food and Agriculture Organization of the United Nations [FAO], "FAOSTAT Forest Land," July 21, 2020, <http://www.fao.org/faostat/en/#data/GF>.
- 10 The State of the World's Forests 2020 [FAO and UNEP, 2020], <https://doi.org/10.4060/ca8642en>.
- 11 Jocelyn Benjamin and Kate MacFarland, "Five Ways Agroforestry Can Grow Forest Products and Benefit Your Land, Your Pockets & Wildlife," US Department of Agriculture, February 21, 2017, <https://www.usda.gov/media/blog/2016/10/19/five-ways-agroforestry-can-grow-forest-products-and-benefit-your-land-your>.
- 12 Richard Jagels, "Management of Wood Properties in Planted Forests - A Paradigm for Global Forest Production," June 2006, <http://www.fao.org/3/j8289e/j8289E00.htm>.
- 13 Food and Agriculture Organization of the United Nations [FAO], "FAOSTAT Forest Land."
- 14 Food and Agriculture Organization of the United Nations [FAO], "FAOSTAT Forestry Production and Trade," March 1, 2021, <http://www.fao.org/faostat/en/#data/FO>.
- Consumption was calculated based on FAOSTAT data using
- 15 BCC Research, "Unfinished Wood/Lumber Manufacturing Market Research Report," August 2018, <https://www.bccresearch.com/market-research/manufacturing/unfinished-wood-lumber-manufacturing-global-markets.html>.
- 16 Research and Markets, "Wood Products Global Market Report 2021: COVID-19 Impact and Recovery to 2030," January 2021, <https://www.researchandmarkets.com/reports/5238003/wood-products-global-market-report-2021-covid-19>.
- 17 IBISWorld, "Lumber Wholesaling in the US - Market Size 2002-2026," IBISWorld - Industry Market Research, Reports, and Statistics, February 28, 2021, <https://www.ibisworld.com/default.aspx>.
- 18 Thomas Publishing Company, "Lumber vs. Timber - What's the Difference?," accessed June 4, 2021, <https://www.thomasnet.com/articles/plant-facility-equipment/lumber-vs-timber>.
- 19 Thomas Publishing Company, "Lumber Grades Explained - What Different Types of Lumber Grades Mean," accessed June 4, 2021, <https://www.thomasnet.com/articles/plant-facility-equipment/lumber-grades>.
- 20 "World Tree: Impact Investing for Everyone – Future for Farmers," World Tree, accessed June 4, 2021, <https://www.worldtree.eco/>.
- 21 M Hakan Akyildiz and Hamiyet Sahin Kol, "Some Technological Properties and Uses of Paulownia [Paulownia tomentosa Steud.] Wood," J Environ Biol 31, no. 3 (May 2010): 351–55.
- 22 Permaship, "Paulownia Overview," accessed June 7, 2021, <http://www.permaship.org/Home/permaculture-concepts/paulownia-overview>.
- 23 Sedeer El-Showk and Nabil El-Showk, "The Paulownia Tree: An Alternative for Sustainable Forestry," 2003, 9.
- 24 Akyildiz and Kol, "Some Technological Properties and Uses of Paulownia [Paulownia tomentosa Steud.] Wood."
- 25 El-Showk and El-Showk, "The Paulownia Tree: An Alternative for Sustainable Forestry."
- 26 Zhu Zhao-Hua et al., Paulownia in China: Cultivation and Utilization [Singapore: Asian Network for Biological Science : International Development Research Center, 1986].
- 27 Benjamin and MacFarland, "Five Ways Agroforestry Can Grow Forest Products and Benefit Your Land, Your Pockets & Wildlife."
- 28 "Technical Characteristics of Paulownia Wood and the Physical Properties of Paulownia," Worldpaulownia [blog], accessed June 16, 2021, <https://worldpaulownia.com/technical/>.
- 29 "Empress Lumber," Pacific Coast Teak [blog], accessed June 16, 2021, <https://pacificcoastteak.com/empress-lumber/>.

- 30 Ross Forcey, Forcey Lumber Consultation, 2021.
- 31 Dave Munkittrick, "Air-Drying Lumber," Poplar Woodworking, June 5, 2014, <https://www.popularwoodworking.com/projects/air-drying-lumber/>.
- 32 Niraj Kumarmangalam Yadav et al., "A Review of Paulownia Biotechnology: A Short Rotation, Fast Growing Multipurpose Bioenergy Tree," American Journal of Plant Sciences 04, no. 11 [2013]: 2070–82, <https://doi.org/10.4236/ajps.2013.411259>.
- 33 "The Wood Database," accessed June 18, 2021, <https://www.wood-database.com/>.
- 34 The Wood Database, "Swamp Ash," accessed June 4, 2021, <https://www.wood-database.com/swamp-ash/>.
- 35 Kelsey Vlamis, "A Tiny, Invasive Bug and the Climate Crisis Are Changing How Guitars Are Made, and Shifting the Course of Music History," Business Insider, April 24, 2021, <https://www.businessinsider.com/how-guitars-are-changing-climate-crisis-ash-wood-fender-2021-4>.
- 36 HMR, "Hardwood Market Report," May 21, 2021.
- 37 "Veneer Locator: Search by Wood Name & Figure/Cut or Product Code," Certainly Wood, accessed June 18, 2021, <https://certainlywood.com/locator.php>.
