North American Forestry Commission

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Preface

The North American Forest Products Study Group (NAFPSG) is one of seven study groups of the North American Forest Commission (NAFC). The NAFC in turn is one of six regional forestry commissions of the Food and Agriculture Organization (FAO). The NAFC was established in 1959 as a statutory body of the FAO and provides a policy and technical forum for Canada, Mexico, and the United States to discuss and address forest issues on a North American basis.

The mandate of the NAFPSG is to promote and enhance the efficient and sustainable use of forest products within North America by bringing together and expanding upon the "Body of Knowledge" of information and scientific and technical expertise related to North American wood and nonwood products.

The goals and objective of the NAFPSG are to: 1) facilitate the exchange of existing and emerging forest products technology within North American; 2) identify appropriate expertise in each country; and 3) facilitate a network of scientific or technical experts to address issues of concern to the forest products sector in North America.

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Wood Product Standards

Codes and standards for structural wood products and their use in the United States

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Roland Hernandez

Abstract

The system of model building codes and voluntary product standards used in the United States for structural lumber and engineered wood products can appear complicated and confusing to those introduced to it for the first time. This paper is a discussion of the various types of structural wood products commonly used in U.S. residential and commercial construction and the system of building codes and product and performance standards that help regulate the quality and use of these products.

Introduction

The United States is the leading producer and consumer of wood products in the world. The majority of this wood resource is used to construct the 1 million new single-family homes built every year or to repair and remodel existing houses. This demand for construction material has led to better utilization of wood, which now comes from second- and third-growth forests. Compared to 50 years ago, the forest resource in the United States can generally be characterized as having a more diverse array of species available for use and is composed of trees with smaller diameters. Efficient utilization of this "new" forest resource is a challenge to the building industry.

Modern technology has made the development of improved grading practices and improved engineered wood products possible. Solid-sawn lumber continues to provide the bulk of structural products used in construction. Although the use of mechanical grading procedures has provided precise control of property assignment, it has introduced an entire new set of "grades" to the marketplace. In addition, engineered wood products, such as laminated veneer lumber (LVL) and parallel strand lumber (PSL), are being substituted for solid-sawn lumber. Large-diameter timbers are increasingly difficult to obtain and are often replaced by glued-laminated timbers (glulam), prefabricated wood I-joists, and larger versions of LVL and PSL products. Oriented strandboard (OSB) is being used as a substitute for structural plywood. This wide assortment of products can lead to concerns about product quality and structural reliability.

The system of codes and standards for lumber and wood products that ensures quality of these products is well established and reliable. However, the system can appear complicated and confusing to those introduced to it for the first time. This paper is a discussion of:

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- the various types of structural wood products that are commonly available in the United States; and
- the system of building codes and product and performance standards that help regulate the quality and use of these products.

Building codes and product standards

The regulation of building construction in the United States is accomplished through a document called a building code. A building code is a collection of laws, regulations, ordinances, or other statutory requirements adopted under the legislative authority of state or local governments. These codes specify the minimum acceptable requirements necessary to protect public health and safety. Because of the complexity of issues faced by state and local governments in writing building codes, so-called "model" building codes began to be developed early in the 20th century. These codes are intended to be a foundation upon which a legislative body can create its own regulations.

Prior to 2000, three organizations of code enforcement officials in the United States wrote model building codes: the International Conference of Building Officials (ICBO), the Building Officials and Code Administrators International, Inc. (BOCA), and the Southern Building Code Congress International (SBCCI). Each code organization was a nonprofit organization owned and operated by voting members. The voting members of each model code organization are composed of representatives of city, county, and state governments who have adopted that organization's model code, plus representatives from the Federal government. The *Uniform Building Code* of ICBO (16) has been adopted by most states west of the Mississippi River. States in the Southeast generally use the *Standard Building Code* of SBCCI (21), and states in the Northeast generally use BOCA's (12) *Standard National Code* (Fig. 1).

In establishing comprehensive regulations for all aspects of building construction, model building codes excerpt, or directly reference, numerous standards promulgated by a variety of nationally recognized technical or trade organizations. The building code describes how each referenced standard is to be used for regulation purposes. Examples of some organizations producing voluntary consensus standards for wood-based materials that are referenced by modeling codes include the following:

- American Forest & Paper Association;
- American Institute of Timber Construction;
- American Society of Civil Engineers;
- American Society for Testing and Materials;
- American Wood Preserver's Association;
- Truss Plate Institute; and
- U.S. Department of Commerce.

In addition, each of the three model building code organizations is a member of the International Code Council (ICC). This organization was established by the three model code organizations about 5 years ago to eliminate discrepancies between the region building codes and provide a single set of comprehensive and coordinated national codes. The new International Building Codes (IBCS) are set to take effect early in 2000. The new parts of the codes set are:

- **The 2000 International Building Code (IBC).—**The IBC addresses design and installation of building systems with requirements that emphasize performance. The IBC is coordinated with all the International Codes.
- **The 2000 International Residential Code.—**This code is for one- and two-family dwellings and townhouses up to three stories. Coordinated with all codes, it includes building, plumbing, mechanical, and electrical requirements.
- **The 2000 International Fire Code.—**This code is coordinated with the International Building Code, International Mechanical Code, and referenced national standards.

Updated existing codes in the 2000 International Code set include the: property maintenance code, plumbing code, mechanical code, energy conservation code, zoning code, private sewage code, fuel gas code, and electrical code.

It remains to be seen how fast the new codes will be adopted across the Nation. Beginning in 2000, the three model code agencies will no longer update their individual model building codes. However, as previously noted, adoption of a building code is a state and local responsibility. Many believe that it will be several years before the new codes are assimilated into most state and local codes (20). For example, in California, code adoption is the responsibility of the Building Standards Commission. However, in the state of Washington the *Uniform Building Code* is written into law, and only the legislature can make a change in the code specified. It should be noted, however, that the IBC adopted reference the *National Design Specifications for Wood Construction* and the *Load and Resistance Factor Design Standards for Engineered Construction*. Thus both allowable stress design and load and resistance factor design may be used with the IBC.

Wood products used in the United States

The following describes the structural wood products commonly used in the United States and the product and performance standards applicable to each. Also discussed is the quality control system that ensures compliance of assigned properties with model building code requirements.

Round timbers

Round timbers are generally used in the form of utility poles, construction poles, piles, or construction logs. They represent some of the most efficient uses of forest products because minimum processing is required for their manufacture. Poles and piles are generally debarked or peeled, seasoned, graded, and treated with a preservative prior to use. Construction logs are often shaped to facilitate their use.

Poles and piles.—The primary use of wood poles is to support utility and transmission lines. For these types of members, the length may vary from 6.1 to 38.1 m (20 to 125 ft.). Poles and piles used for building construction rarely exceed 21.3 m (70 ft.) in length. The product standard for these types of

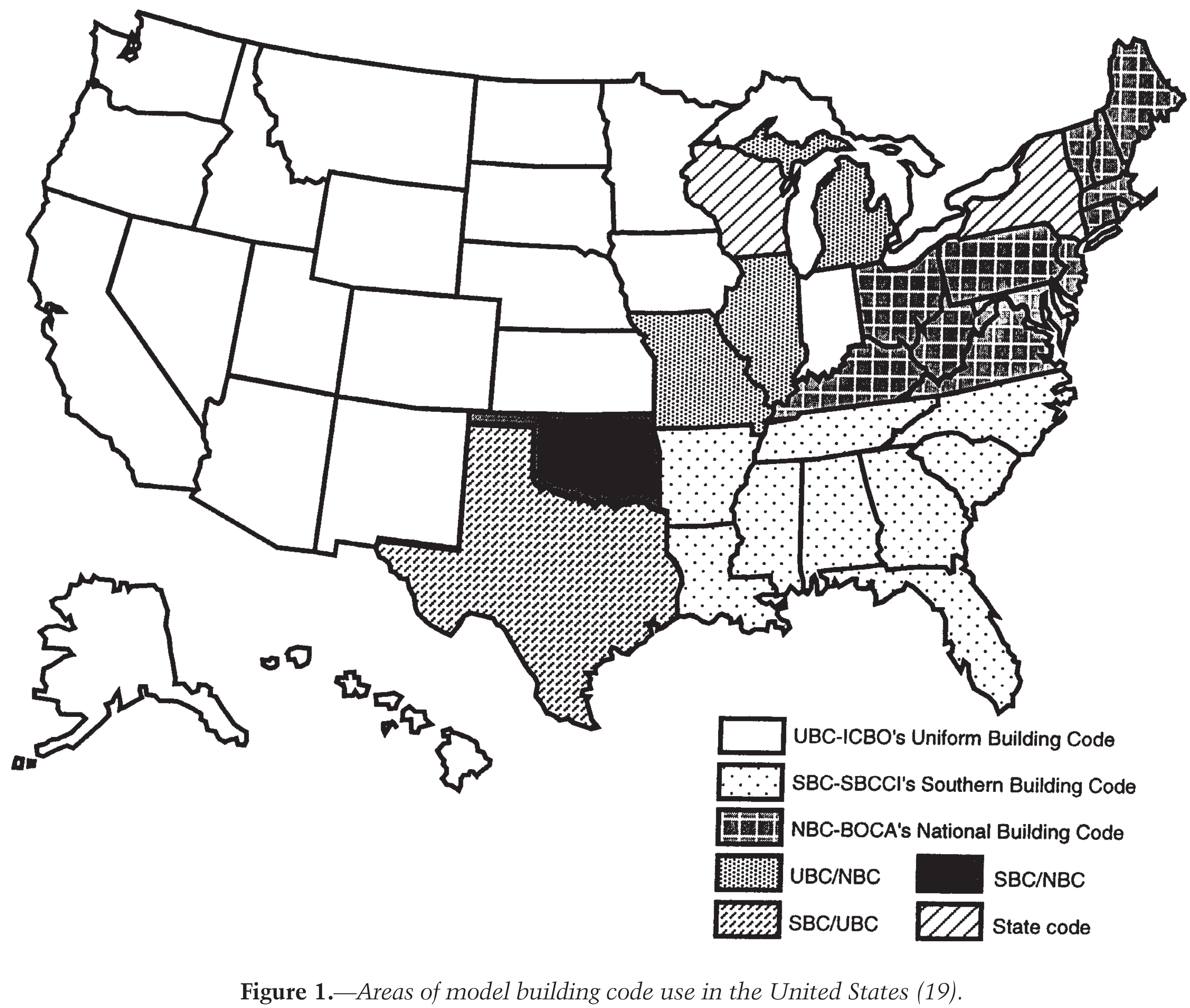

Figure 1.—*Areas of model building code use in the United States (19).*

round timber members includes provisions for geometry, such as diameter and taper, as well as allowable defects, such as knots, warp, and degree of spiral grain. The ANSI 05.1 standard provides these limitations for utility and construction poles (5) and ASTM D 25 for piles (10).

Poles for transmission lines may be designed as single-member or guyed cantilevers or as structural members of a more complex structure. Values for fiber stress in bending are given in ANSI 05.1 for most species used in transmission lines. These are near-ultimate values for poles used as cantilever beams and, as such, they are not compatible with the working stress design philosophy of the *National Design Specifications for Wood Construction (NDS)* (1). Reliability-based design techniques have been developed for the design of transmission line systems (6). Procedures for establishing design stresses for round timber piles are published in ASTM D 2899 (10) for various species. These procedures basically take published clear wood design stresses and adjust them to a corresponding design value for poles and piles. Design values for piles are provided in the *NDS* (1). For construction poles, these design stresses are adjusted so that the tip stress for piles is adjusted to a groundline design stress for poles. Methods for establishing design stresses for construction poles are set forth in ASTM D 3200 (10). The American Society of Agricultural Engineers standard EP 560 (9) publishes a complete set of calculated design values for construction poles based on ASTM D 2899 procedures.

Whether used for utility or construction, standard practice requires that the poles be pressure-treated with a preservative in accordance to an applicable AWPA standard. AWPA C3 establishes preservative retention and penetration values for piles; AWPA C4 establishes retention and penetration values for utility poles; AWPA C23 sets forth retention and penetration values for poles used in building construction; AWPA C35 and other standards relate to poles requiring thermal treatments or that belong to certain species (11).

Construction logs.—Log buildings are a popular form of construction for both recreational and residential structures. Logs are usually peeled then machined into a variety of cross-sectional shapes. There are no standardized design properties for construction logs; however, procedures to calculate design stresses based on the largest rectangular cross section that fits within the machined cross section are found in ASTM D 3957 (10).

Solid-sawn structural lumber

Lumber grading.—Lumber is the product of the sawmill and planing mill and is usually not further manufactured other than by sawing, resawing, passing lengthwise through a standard planing machine, crosscutting to length, and matching (ASTM D 9). Lumber sawn from a log, regardless of species and size, is quite variable in its mechanical properties. In the same manner, its manufacture can be subject to considerable variation. Structural grading rules limit these variables by requiring conformance to a specified set of parameters. Grading rules allow users to purchase material that suits their particular purposes and allow calculation of engineering design values for use by architects and engineers. Understanding the grading system in the United States and the standards that govern its development requires some understanding of lumber size classifications.

During the evolution of stress grading in the United States, lumber size served as a guide to anticipating the final use of the piece. The three size classifications for structural lumber are boards, dimension lumber, and timbers. Boards are lumber less than nominal 2 inches (51 mm) thick and 2 inches or more wide. Dimension lumber is lumber that is nominal 2 to 4 inches (51 to 102 mm) thick and nominal 2 inches (51 mm) or more wide. Timbers are lumber 5 inches (127 mm) or more in the least dimension.

It is important to understand that lumber size classifications are based on the most efficient anticipated use of the member rather than on the actual use. Although grading system development has tended to parallel size classification, there are no restrictions on actual use for any size classification, provided design stresses are within the stresses allowed for the grade.

In the United States, there are two approaches to grading structural lumber: visual grading and mechanical grading.

Visual grading is the sorting of lumber into specific grades by a person trained to grade lumber solely on its visible characteristics. Visual grading is used with all three size classifications of lumber. Allowable design values for visually graded lumber may be based on the results of strength tests conducted on full-size pieces of lumber or derived from tests of small, clear specimens of wood (Table 1).

Mechanical grading is the sorting of lumber by a machine that evaluates its mechanical or physical properties using a nondestructive test, followed by visual grading to gauge certain characteristics that the machine cannot assess. Quality control procedures are used to ensure that the output of the mechanical grading process meets specified property values. At present, mechanical grading in the United States is limited to dimension lumber.

Most structural lumber sold in the United States is produced from softwood species that have been visually graded. However, both grading systems have also been used with hardwood species. The production of mechanically graded lumber continues to increase, particularly for 2 by 4s and in 1650f and higher grades.

Lumber standards.—The American Softwood Lumber standard, Voluntary Product Standard PS 20 (17), establishes nationally recognized requirements for the grading of lumber. PS 20 was developed by the American Lumber Standard Committee (ALSC) in accordance with the procedures of the U.S. Department of Commerce, and it is administered by the National Institute of Standards and Technology (NIST). ALSC membership is appointed by the U.S. Secretary of Commerce to constitute an independent consensus body. The ALSC consists of the following:

- representatives from each agency that participates in this program and publishes and maintains grading rules and inspection facilities covering the various species (rules-writing agencies (Appendix A));
- representatives from each lumber inspection agency participating in the program that does not publish grading rules (nonrules-writing agencies); and
- representatives from each of the following groups: architects, construction engineers, general contractors, home builders, consumers, wood-using industries, millwork manufacturers, lumber wholesalers, and lumber retailers.

The ALSC operates as an independent body with defined functions regarding the maintaining, implementing, and enforcing of the PS 20 requirement. The ALSC established the National Grading Rules Committee (NGRC) as an autonomous body charged with establishing and maintaining nomenclature and descriptions of lumber grades. The NGRC is composed of: members of rules- and nonrules-writing agencies from the United States and Canada, BOCA, ICBO, SBCCI, the American Society of Civil Engineers (ASCE), the American Institute of Architects (AIA), consumer and distributor organizations, the Federal Highway Administration, the Defense Logistics Agency, NIST, and the USDA Forest Service, Forest Products Laboratory (FPL).

The ALSC also establishes a Board of Review, an independent body that is composed of three members elected by the ALSC. The function of the Board is certification and accreditation of grade rules and design values as established by the NGRC, and of agencies that wish to grade lumber under PS 20 provisions. PS 20 states that design values contained in grading rules shall be developed in accordance with appropriate standards of the American Society for Testing and Materials (ASTM) and other technically sound criteria. NIST, with the advice and council of the FPL, is the final authority on the appropriateness of such standards and criteria. Figure

Table 1.—*Standards and specifications to determine design values for solid-sawn structural lumber under PS 20 (17).*[a]

Size class	Grading	Property basis	Primary standard	Applicable to
Boards	Visual	Clear wood	ASTM D245	All species
Dimension	Visual	Clear wood	ASTM D245	Redwood, cedars, minor western softwoods, hardwoods
		Full size	ASTM D1990	Other softwoods
	Mechanical	Full size	MSR policy, rating by specific gravity policy	All species
Timbers	Visual	Clear wood	ASTM D245	All species

[a] Preservative treatment of solid-sawn wood members by pressure processes is given in AWPA C2 (11).

2 is a representation of the ALSC process. When grade marks are approved, Board-recognized quality inspectors conduct periodic inspections to verify that the grading agencies are following ALSC-approved procedures. Additional sources of information on the ALSC procedure are given in Francis and Collins (14) and *Wood Design Focus* (23).

As noted, ASTM procedures are generally used to derive allowable properties for lumber sold in the United States. However, ASTM standards may not always exist for some products or procedures. In some cases, the Board may have "policy" documents that cover such omissions. For example, ASTM D 1990 (10) does not provide guidance for determining allowable properties for species growing outside of the United States. The Board's "Foreign Lumber Policy" authorizes guidelines and criteria for agencies accredited to grademark and supervise the grademarking of lumber produced outside of the United States (18). The Board also has guidelines on how to apply the principles of D 1990 to foreign species. Another example is mechanically graded lumber. Although a standard is under development, no ASTM standard currently exists on property assignment procedures for mechanical graded lumber. Again the Board has policy documents on mechanically graded lumber. In addition, each of the rules-writing agencies that wish to mechanically grade lumber must have Board-approved documents on their property assignment and quality control procedures. The Board also provides guidelines on how to adapt these procedures to the mechanically graded lumber produced outside the United States.

Model building code approval for solid-sawn structural lumber is generally through the codes recognition of the *NDS* (1). Although the model code may recognize ALSC-approved design values directly, tying their use to the *NDS* helps keep allowable properties in sync with other *NDS* procedures. Preservative treatment requirements for lumber are given in AWPA C2, and requirements for fire-retardant treated lumber (FRT) are given in AWPA C20 (11).

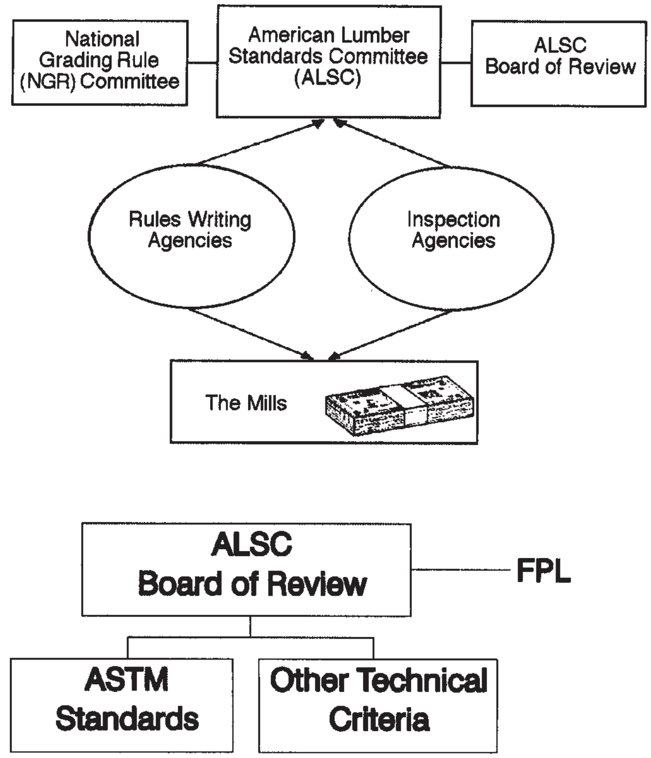

Figure 2.—*American Lumber Standard Committee: (top) the process, and (bottom) the Board of Review.*

Structural composite lumber

Structural composite lumber is a generic term for a family of proprietary lumber products composed of wood elements combined with exterior structural adhesives to form lumber-like members. All current composite lumber products have the grain of the wood elements oriented parallel to the length of the member. Structural composite lumber is made commercially from both softwood and hardwood species. Three types of structural composite lumber are currently commercially produced in the United States: LVL, PSL, and laminated strand lumber (LSL). There are many producers of LVL in the United States and around the world. At present, only one company makes PSL and LSL products in the United States.