- 38 The Wood Database, "Redwood," accessed June 4, 2021, <https://www.wood-database.com/redwood/>.
- 39 The Wood Database, "Western Red Cedar," accessed June 4, 2021, <https://www.wood-database.com/western-red-cedar/>.
- 40 Naturally Wood, "About Western Red Cedar," accessed June 4, 2021, <https://www.naturallywood.com/species/western-red-cedar/>.
- 41 The Wood Database, "Teak," accessed June 4, 2021, <https://www.wood-database.com/teak/>.
- 42 The Wood Database, "Balsa," accessed June 4, 2021, <https://www.wood-database.com/balsa/>.
- 43 Wood Solutions, "Balsa," accessed June 4, 2021, <https://www.woodsolutions.com.au/wood-species/balsa>.
- 44 "4X5X48 BALSA PLANK," National Balsa, accessed June 18, 2021, https://www.nationalbalsa.com/product_p/4548.htm.
- 45 "Wood Surfboard Kits," Wood Surfboard Supply, accessed June 18, 2021, <http://woodsufboardsupply.com/wood.html>.
- 46 USDA Foreign Agricultural Service, "Global Agricultural Trade System [GATS]," March 5, 2021, <https://apps.fas.usda.gov/gats/default.aspx>.
- 47 The Wood Database, "Paulownia," accessed June 4, 2021, <https://www.wood-database.com/paulownia/>.
- 48 "Veneer Locator: All Available Figures and Cuts for PAULOWNIA," Certainly Wood, accessed June 18, 2021, <https://certainlywood.com/results-locator.php?name=PAULOWNIA&menu=--Figure%2F-Cut+%28or+leave+as+is+to+see+all+available%29--&SubmitLocator=Submit+Veneer>.
- 49 Teresa McConchie, "ISSN 1174-5096 ©New Zealand Forest Research Institute Limited 2007," n.d., 76.
- 50 Future Market Insights, "Veneer Sheets, Global Industry Analysis 2015-2019 and Opportunity Assessment 2020-2030," 2020.
- 51 Grand View Research, "Leisure Boat Market Size | Global Industry Report, 2021-2028," April 2021, <https://www.grandviewresearch.com/industry-analysis/global-leisure-boat-market>.
- 52 Grand View Research market value for leisure boats includes includes boat manufacturers, engine manufacturers, independent dealers, service providers and equipment manufacturers
- 53 The Freedonia Group, "World Cabinets," The Freedonia Group, 2018, <https://www.freedoniagroup.com/industry-study/world-cabinets-3245.htm>.
- 54 IBISWorld, "Cabinet & Vanity Manufacturing in the US - Market Size," November 20, 2020, <https://www.ibisworld.com/industry-statistics/market-size/cabinet-vanity-manufacturing-united-states/>.
- 55 Research and Markets, "United States Construction Markets, Trends and Opportunities Report 2020-2024," Business Wire, February 9, 2021, <https://www.businesswire.com/news/home/20210209005833/en/United-States-Construction-Markets-Trends-and-Opportunities-Report-2020-2024---ResearchAndMarkets.com>.
- 56 Technavio, "Home Furniture Market to Grow Over \$ 8 Billion in the US During 2020-2024 | Technavio," Business Wire, December 5, 2020, <https://www.businesswire.com/news/home/20201204005524/en/Home-Furniture-Market-to-Grow-Over-8-Billion-in-the-US-During-2020-2024-Technavio>.
- 57 "Outdoor Furniture Market Trends 2026 | Industry Analysis Report," Global Market Insights, Inc., accessed May 11, 2021, <https://www.gminsights.com/industry-analysis/outdoor-furniture-market>.
- 58 ReportLinker, "North America Outdoor Furniture Market Forecast to 2027 - COVID-19 Impact and Regional Analysis By Material ; Product ; and End User," September 2020, https://www.reportlinker.com/p05978906/North-America-Outdoor-Furniture-Market-Forecast-to-COVID-19-Impact-and-Regional-Analysis-By-Material-Product-and-End-User.html?utm_source=GNW.
- 59 Kiran Pulidindi and Hermant Pandey, "Wooden Decking Market Share 2021-2027 | Industry Growth Report," Global Market Insights, Inc., February 2021, <https://www.gminsights.com/industry-analysis/wooden-decking-market>.
- 60 Sarah Schmidt, "7 Key Facts to Know About the U.S. Decking Market," February 24, 2020, <https://blog.marketresearch.com/7-key-facts-to-know-about-the-u.s.-decking-market>.
- 61 Research and Markets, "Board Sports - Global Market Trajectory & Analytics," April 2021, https://www.researchandmarkets.com/reports/1824124/board_sports_global_market_trajectory_and.
- 62 Technavio, "Musical Instrument Market to Grow by USD 807.99 Million," PR Newswire Cision, April 2021, <https://www.prnewswire.com/news-releases/musical-instrument-market-to-grow-by-usd-807-99-million--2-11-year-over-year-growth-in-2021--technavio-301261333.html>.
- 63 Food and Agriculture Organization of the United Nations [FAO]. "Yearbook of Forest Products Definitions." Accessed July 1, 2021. <http://www.fao.org/waicent/faostat/forestry/products.htm>.



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