Laminated veneer lumber.—LVL is manufactured from layers of veneer with the grain of all veneers parallel to the length of the member. This contrasts with plywood, which traditionally has the grain angle in adjacent veneers perpendicular to each other. Most manufacturers use sheets of 2.5- to 4.2-mm-thick veneers. Typically, the rotary cut veneer is dried, then graded ultrasonically for stiffness and graded visually for defects. The veneers are laid-up with the higher grades on the face and the lower grades in the core. These veneers are stacked to achieve the desired thickness and laid end-to-end to achieve the desired length. Within the stack, the end joints of the veneer are staggered to minimize their effect on strength. The veneer and adhesive are bonded under pressure into a billet that is typically 44 mm thick, 1.2 m wide, and up to 24.4 m long. Billets are then ripped to the desired width and cut to the desired length. The common sizes of LVL closely resemble those of solid-sawn dimension lumber.

Parallel strand lumber.—PSL is manufactured from strands or elongated flakes of wood. As with LVL, production typically starts with rotary cut and graded veneer. However, it is not necessary to start with full sheets. Because the logs are rotary peeled, veneers for PSL are mostly sapwood from the outer portions of the tree. The veneer sheets are then clipped into approximately 19-mm-wide and 2.4-m-long strips. A waterproof adhesive is applied, and the strands are fed into a continuous press. Adhesive curing is accomplished using microwave equipment. Billets, which are up to 20 m long, are then cut into smaller members. Although any species could be used to produce PSL, species currently used include Douglas-fir, southern pine, western hemlock, and yellow-poplar.

Laminated strand lumber.—LSL is made from elongated flakes using technology similar to that used to produce OSB. Strands used in LSL are significantly longer than those used to produce OSB. This greater strand length and the orientation of the strands parallel to the length of the finished product are the key to the longitudinal strength of LSL. Unlike LVL and PSL, logs for the production of LSL need not be peelable. Thus, smaller logs and crooked logs of many species could be used in LSL production. Species currently being used for production of LSL include aspen and yellow-poplar.

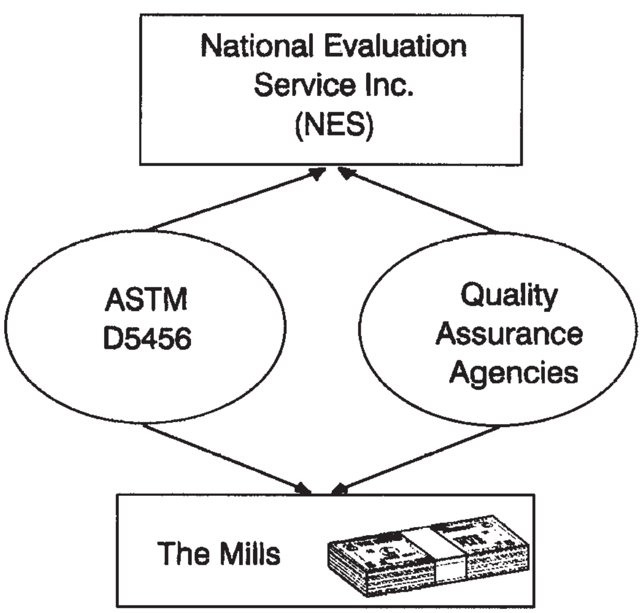

Figure 3.—*Approval process for composite lumber products.*

Structural composite lumber standards.—Manufacturers of composite structural lumber would first obtain data and conduct analysis according to ASTM D 5456 (10) (Fig. 3). This documentation could be submitted to building officials in every city, county, and state where the product will be marketed. This, however, would usually be impractical, so the model building code organizations created "evaluation services." The evaluation service of each of the three model building codes is a subsidiary corporation that reviews the technical report, grants recognition if the information meets the requirements of that particular building code, and publishes Evaluation Service Reports. These reports verify the product's compliance with the model code. The process may also include periodic inspection and testing by a quality control inspection service approved by the model building code agency. For manufacturers who plan to distribute their products nationally, application can be made to the National Evaluation Service (NES). Although more cumbersome and expensive, issuance of an NES report carries the seal of all three model code agencies and the IBC. For a detailed discussion of the process, see Smulski (19).

Standard design values have not been established for each type of structural composite lumber. Rather, each manufacturer submits data for approval by the model building code agencies as discussed previously. Thus, design information varies among manufacturers and is given in their product literature. In general, the products are manufactured so that allowable properties compare favorably with those of solid-sawn dimension lumber (Table 2). Preservative retention and penetration limits for structural composite lumber can be found in AWPA C33 (11).

Structural panel products

Structural panel products are a family of wood products made by bonding veneer or flakes into flat sheets to form large structural elements. The primary members of this family are plywood (which consists of products made completely or in part from bonded wood veneer) and flakeboards (made from bonded strands, wafers, or flakes). Plywood and flakeboard products make up a large percentage of the panels used in structural applications, such as roof, wall, and floor sheathing. Other panel products include particleboard made from particles and fiberboard and hardboard made from wood fibers. These other panel products are typically used in nonstructural applications and are not discussed here.

Plywood

Plywood is composed of relatively thin layers of plies or veneer with the wood grain of adjacent layers at right angles. The outside plies are called faces or face and back plies. The inner plies with grain parallel to that of the face and back are called cores or centers, and the inner plies with grain perpendicular to that of the face and back are called crossbands. Total panel thickness is typically no less than 1.6 mm (1/16 in.) nor more than 76 mm (3 in.). Veneer plies may vary in number, thickness, species, and grade. Stock plywood sheets usually measure 1.2 by 2.4 m (4 by 8 ft.), with the 2.4-m (8-ft.) dimension parallel to the grain of the face veneers.

The alternation of grain direction in adjacent plies provides plywood panels with dimensional stability across their width. It also results in fairly similar axial strength and stiffness properties in perpendicular directions within the panel plane. The laminated construction results in a distribution of defects and markedly reduces splitting (compared with solid wood) when fasteners penetrate the plywood. The process of bonding wood has been known to exist since the time of the ancient Egyptians, approximately 3,500 years ago. Plywood as we know it today has existed since about 1905, when it was introduced at the Lewis and Clark Centennial Exposition in Portland, Oregon. Today, more than 1.86 billion m^2 (20 billion ft.^{2}) of plywood (3/8-in.-thick basis) is produced annually in the United States.

Two general classes of plywood, covered by separate standards, are available:

- construction and industrial plywood; and
- hardwood and decorative plywood.

Voluntary Product Standards PS 1-95 and 2-92 cover the performance requirements for construction and industrial plywood. The performance requirements for hardwood and decorative plywood are covered by ANSI/HPVA HP-1 (15). Each standard recognizes different exposure durability classifications, which are primarily based on the moisture resistance of the adhesive used, as well as the grade of veneers. The majority of U.S. structural applications involve construction and industrial plywood; therefore, the remainder of this section discusses only this product.

A significant portion of the market for construction and industrial plywood is in residential con-

Table 2.—*Example of design values for structural lumber products.*[a]

Product	Modulus of elasticity	Bending strength (F_b)	Tensile strength parallel to grain (F_t)	Compression strength parallel to grain (F_c)	Horizontal shear strength (F_v)	Shear strength perpendicular to grain (F_{cp})
	(× 10^6 lb./in.^{2})	(lb./in.^{2})				
Composite						
LVL	2.0	3,452	1,805	2,725	285	750
PSL	2.0	3,335	2,400	2,900	210	525
LSL	1.5	2,520	1,580	1,950	400	775
Solid-sawn						
Select Structural	1.8	2,850	1,600	2,100	100	565
No. 2	1.6	1,500	825	1,650	90	565
Machine stress rated	2.0	2,400	1,925	1,975	90	565
Machine stress rated	1.5	1,650	1,020	1,700	90	565

[a] Values are for dry 2 by 4s. Solid-sawn lumber is southern pine. Approximate design values can be obtained by multiplying lb./in.^{2} values by 6,894 to obtain millions of pascals (GPa).

struction. This market reality has resulted in the development of performance standards for sheathing and single-layer subfloor or underlayment for residential construction. Plywood panels conforming to these performance standards for sheathing are marked with grade stamps indicating conformance to a particular product standard, exposure durability classification, span rating, thickness, and the logo of the third-party inspection agency overseeing the panel's manufacture. Nonmandatory information, such as the manufacturer's name or mill number, is often included.

The span rating system for construction and industrial plywood was established to simplify specifications of plywood without resorting to specific structural engineering design. This system indicates performance without the need to refer to species group or panel thickness. It gives allowable span when the face grain is placed across supports. If design calculations are desired, APA–The Engineered Wood Assocation provides a design guide titled *Plywood Design Specifications* (7). This design guide contains tables of grade stamp references, section properties, and allowable stresses for plywood used in construction. Preservative treatment requirements for plywood are listed in AWPA C9 and C22, and FRT requirements in C27 (11).

Flakeboard products.—Structural flakeboards are wood panels made from specially produced flakes typically from relatively low-density species, such as aspen or pine, and bonded with an exterior-type water-resistant adhesive. Two major types of flakeboards are recognized: OSB and waferboard. OSB is a flakeboard product made from wood strands (long and narrow flakes) that are formed into a mat of three to five layers. The outer layers are aligned in the long panel direction, and the inner layers are aligned at right angles to the outer layers, or are randomly aligned. In waferboard, products are made almost exclusively from aspen wafers (wide flakes), the flakes are not usually oriented in any direction, and they are bonded with an exterior-type resin. Because flakes are aligned in OSB, the bending properties (in the aligned direction) of this type of flakeboard are generally superior to those of waferboard. For this reason, OSB is the predominant form of structural flakeboard. Panels commonly range from 6- to 19-mm (0.25- to 0.75-in.) thick and 1.2- by 2.4-m (4- by 8-ft.) surface dimension. However, thicknesses up to 28.58 mm (1.125 in.) and surface dimensions up to 2.4 by 7.3 m (8 by 24 ft.) are available by special order.

Waferboard originated in the 1950s as a product that utilized species such as aspen that were not considered suitable as sources of lumber, veneer, and pulp. OSB evolved from the original waferboard product, and it was not until 1982 that the first true OSB mill was constructed. Today, approximately 1.15 billion m^2 (12.4 billion $ft.^2$) (3/8-in.-thick basis) of OSB is produced annually in the United States.

A substantial portion of the market for structural flakeboard is in residential construction. For this reason, structural flakeboards are usually marketed as conforming to a product standard for sheathing or single-layer subfloor or underlayment and are graded as a performance-rated product similar to that for construction and industrial plywood. The Voluntary Product Standard PS 2-92 (17) is the performance standard for wood-based structural-use panels, which governs such products as OSB, waferboard, composite panels, and includes plywood. The PS 2-92 is not a replacement for PS 1-95, which contains necessary veneer grade and adhesive bond requirements as well as prescriptive lay-up provisions and includes many plywood grades not covered under PS 2-92. The same span-rating system used for structural plywood is also applied for structural flakeboard products. The only difference is that the grade stamp used for structural flakeboard references the PS 2-92 standard (17).

Design capacities of structural flakeboards can be determined by using procedures outlined in the APA (8). In this reference, allowable design strength and stiffness properties, as well as nominal thicknesses and section properties, are specified based on the span rating of the panel. Additional adjustment factors based on panel grade and constructions are also provided. Because of the complex nature of structural flakeboards, formulas for determining actual strength and stiffness properties, as a function of the component material, are not currently available. No preservative standards exist for structural flakeboards because serviceability after pressure preservative treatment is quite variable.

Glued-laminated timber

Glulam is an engineered product made by end jointing solid-sawn structural lumber end-to-end to make continuous laminations. These laminations are then face bonded to produce structural members that can have a wide range of lengths, sizes, or structural shapes. Laminations are typically made of specially selected and prepared sawn lumber. Standard 38-mm-thick (nominal 2-in.-thick) lumber is used for straight or slightly curved members, and standard 19-mm-thick (nominal 1-in.-thick) lumber is used for members with significant curvature. Glulam members are specially designed to resist stresses based on their intended use as bending, axial, curved, or tapered members by strategically placing higher grade laminations in areas that will be subjected to higher stresses. These members are used as main, load-carrying structural members in residential as well as commercial applications. Recent advancements in this technology have also included the use of high-strength fiber-reinforced plastics as a tension reinforcement layer to the glulam members. The high strength and stiffness properties of these advanced materials enable the design of these reinforced glulam members to utilize a larger percentage of low-quality laminating lumber in the beam cross section.

Glulam, as it is known today, was first used in 1893 to construct an auditorium in Basel, Switzerland. Patented as the "Hetzer System," it used adhesives that were not waterproof, thereby limiting its applications to dry-use conditions. Today, approximately 30 laminating plants in the United States and Canada produce approximately 708,000 m^3 (300 million board feet) of glulam timber per year.

Bending members.—Glulam members intended to carry flexural loads are designed using bending combinations. Referred to as horizontally laminated members, they are based on combinations that provide the most efficient and economical cross section for resisting the bending stresses caused by loads applied perpendicular to the wide faces of the laminations. Typically, lower grades of laminating lumber are used for the center portion (core) of the combination where bending stress is low, and higher grades are placed on the outside faces where bending stress is relatively high.

Axial members and those loaded parallel to the wide face.—Axial combinations were developed to optimize the cross section of glulam members designed to resist the axial tension and compression stresses. They are also used as members having flexural loads applied parallel to the wide faces of the laminations, called vertically laminated members.

Curved members.—The same combinations that are used for straight, horizontally laminated bending members are also used for curved members. However, an important consideration with these members is the development of radial stresses in the curved portion, commonly referred to as radial tension. Loads that cause a change in the curvature of a curved member induce radial tension stresses perpendicular to the wide faces of the laminations. As the radius of curvature of a glulam member decreases, the radial stress in the curved portion increases. Because of the relatively low strength of lumber in tension perpendicular to grain compared with tension parallel to grain, these radial stresses can become a critical factor in designing curved glulam combinations.

Tapered members.—Straight or curved beams of glulam can be tapered to achieve architectural effects, provide pitch roofs, facilitate drainage, and lower wall height requirements at the end supports. The taper is created by sawing across one or more laminations at the desired slope. The cut is made only on the compression side of a glulam member, because interrupting the continuity of the tension-side lamination would decrease strength capacity. Common forms of tapered combinations include single tapered (a constant slope from end to end), double tapered (two slopes that form a peak), tapered both ends (slope at each end of a flat middle), and tapered one end (slope only at one end).

Glued timber standards.—The product standard for glulam members is the ANSI/AITC A190.1, *The American National Standard for Wood Products—Structural Glued Laminated Timber* (2). This standard has a two-step approach to all phases of the manufacturing process. The first is a qualification step in which all equipment and personnel critical to the production of a quality product are thoroughly examined by a third-party agency. Next, daily quality assurance procedures and criteria are established that are targeted to keep each of the critical phases of the manufacturing process under control. The manufacturing process involves:

- drying and grading the lumber;
- end jointing the lumber into longer laminations;
- face gluing the laminations;
- finishing and fabrication; and

- preservative treatment, when necessary.

Specific combinations for softwood glulam are published in the AITC 117—Manufacturing. Design values assigned to these various glulam combinations are published in AITC 117—Design (3). Provisions for hardwood glulam combinations are provided in AITC 119 (4). Design values published in these standards are based on procedures of ASTM D 3737 (10). Preservative treatment requirements for glulam are published in AWPA C28 and C32 (11).

Mechanically laminated members

Mechanically laminated members refer to a family of structural members in which the individual layers of lumber are mechanically fastened together. Typical mechanical fasteners include nails, screws, bolts, and/or shear transfer plates. Additional discussion of mechanically laminated member design is given in Chapter 15 of the *NDS* (1). These types of members are commonly used in agricultural structures to house equipment and/or farm animals.

Performance of these members is based primarily on the grade of the laminating lumber and the adequacy of the mechanical fasteners to transfer the shear loads between plies. Thus, grade requirements of the laminating lumber are governed by the same Voluntary Product Standard (PS 20) used for solid-sawn lumber; lumber design values are those published in the *NDS*. The American Society of Agricultural Engineers standard EP 559 (9) publishes recommendations on the proper pattern and density of mechanical fasteners, as well as procedures for determining design values for these members. Basically, design values for mechanically laminated members are determined by applying repetitive-member adjustment factors to the lumber design values. These materials should be preservative-treated before construction only as required in AWPA C15 or C16 (11).

Prefabricated structural I-joists

Prefabricated structural I-joists are a second-generation engineered wood product that evolved from the marriage of structural panel products to form the web and lumber-type products to form the flanges. The concept of using a wood panel product web and sawn lumber flanges was not fully developed until the 1940s, when it was driven by war-related research on wood aircraft construction. A structural wood I-joist, as we know it today, first appeared in 1968 when Trus Joist Corporation began marketing this as a proprietary product. Today, the United States has over a dozen wood I-joist manufacturing plants producing more than 12.2 million lineal meters (300 million lineal feet) annually (19). Wood I-joists manufactured today can vary in depth from 23.5 cm (9.25 in.) to 97 cm (38 in.) and are available in lengths up to 24 m (80 ft.). Flanges range from 3.8 by 3.8 cm (1.5 by 1.5 in.) to 11.7 by 6.7 cm (4.625 by 2.625 in.) in cross section, and webs range from 0.95 cm (0.375 in.) to 2.2 cm (0.875 in.) thick.

Wood I-joists are proprietary products; the manufacturing procedures used by each producer vary. There are no standards that provide guidelines on required flange and web properties; each manufacturer produces a product that is unique to that facility. Therefore, each wood I-joist manufacturer must individually gain building code acceptance for its product. Manufacturers use either empirical (testing-based), rational (engineering theory-based), or combined empirical/rational analysis procedures to establish wood I-joist allowable design properties. ASTM D 5055 outlines the empirical/rational procedures (10). Treatment of wood I-joists is currently not recommended.

Metal-plate-connected wood trusses

Metal-plate-connected (MPC) wood trusses are an efficient framework of lumber-type products held together by toothed metal plates that are designed to support loads over large spans. Truss construction has existed in the United States for more than 200 years, when heavy timber structures were commonplace, and has existed for hundreds of years in Europe. The first light-frame MPC wood trusses were designed and constructed in the mid-1950s and have since become a standard structural element in residential and commercial construction. Clear spans of 9 m (30 ft.) are easily achieved in residential structures and up to 30 m (100 ft.) in light commercial and agricultural applications. The Wood Truss Council of America estimates that more than 75 percent of all new residential roofs constructed in the United States today use MPC wood trusses.

Similar to all other engineered wood products, the individual components and the manufacture of MPC wood trusses must meet certain established requirements. The majority of manufacturers in the United States use web and chord members consisting of standard 5- by 10-cm (nominal 2- by 4-in.)

Table 3.—*Standards and specifications for various structural wood products.*

Product	Product standard	Preservative treatment[a]	Engineering design values: Calculation procedure	Engineering design values: Published design value
Round timbers				
Piles	ASTM D25	AWPA C3	ASTM D2899	NDS
Utility poles	ANSI 05.1	AWPA C4, C35	- -	ANSI 05.1
Construction poles	ANSI 05.1	AWPA C23	ASTM D3200	ASAE EP 560
Construction logs	- -[b]	- -	ASTM D3957	- -[b]
Structural composite lumber	- -[b]	C33	ASTM D5456	- -[b]
Structural panel products				
Construction plywood	PS 1, PS 2	AWPA C9, C22, C27	APA-PDS	APA-PDS
Hardwood plywood	HPVA HP-1	NR	- -	***
Flakeboard products	PS 2	NR	APA-N375B	APA-N375B
Glulam	ANSI 05.1	AWPA C28, C32	ASTM D3737	AITC 117, AITC 119, NDS
Mechanically laminated members	EP 559	AWPA C2	ASAE EP 559	- -[b]
Wood I-joists	- -[b]	NR	ASTM D5055	- -[b]
Wood trusses	ANSI/TPI 1	AWPA C2, C20	ANSI/TPI 1	- -[b]

[a] Standards listed are specific to the product; all timber products are also covered by AWPA C1 (1998); NR is not recommended.
[b] Due to the proprietary nature of the product, this information is normally supplied by the manufacturer.

lumber; however, members as large as standard 5- by 30-cm (nominal 2 by 12 in.) lumber are not uncommon. The same product standards and design values used for the visually graded, machine stress rated, and machine evaluated lumber are applied to these members. The primary concern with the performance of the web and chord material is the variability of material properties. For this reason, manufacturers of light-frame wood trusses are the largest users of MSR lumber in the wood industry. This is also the reason that glued-laminated timber, LVL, and PSL are gaining acceptance as alternative web and chord material.

The connector plates consist of 20- to 14-gauge sheet metal having teeth that are punched out of one side. Two metal plate connectors are pressed into the wood joints, one on each side, to provide the load transfer between elements. These connector plates must meet the requirements published in ANSI/TPI 1-95, *National Design Standard for Metal Plate Connected Wood Truss Construction* (22). This standard also provides the procedures for designing MPC wood trusses in the United States. The design process involves determining internal truss member forces through a structural analysis, computing combined stress indices for each member from the forces determined, selecting wood member sizes and grades, and sizing plates for connections. The number of structural analysis models and methods can be many; therefore, the ANSI/TPI 1-95 standard provides some guidance for choosing a mathematical model for typical design situations. The structural analysis model can then be used to ensure that stresses in the individual members do not exceed design values and that overall truss deflection does not exceed specified design criteria.

Concluding remarks

The system of model building codes and voluntary product standards in the United States has been refined over many years (Table 3). These codes and standards provide the public with assurance of product quality for structural wood products within a legal framework that is responsive to both public needs and technological developments. Understanding this system, and equivalent systems in Canada and Mexico, is essential in promoting free exchange of wood products within North America. To foster this exchange, a list of selected Spanish language publications related to standards and uses for structural wood products is contained in Appendix B.

Literature cited

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3. _________. 1993. AITC 117. Standard specification for structural glued laminated timber of softwood species. AITC, Englewood, Colo.
4. _________. 1996. AITC 119. Standard specification for structural glued laminated timber of hardwood species. AITC, Englewood, Colo.
5. American National Standards Institute, Inc. 1992. ANSI 05.1. American National Standard for Wood Poles—Specifications and Dimensions. ANSI, New York, N.Y.
6. _________. 1992. ANSI C2. National Electrical Safety Code. ANSI, New York, N.Y.
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8. _________. 1995. Design capabilities of American Plywood Association performance-rated structural-use panels. Tech. Note N375 B. APA, Tacoma, Wash.
9. American Society of Agricultural Engineers. 1998. EP 559: Design Requirements and Bending Properties for Mechanically Laminated Columns. EP 560: Design Values for Round Construction Poles. ASAE, St. Joseph, Mo.
10. American Society for Testing and Materials. 1998. Volume 04.10, Wood. Annual Book of Standards. ASTM, West Conshohocken, Pa.

    D 9 Standard terminology relating to wood.

    D 25 Standard specification for round timber piles.

    D 245 Standard practice for establishing structural grades and related allowable properties for visually graded lumber.

    D 1990 Standard practice for establishing allowable properties for visually graded dimension lumber from in-grade tests of full-size specimens.

    D 2899 Standard practice for establishing design stresses for round timber piles.

    D 3200 Standard specification and test method for establishing recommended design stresses for round timber construction poles.

    D 3737 Standard practice for establishing stresses for structural glued laminated timber (glulam).

    D 3957 Standard practice for establishing stress grades for structural members used in log buildings.

    D 5055 Standard specification for establishing and monitoring structural capacities of prefabricated wood I-joists.

    D 5456 Standard specification for evaluation of structural composite lumber products.
11. American Wood-Preservers' Association. 1997. Book of Standards. AWPA, Woodstock, Md.

    C1 All timber products—preservative treatment by pressure processes.

    C2 Lumber, timbers, bridge ties and mine ties— preservative treatment by pressure processes.

    C3 Piles—preservative treatment by pressure processes.

    C4 Poles—preservative treatment by pressure processes.

    C9 Plywood—pressure treatment.

    C15 Wood for commercial-residential construction —preservative treatment.

    C16 Wood used on farms—pressure treatment.

    C20 Structural lumber—fire-retardant treatment by pressure processes.

    C22 Lumber and plywood for permanent wood foundations—preservative treatment by pressure processes.

    C23 Round poles and posts used in building construction—preservative treatment by pressure processes.

    C27 Plywood—fire-retardant treatment by pressure processes.

    C28 Standard for preservative treatment of structural glued laminated members and laminations before gluing of southern pine, Pacific Coast Douglas fir, hem-fir, and western hemlock by pressure processes.

    C32 Glue laminated poles of southern yellow pine or Coastal Douglas-fir—preservative treatment by pressure processes.

    C33 Preservative treatment of structural composite lumber.

    C35 Western red cedar, Alaska yellow cedar, northern white cedar, western larch poles—thermal treatment.
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16. International Conference of Building Officials. 1994. Uniform Building Code. ICBO, Whittier, Calif.
17. National Institute of Standards and Technology. Voluntary product standards. U.S. Dept. of Commerce, Gaithersburg, Md.

    PS 2-92. Performance standard for wood-base structural-use panels, 1992.

    PS 20-94. National Institute of Standards and Technology, 1994.

    PS 1-95. Construction and industrial plywood, 1995.
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21. Southern Building Code Congress International. 1994. Standard Building Code. SBCCI, Birmingham, Ala.
22. Truss Plate Institute. 1995. ANSI/TPI 1-95. National design standard for metal plate connected wood truss construction. TPI, Madison, Wis.
23. Wood Design Focus. 1997. Machine-stress rated lumber. Forest Prod. Soc., Madison, Wis. 8(2):1–24.

Appendix A: Rules writing grading agencies for solid-sawn lumber

- Northeastern Lumber Manufacturers
  272 Tuttle Road
  P.O. Box 87A
  Cumberland Center, ME 04021
  www.nelma.org
- Northern Softwood Lumber Bureau
  272 Tuttle Road
  P.O. Box 87A
  Cumberland Center, ME 04021
  www.nelma.org
- Southern Pine Inspection Bureau
  4709 Scenic Highway
  Pensacola, FL 32504
  (850) 434-2611, fax (850) 433-5594
  www.spib.org
- Western Wood Products Association
  Yeon Building
  522 SW Fifth Ave.
  Portland, OR 97204-2122
  (503) 224-3930, fax (503) 224-3934
  www.wwpa.org
- West Coast Lumber Inspection Bureau
  Box 23145
  6980 SW Varns Road
  Portland, OR 97223
  (503) 639-0651, fax (503) 684-8928
  www.wclib.org
- Redwood Inspection Service
  405 Enfrente Drive
  Suite 200
  Novato, CA 94949
  (415) 382-0662, fax (415) 382-8531
  www.calredwood.org
- American Wood Preservers' Association
  P.O. Box 5690
  Granbury, TX 76049
  (817) 326-6300, fax (817) 326-6306
  www.awpa.com

Appendix B: Selected Spanish language publications

Anonymous. 1994. Manual de construccion de estructuras ligeras de madera: Manual of light-frame timber construction. Nat'l. Council of Wood Construction, Mexico City, Mexico. 472 pp.

PFS Research Foundation, 2402 Daniels St., Madison, WI 53718. Phone: 608-221-3361, Fax: 608-221-0180, e-mail: pfsrf@pfs-teco.com.

PS 2-92. Norma de realizacíon para entrepaños de uso estructural basados en madera.

PS 1-95. Madera contrachapada industrial y de construcción

Southern Pine Council, Kenner, La. Available in Mexico from Dr. Ramon Echenique-Manrique, Western Wood Prod. Assoc., Mecma S.A. de C.V., Apartado Postal 459, Xalapa, Veracruz 91000. Phone: 522-816-3275, Fax: 522-816-3275.

Answers to Often-Asked Questions About Treated Wood. Publ. No. 516.

International Buyer's Guide. Publ. No. 501.

Pressure-Treated Southern Pine—Int'l. Ed. Publ. No. 509.

Southern Pine Lumber: An Importer's Reference Guide. Publ. No. 505.

Southern Pine Inspection Bureau, Inc., Pensacola, Fla. Available from SPIB, 4709 Secenic Highway, Pensacola, FL 32504-9094. Phone: 850-434-2611, Fax 850-433-5594.

Spanish Graders Manual for Boards and 2-Inch Dimension. Publ. No. 9000.

Spanish Pocket Guide for 2-Inch Dimension. Publ. No. 9001.

Spanish Pocket Guide for Finish and Boards. Publ. No. 9003.

Spanish Pocket Guide for Timbers. Publ. 9004.

Spanish Pocket Guide for Radius Edge Decking. Publ. No. 9005.

Western Wood Products Association, Portland, Oreg. Available in Mexico from Dr. Ramon Echenique-Manrique, Western Wood Prod. Assoc., Mecma S.A. de C.V., Apartado Postal 459, Xalapa, Veracruz 91000. Phone: 522-816-3275, Fax: 522-816-3275.

Ponderosa Pine Species Facts. Publ. No. FS-2S.

Softwoods of the Western USA. Publ. No. WW-S.

Western Wood Species Book, Vol. 1: Dimension. Publ. No. EX-10S.

Western Wood Species Book, Vol. 2: Common Boards. Publ. No. EX-11S.

Western Wood Species Book, Vol. 3: Factory Lumber. Publ. No. EX-12S.

Role of building codes and standards on wood products utilization: A Canadian perspective

Vishwa Mathur
Conroy Lum
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Abstract

As a major exporter and consumer of wood products, Canada relies on a number of codes and standards to support the use and marketing of wood products. The large number of commercial wood products and applications for these products has created a need for a wide array of wood product standards. These standards may be maintained by Canadian-based or internationally recognized organizations.

The successful use of wood products in building construction ensures that these codes and standards function efficiently and effectively as a system. Issues requiring codes and standards may arise from quite diverse areas, from the manufacture of the wood product to the design of the building assembly that uses the product. As a result, the codes and standards system involves a number of organizations, experts, and stakeholders.

In this paper, we provide a partial list of Canadian wood products codes and standards. As an example of the role of codes and standards in wood product utilization, we present a description of the Canadian lumber quality system and the roles of the organizations who maintain the codes and standards that form the lumber quality system.

The presence of codes and wood product standards help producers and consumers align their expectations of the product and the structure. This, in turn, helps to ensure a reliable supply of wood products and support for economical wood-based construction.

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Introduction

Wood has long been and continues to be the predominant material used in residential construction in Canada (13). There are also many notable examples of wood use in commercial and industrial buildings. Codes and standards have influenced the use of wood as a structural material, and building practice has played a role in shaping how codes and standards have developed in Canada.

Canada is one of the world's largest producers of wood members and components that form the structural system of wood construction. One class of these products, dimension lumber, is used in a wide variety of building applications. The Canadian system of codes and standards, although large in scale and diverse in geography, deals efficiently with a construction material that can be used in applications ranging from a member in an engineered truss component to a spacer block around a window or door opening.

The number of codes and standards on wood use and production in Canada and around the world is very large. To attempt to discuss all of the details and roles of these standards would be impossible. Instead, we focus on the lumber quality system and its relationship to the design and building codes for wood construction.

A global view of this system demonstrates how codes and standards have evolved to support the use of structural dimension lumber. Over time the production and use of structural dimension lumber not only represents a large part of the overall economic activity, but also provides society with an efficient means of renewing and expanding the housing stock.

The resource

Canada's supply of softwood has been utilized commercially for many years. The industry has grown to represent a significant proportion of the world's production and potential supply of softwood lumber. Table 1 lists major Canadian species that are used for softwood lumber production. The use of wood in building construction began well before the adoption of the current practice of testing large samples of softwood production to establish strength property distributions.

Table 1.—*Commercially harvested softwood species in Canada.*

Commercial group (stamp ID)	Softwood species
Spruce-Pine-Fir	White spruce Englemann spruce Black spruce Red spruce Lodgepole pine Jack pine Alpine fir Balsam fir
Douglas-fir-Larch	Douglas-fir Western larch
Hem-Fir	Western hemlock Amabilis fir
Northern species	Any other Canadian softwood species graded according to the NLGA rules, including cedars, red and white pines, eastern hemlock, aspen, and others

Forests generally contained a number of species that were harvested together and consequently used as a mix in building construction. The table also shows how the softwood species are grouped into "commercial species groupings". The majority of Canadian production falls within the first three commercial species groups.

Overview of the quality system

Various parts of the production and quality system associated with structural dimension lumber have evolved together. It is difficult to know which part of the system developed first into what we have today. There are, however, basic elements of standardization that have facilitated the recognition of structural dimension lumber everywhere. These include the development and accreditation of a nationally recognized set of lumber grading rules covering species groupings, lumber sizes, and other specifications.

In Canada, the two bodies that play a key role on these issues are the Canadian Lumber Standards Accreditation Board (CLSAB) and the National Lumber Grades Authority (NLGA). As a result of this standardization, it is possible to develop and maintain a lumber marking system that is recognized across Canada, in the United States, and in many overseas markets.

Canadian Lumber Standards Accreditation Board

The CLSAB is an independent organization that was formed to create uniformity in the grade stamping of lumber across Canada. It is recognized in codes and standards as the accreditation body for lumber grading in Canada. The CLSAB role is to ensure that the system produces lumber that conforms to approved rules or standards. This includes ensuring that lumber produced to meet these requirements is properly identified. It is also to review changes to grading rules and procedures, and to enforce the system with sanctions where necessary.

The CLSAB accredits the regional grading agencies that certify the application of Canadian grade rules and are given the authority to issue and revoke grade-stamps. There are currently 16 Canadian agencies accredited by the CLSAB. Each agency has a unique logo that must appear on the grade-stamps issued to qualified mills.

The grade-mark provides the end-user with the assurance that the lumber has been produced in accordance with the published rules. The identified grade is indexed to design information, such as design values or spans. The grade marking also assists contractors in locating the appropriate building material, and building inspectors in checking that the correct lumber has been used. The moisture content at time of manufacture, species, and grade designations are identified on the mark.

As indicated in the previous discussion on the resource, the lumber may be from one of a number of production regions. This is usually not relevant to the end-user. However, in the event of a dispute, the information on the grade-stamp will allow the mill to be identified through the agency.

National Lumber Grades Authority

The NLGA is the lumber grade rules-writing agency in Canada. While there are several such agencies in the United States, there is only one agency in Canada that writes the lumber grading rules (8). There are several regional agencies, on the other hand, that apply these rules by licensing producers to use their grade-stamps.

All grading rules in the United States and Canada include the requirements of the National Grading Rule (NGR) for Dimension Lumber. The NGR requirements are based on a visual grading system, with maximum allowed characteristics linked to grade definitions and sizes. This is a recipe-type approach to minimum requirements for lumber. The system balances interests of producers and consumers in a way that has been harmonized and rationalized over many years.

The NLGA is also responsible for maintaining a series of standards governing the production of structural lumber products that involve grading by mechanical means or finger-jointing. These standards are referred to as Special Product Standards (SPS) and provide manufacturers with alternate means of producing a structural lumber product (9–11).

The same applications are generally available to all structural lumber products, regardless of whether they are visually graded, mechanically graded, or finger-jointed. In some cases, the special products may be more suitable for end uses than the general product. In other cases there may be restrictions, such as finger-jointed lumber that is produced for vertical use applications only (i.e., wood frame walls).

The need for a special standard is not dictated by the potential end use of the product, but by the steps involved in the production. In the case of mechanically graded lumber, a machine is used to first pre-sort the lumber into categories. Because of this, visual graders examining the pieces further down the production line are not required to consider the usual grade characteristics. Furthermore, the mechanical process is able to determine the stiffness of a piece of lumber.

Since the mechanically graded product is different, so is its standard. Unlike the visual grade rules, the SPS for mechanically graded lumber does not provide specific machine settings. Instead, the standard specifies the sampling, test, and evaluation procedures to assess whether or not the producer is qualified and whether or not the product conforms. Reinspection procedures, which are used in the event of a dispute over whether the product meets the requirements of the standard, are also provided.

Canadian Standards Association (CSA)

The CSA also develops standards on wood products. The CSA is accredited by the Standards Council of Canada to develop consensus-based standards. Its Strategic Steering Committee for the Forest Products Sector oversees a wide range of wood product standards. The Committee authorizes technical committees to develop and revise the standards. The steering and technical committees include balanced representation from users, producers, regulatory bodies, and general interest groups.

The CSA has published Standard O141, Softwood Lumber, which lays out the framework for a lumber grading system in Canada (6). This standard is recognized in the Canadian building code as the basis on which the NLGA grading rules and the CLSAB accreditation are formed. The fundamental requirements in the CSA standard are relatively stable, whereas NLGA rules change from year to year. This provides greater flexibility to satisfy both producer and consumer demands, while maintaining the basic lumber grading system.

Overview of design values

Structural materials must have engineering design values for use in housing as well as engineered construction. Some building designs, such as arenas or bridges, require significant engineering input. In these cases every structure is a prototype, and design values are critically important. In the case of housing, experience from the millions of structures that have been built over the years lends a valuable perspective to design values.

Traditionally, there have been two approaches used to develop design values. The first approach is based on tests of small clear wood specimens. Adjustments are made to clear wood strength properties to account for the effect of potential strength reducing characteristics that are permitted in the grade. The key feature of this approach is that the development of design values and the writing of grade rules are explicitly linked.

The clear wood approach to developing design values has been largely replaced by the in-grade lumber testing. The philosophy of this approach is that a more accurate assessment of the mechanical properties can be made by testing samples of full-size lumber that meet the grade requirements rather than testing small clear samples and adjusting the test values for permitted grade characteristics.

The basic requirement of the in-grade approach is that there be a mature system of producing and grading the lumber. This is the case for the major species groups in Canada. As a result, there are implicit links between the grade rules and the design values, even where the links are not explicit. In the North American In-Grade program, the wood was sampled as commercially produced and sent to the national laboratory (Forintek Canada Corp.) for testing. All of the testing was done in laboratory conditions.

An alternative approach to the in-grade philosophy would be a strength-class system, where lumber is produced and graded to meet pre-existing strength and stiffness levels (similar to mechanical grading).

American Society for Testing and Materials (ASTM) Committee on Wood

The development of design values involves two basic steps: establishing characteristic mechanical property values and strength distributions, and conversion of the characteristic property values to design values. In this section, we will briefly discuss the first step of the process. The second step will be discussed in the next section on design codes.

Statistical values to characterize basic mechanical properties of lumber can only be established by testing samples of lumber. Test standards are needed because there is no single correct method for conducting such an evaluation. This is particularly important for lumber, which is a nonhomogeneous anisotropic material whose mechanical properties, such as bending strength or modulus of elasticity, can vary depending on the testing configuration.

Furthermore, the analysis of the raw test results to develop the basic statistical values should also follow a standard. The two main documents that support the in-grade lumber testing approach are ASTM D4761 on testing and ASTM D1990 on data analysis and conversion of the test data to characteristic values (1,2). These two standards were developed under the ASTM consensus process and are designed specifically for the development of lumber design values from tests of samples of in-grade lumber.

In the past, design values were developed on the basis of tests of small clear wood specimens. Standards to support that approach were also developed under the ASTM standards process: ASTM D143 provides the test protocol, while ASTM D2555 and ASTM D245 provide procedures for statistical analysis and reducing the data to characteristic values (3–5). This method of establishing the characteristic mechanical properties continues to be used for some solid-sawn products.

For low-volume grades, sizes, and species, it is more cost-effective to take the small clear wood sample approach in developing characteristic strength values. However, for high-volume grades and species combinations where large random samples of production can be selected, the approach of deriving characteristic strength values from tests of in-grade lumber samples is currently preferred in the United States and Canada since it assesses the products in nearly final use conditions.

CSA Engineering Design in Wood Committee

The next step in the development of lumber standards is the conversion of characteristic values to design values that can be used to properly specify lumber for end use applications. In Canada, the design document that governs and forms the basis of engineering design in wood is the Canadian Standards Association Engineering Design in Wood Standard CSA O86.1 (7). The Canadian Wood Council is the Secretary for the CSA O86.1 committee.

CSA O86.1 has a limit states design format, as opposed to the allowable stress design format found in ASTM and other U.S. standards. Limit states design includes consideration of material property variability, in addition to statistical property estimates. The United States has recently completed a wood design standard that is similar in format to the Canadian standard, called the load resistance factored design approach.

Although the U.S. and Canadian design standards may differ, underlying data that was used to develop design values for Canadian lumber in the United States and Canada are the same. This is only possible because both standards recognize the same lumber quality system and the methodology for developing basic lumber properties (i.e., the in-grade lumber testing approach).

The CSA Engineering Design in Wood committee is where consensus is reached on how best to utilize and implement information on the performance of wood products and assemblies. Much of the lumber information has been simplified to make it easier for the general engineer to design wood structures. The determination of member capacities has been formatted to take into account the potential end use of the material, as well as the manner in which the material is produced.

Because of the simplification in the development of basic design values, efficiencies in generic systems such as floors and walls are typically achieved by developing "system factors" for use by designers. Results from in-grade lumber testing programs can provide a more accurate estimate of the variability in mechanical property for use in system analyses. The alternatives would be to ignore such efficiencies or inundate the designers with additional information so that they are able to optimize the system.

One of the roles of the CSA committee on Engineering Design in Wood is to determine whether a particular design condition can be improved by the introduction of a system factor. The use of data from full-size lumber-testing programs helps provide a rational basis for such factors. This in turn allows the code to rationally evolve as products, such as engineered wood products, are developed.

National Building Code of Canada (NBCC)

The National Building Code of Canada (NBCC) is a model code that provides minimum requirements for health and safety issues associated with buildings (12). Provincial or municipal regulatory authorities adopt this model code "as is" or supplement its provision to account for specific local requirements.

The NBCC offers two paths for wood frame building construction (Fig. 1): an engineered design approach where a registered designer oversees de-

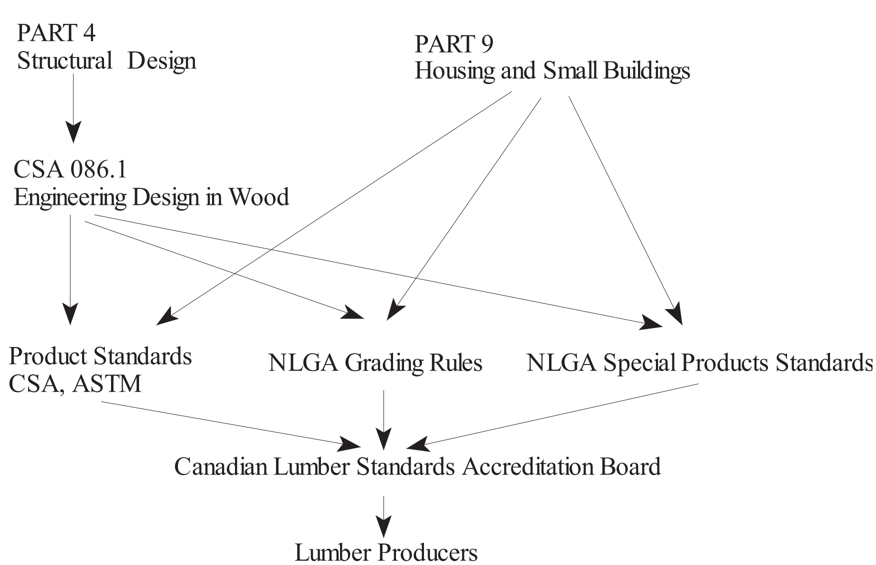

Figure 1.—*Canadian codes and standards related to the lumber quality system: National Building Code of Canada.*

sign and construction of the structure; and a prescriptive approach that provides a description of basic building blocks that are considered acceptable provided specific end-use conditions are met. The latter approach takes into account the myriad of prototypes of small wood buildings across the country.

The NBCC is moving to an Objective-Based Code format in 2001. This means that the objectives of the code will be clearly stated and that each provision will be referenced to an intent statement that relates to the higher objectives. Although this resembles a performance-based code, it will continue to include prescriptive requirements so long as they can be related to accepted objectives.

NBCC Part 4: Engineering Design

This section of the NBCC describes the minimum design loads for engineered construction. These loads are largely material independent. However, some of the loads are interrelated with material properties. For example, earthquake performance of wood-frame buildings is scaled to seismic response factors that are listed in Part 4.

Material design values are also specified in Part 4 by reference. For the major categories of engineering materials for building construction (wood, steel, reinforced concrete, masonry, plastics, and aluminum), references are made to the specific engineering design standard for that material. In the case of wood, that standard is CSA-O86.1.

Structural systems are often built from a number of engineering materials. Directives from the committee on the NBCC for all engineering design standards to be converted to a limit states and reliability-based format has enabled design in combinations of materials to be done more efficiently. For a typical structure consisting of a combination of materials (for example, a timber-framed floor supported on a reinforced masonry wall), the intent of the building code is to ensure that the minimum level of reliability is consistent between materials.

Wood trusses are an example of a product that uses lumber and sheet steel connectors to make an engineered component. A CSA standard on metal truss plates addresses design values for the connectors. Lumber properties are used together with metal properties to resist the loads specified in Parts 4 and 9 of the NBCC.

NBCC Part 9: Housing and Small Buildings

The majority of wood construction is built under the scope of this part. As indicated in its title, the section is only applied to homes and small buildings. Application is limited to structures that are less than 600 m^2 in floor area and three storeys in height; however, it is possible for such buildings to exceed these limitations.

Part 9 is a prescriptive code: it uses simple instructions as the basis for its requirements. One advantage of this system is that it allows simple and routine structures to be built without the intervention of a design professional. It does not preclude the involvement of a design professional if there are details that fall outside of the scope of the section.

Another advantage of Part 9 is that it offers economy based on past performance. Given the broad experience with wood frame construction, there are considerable savings in this approach. For one thing, the loads are less. Wood trusses designed in accordance with Part 9 can be made lighter, given the history of good performance.

The Canadian Wood Council (CWC) develops tools such as span books based on the engineering provisions of Part 9. CWC is also working on a guide that lays out the engineering provisions that are implicit in the design of housing and small buildings in Canada.

There is also work underway on the application of the building code, including Part 9, to existing buildings. As the occupants' needs change, many of these small structures or homes also may be periodically renovated. This section permits such alterations to be made quickly and economically.

Concluding remarks

The Canadian system of codes for producing and using structural dimension lumber in building construction has been and continues to be an effective means of expanding and renewing the inventory of buildings in Canada and the United States. The efforts placed on standardization have meant that there is always a ready supply of construction material for building projects ranging from erection of a simple partition wall to the construction of a low-rise office structure.

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Mexican standards for forest products

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Introduction

The primary purpose of standards is to protect society from the failure or malfunctioning of products. In terms of the Federal Law on Measurements and Standardization, these documents present common and repeated usage rules, specifications, attributes, testing methods, characteristics, or prescriptions applicable to a product, process, installation, system, etc. In Mexico, there are two forms of standards. Official Standards (NOM) are issued by authorized government agencies; they are compulsory and of general applicability. Mexican Standards (NMX) are issued by recognized standards organizations; except in certain situations they are voluntary.

The great majority of standards employed in Mexico are voluntary. However, the use of the NMX is desirable from many points of view. The products manufactured according to approved standards are much more acceptable than those produced without the benefit of a defined pattern. Users who buy standardized products know exactly what they are getting, whereas users who acquire nonstandardized products face greater uncertainty. In addition, massive industrialized production of components of any kind is only possible if the manufacturer follows some standard that establishes the specifications, characteristics, and tolerances of a product.

National measurement and standardization law

In 1992, the Congress of the Union established the Federal Law on Measurements and Standardization. This Law represented a very important qualitative change with respect to previous versions. For the first time formal recognition was granted to the activities of private organizations in the area of standardization, laboratory accreditation, and certification. Heretofore, the only government office authorized to issue standards was the Mexican Federal Bureau of Standards (Dirección General de Normas—DGN) of the Mexican Ministry of Commerce (Secretaría de Comercio y Fomento Industrial—SECOFI). The new Law recognized Certification Organizations (private businesses that carry out certification activities) and National Standardization Organizations (private businesses that prepare Mexican Standards). The Law was recently modified (May 20, 1997) to better reflect the new realities of globalization and international competition, as well as to correct some deficiencies in the previous version.

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Mexican Standards for wood and wood-based products

The most useful standards for wood building construction among those published in the Official Federal Government Gazette (Diario Oficial de la Federación) are included in the following groups:

Series	Industrial sector
B	Steel products
C	Construction materials
CH	Control and measurement apparatus
EE	Packaging products
R	Miscellaneous industries
H	Metal: mechanics products, welding, and metal coatings
X	Basic standards and symbols

Quality specifications for wood and other products utilized in wood building construction are included in series C. Fasteners for timber structures are included in series H.

The standards of greatest interest for wood building construction are the following:

B-9-1979.—Carbon steel sheets galvanized by the hot immersion process for general uses.

C-145-1982.—Grouping and minimum distances in relation to fire protection specifications.

C-178-1983.—Wood preservatives soluble in water and oil. Establishes the specifications that commercial preservatives soluble in water (chemical salts based on copper, chrome, and arsenic (CCA)) and oil-soluble preservatives (pentachlorophenol and creosote) must meet to be used in the preservation of wood for building construction. It details the classification, products, base oxides, concentration, or presentation among other aspects. Unfortunately, it contains several significant factual errors that render it less reliable. The existence of new preservatives in the market make the revision of this standard necessary.

C-222-1983.—Prevention of termite attack specifications. It describes the way in which the soil in contact with the foundation must be treated and the products that can be applied. Some of the insecticides recommended in this standard have recently been prohibited in Mexico, which makes revision of this standard necessary.

C-224-1983.—Standard sizes for sawn lumber for building construction specifications.

C-239-1985.—Visual stress grading of sawn pine lumber for structural purposes specification.

C-294-1980.—Determination of burning surface characteristics of construction materials.

C-322-1981.—Pressure-treated wood. Establishes the classification and penetration/retention requirements that pressure-treated softwoods for structural purposes must meet according to the use and expected risk in service to prolong the service life of buildings. Three levels of risk are established for wood in service along with the retention and penetration levels that must be achieved in the impregnation processes, depending on the type of preservative employed (creosote, pentachlorophenol, CCA salts, arsenic-copper-ammonium salts). This standard is based on similar American Wood-Preservers' Association (AWPA) standards and COPANT 30-2-003 from 1977.

C-326-1978.—Pine plywood.

C-307-1980.—Fire resistance determination.

H-64-1960.—Cylindrical nails.

H-23-1951.—Steel screws for wood.

H-47-1972.—Hex-bolts.

R-017-1981.—Lumber industry; Preserved wood. Establishes uniform terminology employed in the wood preservation industry. It includes 76 terms related to the impregnation processes, preservative products, and pressure-treated wood. It is based on the COPANT 30.2 standard of 1977. Several of the definitions of terms are imprecise or erroneous.

R-031-1976.—Pressure-treated wood with reaction salts that form no leaching salts. This standard was first written in 1973 with the code number G-16. It makes reference to treatment with CCA salts, focusing basically on the qualities of the pressure-treated wood, rather than on the characteristics of the salts or on pressure treatment itself.

The majority of these Mexican standards were issued between 1973 and 1992. Many of them must be revised before our industry can be competitive on the international scene.

In 1997, a performance standard was approved for structural panels employed in walls, roofs, and floors in light construction of any material, including wood (32). We consider the requirements specified in the standard to be excessive, particularly those related to the allowable limits of deformation under static and impact loads. In all likelihood these requirements will not be met by conventional light-frame wood construction or similar concepts, which represents a tremendous disadvantage for this type of construction. The same is true for more modern wood-based construction techniques used in other countries in North America, which will be at similar disadvantage if this standard is enforced by the housing authorities in Mexico.

There are three new Mexican standards that should be published in the foreseeable future:

- a performance standard for structural wood-based boards used in housing construction,
- a stress-grading rule for structural-use of hardwoods, and
- testing methods to determine the effectiveness of wood preservatives.

Some of the procedures used to obtain information about the mechanical behavior and strength of wood are standardized in Mexico. They are included in the series EE (Packaging) and are for small clear specimens of wood.

EE-95-1980.—Wood—Determination of defects in planed sawn wood.

EE-103-1981.—Wood—Determination of moisture.

EE-121-1981.—Wood—Determination of compression perpendicular to grain strength.

EE-122-1981.—Wood—Determination of compression parallel to grain strength.

EE-137-1982.—Wood—Determination of static bending strength.

EE-164-1983.—Wood—Tension perpendicular to grain, testing method.

These standards took as a model the test methods used in the United States and published by the American Society for Testing and Materials (ASTM) (2). The specimens detailed in these standards have a 5- by 5-cm cross section. The length varies according to the type of test. The tests must be made on standard durations of load and moisture contents. The tests are made with straight grain specimens free from defects such as knots and splits. These tests are particularly useful to compare the properties of different species. The tests for structural-size lumber and fasteners are not yet standardized.

Building codes

The set of steps and actions that influence the economy of the structures is very large, involving building codes and complementary documents. Building codes for the design of structures are official documents intended to protect society against the collapse or structural malfunctioning of buildings.

In Mexico the most advanced building code and the one that serves as a model for the building codes of the states and municipalities is the Federal District Building Code (7). This code refers only to urban constructions (buildings).

The building code for the Federal District

In 1987, the current version of the Federal District Building Code was issued. The regulations that it contains are grouped in sections called Titles. The regulations related to structural design are included in Title VI (8), and they contain a general description of the design problem which is applicable to any material and structural system. This Title also includes detailed regulations relative to earthquake design and foundations design.

The particular requirements, derived from the application of the general principles to the specific materials and structural systems, are found outside the main body of the code and are grouped in a series of Complementary Technical Standards (NTC) which have the same legal value as the code. We advocate that the code remain in place without changes, since its principles and general procedures are not prone to be outdated soon due to advances in the knowledge of structures or the development of new materials and construction techniques. On the other hand, the Complementary Technical Standards can be updated much more easily, since the process for becoming official is simplier than for the building code.

Title VI of the code contains the basic design concepts according to the limit states design approach. This is a format in which all aspects of design are considered in a rational and ordered way, and it permits the easy incorporation of probabilistic criteria.

Procedure to evaluate safety

The procedure prescribed to evaluate safety consists of verifying that—for the different load combinations specified and before the appearance of any limit state that could present itself—the design strength be equal or greater to the effect of the nominal actions that participate in the load combinations being studied, multiplied by a load factor.

The values of the nominal actions and of the load factors (F_c, generally greater than unity) that must be considered are specified in Title VI. The procedure to determine applicable nominal resistance and the resistance factors (F_R, less than unity) are generally established in the Complementary Technical Standards corresponding to the different materials. The strength reduction factors vary according to the degree of safety and the precision of the equation used in the calculations, according to the expected mode of failure and type of structural element.

The Complementary Technical Standards apply the general procedures specified by the code in the design of concrete, steel, masonry, and wood structures. The requirements follow a common criteria of limit states in which the actions and the load factors are equal for all the materials, and the strength reduction factors are determined to achieve comparable reliability levels.

Documents related to the building code

In order to facilitate the comprehension and application of the requirements of the NTC, Commentaries, Examples, and Design Aids have been prepared which are published separately (27). The preparation of these Commentaries is a systematic practice in United States, Canada, New Zealand, and Mexico, among other countries.

Complementary technical standards for design and construction of wood structures

The standards are applicable to sawn wood which meets the requirements of visual stress grading specified in the standard C-239-1985 for softwoods, and rules for hardwoods specified in an Appendix, and whose average specific gravity is greater than 0.35. Four groups of woods are considered: one for conifers and three for hardwoods according to their modulus of elasticity.

The design of plywood elements is also included, but there are no specifications for glued laminated lumber since this material is not commonly used in the country. Nails, toothed plates, perforated plates, lag-screws, and bolts are considered for fastener design. Special connectors such as split rings and shear plates that are not commonly used in Mexico are not included.

According to the limit states methods, it must be verified that the design strength be equal or greater to the internal design force. The standard for wood specifies that the strength of the elements for different actions be determined with the conventional solid mechanics formulas for elastic materials, considering that the behavior of the wooden members is approximately linear up to the failure. This hypothesis is also utilized in Canadian building codes for bridges (31) and others.

In the strength formulae, the strength of the material is expressed as a modified characteristic strength, which is defined as the characteristic strength multiplied by the product of a series of modification factors (K_i) that take into account the influence of the moisture content, load duration, size of the elements, grading rules, and other aspects.

The characteristic strengths correspond to the fifth percentile of the strength distributions obtained from the test of structural-size elements in bending, compression, tension, and shear. The values included in the standards are based on an extensive in-grade testing program for pine species (23–25) and for tropical hardwoods (4), and data from studies carried out in other countries with species similar to those included in the standard. The modification factors are similar to those specified in other codes.

Serviceability limit states

The main serviceability limit state considered is deflection. Instantaneous deflections due to the service loads of short duration are to be calculated with the conventional formulae of solid mechanics, using the average value of modulus of elasticity. To take into account the effects of long duration of load, the immediate deflection due to the part of the load that acts continuously is to be multiplied by 1.5 if the wood is installed in dry conditions and by 2.0 for humid conditions.

Plywood

In general terms, the limit states for plywood elements are revised similar to the case of sawn wood. The mechanical properties and the determination of strength are based on Canadian studies available on these subjects (33,34) and an experimental program carried out in Mexico (5).

Fasteners

The standard contains tables with the basic short duration strength of joints with nails, toothed plates, perforated plates, bolts, and lag-screws. These basic strengths must be equal or greater to the design loads acting over the joint. The basic strength takes the smallest of the following values:

- characteristic strength of the section multiplied by the resistance factor and the appropriate modification factors; or
- characteristic load that produces a relative slip of the joined pieces of 0.5 mm, multiplied by the resistance factor and the appropriate modification factors.

The determination of the proposed values was made following the recommendations of Keenan et al. (29). The validity of the values calculated analytically was verified with a series of experimental studies (4,35).

Observations regarding standardization in Mexico

The impact of standardization in the development of the forest products industry in the country is still not significant. The standardization culture in Mexico is rather incipient with many officials, industry people, and distributors. One of the reasons for this state of affairs is that Mexico had a fundamentally closed economy for a long time and standardization in its broadest sense was not needed.

We consider that at the present time the vast majority of the industrial sectors, including the forest sector and the commercialization sector in general, have a better conscience about the importance of standardization—above all, when considering export opportunities. It is necessary to give greater diffusion to the standards and their related concepts to promote a culture of standardization.

Proposal to be considered for compatibility of standards and building codes

In order to facilitate the exchange of goods and services in the field of forest products and construction materials between Canada, the United States, and Mexico, it is necessary to seek the harmonization of the regulatory and standardization aspects. In the field of construction, for instance, it is required that the design procedures be similar and compatible in order to assure the free transfer of technical information. Additionally, it is also important that the technical standards and specifications of materials be understandable for the professionals and the organizations in charge of enforcing them in the three countries. In this respect, the building codes in the United States (1), Canada (3), and Mexico (9) are comparable since they are based on the same approach of limit states, but they do have important differences in certain aspects.

Species grouping

The codes and specifications for building construction in United States and Canada include information about the forest species of both countries. On the other hand, the Mexican design standards contain information only about Mexican species: softwoods graded according to standards NMX-C-239-1985 (22) and hardwoods graded with a rule described in Appendix 1 of that document. Across the North American market, however, there is a great variety of wood products for structural uses, particularly in the United States and Canada. With the idea of fostering optimal usage of these products by builders in all three countries, a grouping system for wood with structural purposes has been devised (6). This system would permit the utilization of virtually any forest species available, with the condition that the relevant values of characteristic strength in bending and modulus of elasticity are known. The grouping system proposed is based in the Renard progression (30) and is very similar to the system proposed by the international organization ISO (28) and to a system developed in the United States by Green and Kretschmann (26). According to this proposal, it would only be necessary to take the modulus of elasticity values to determine the category corresponding to the species in the grouping system; bending strength would be verified to be similar to that required in that group.

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Nonwood Forest Products

Nontimber forest products exploitation in Canada

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Introduction

Mechanization of forestry operations are putting new pressures on the work force. Indeed, a 1994 Price-Waterhouse study demonstrated that between 1989 and 1994, the number of jobs available in Ontario's forest industry declined by 24 percent while there was an increase of 15 percent in wood harvesting. These trends, experienced country-wide, along with the often low margin of profitability associated with forestry operations result in increased unemployment in forestry-dependant communities, despite increased forest harvest. Unfortunately, increased unemployment in forestry-dependant communities is difficult to circumvent because of a widespread lack of opportunity and incentive for business expansion in primary resource exploitation. This problem is exacerbated by the fact that there are no new boom-like opportunities in the timber harvesting sector in Canada.

In recent years, the public, entrepreneurs, and government agencies have begun to realize that new economic opportunities are needed to revitalize local stagnant or shrinking economies. Along with tourism and high technology, one alternative that catches the imagination of many is secondary or nontimber forest products (NTFPs). NTFPs encompass a wide variety of products derived from forests, including conifer boughs, wild rice, wild blueberries, maple syrup, wild mushrooms, and wild medicinal herbs. With the exception of British Columbia, there is no legal or broadly accepted definition of NTFPs in Canada. For the purpose of this paper we define NTFPs as nontimber products growing in forests and derived from plants or animals in their natural environment. However, we exclude animal products from this discussion because of wildlife regulations that control and/or prohibit the sale of wildlife or their products in many Canadian provinces. Applied broadly, our definition includes logging residues such as branches, stumps, or rotten logs that have been culled during timber harvesting operations. Products such as wild ginseng that have been domesticated for cultivation in agricultural settings are excluded from this definition. In this paper we present a brief overview of the current and potential harvest of NTFPs in Canada.

Current NTFP industry in Canada

For the purpose of this paper we have conducted an informal survey of NTFP value of shipments by dealing with known entrepreneurs, local and regional economic development agencies, academics,

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Table 1.—*Estimated value of annual shipments of non-timber forest products in Canada for 1997.*

	(thousand $)
Maple syrup	$120,000
Mushrooms	$100,000
Berries (*Vaccinium* spp, *Amelanchier* spp)	$20,000
Medicinal plants	$1,000
Ornamentals	$500
Essential oils	$50
Total value of shipments	$241,000

Table 2.—*Value of shipments from Canada's timber industry for 1997.*

	(million $)
Newfoundland	$603
Nova Scotia	$1,009
New Brunswick	$2,960
Quebec	$15,102
Ontario	$12,059
Manitoba	$702
Saskatchewan	$714
Alberta	$3,482
British Columbia	$22,039
Total Canada	$58,700

consultants in the fields of NTFPs, and government agencies. Table 1 reports the findings for 1997 illustrating a total yearly value of approximately $241 million in NTFP shipments. Indeed, NTFPs outputs make up 0.4 percent of the $58.7 billion yearly output in forest products from Canada. However, NTFPs play a critical socio-economic role at the regional levels as they contribute greatly to rural economies through seasonal employment. At present, maple sap products and wild mushrooms make up the bulk of Canada's NTFP output for national consumption and international export. In contrast, wild berries, medicinal plants, and other NTFPs play a relatively unimportant economic role at the national level. It is difficult to determine the actual potential of NTFP outputs in Canada. In this discussion we elected to estimate the yearly potential of NTFPs at $750 million mostly based on the reported abundance of wild mushrooms and medicinal plants. This output is comparable to the total value of timber product shipments from Manitoba, Newfoundland, and Saskatchewan for 1997.

Advantages and drawbacks of the NTFP industry

Despite its small size, the NTFP industry offers a number of advantages that are of interest to economic development agencies. NTFPs can take advantage of regional unemployment problems generated by the recent restructuring of Canada's economy because they require relatively unskilled labor compared to other primary sector industries such as mining and logging. As well, NTFP exploitation is a relatively easy industry to initiate because it requires low capital investments. Finally, training of harvesters is easy, particularly since a limited number and/or products are harvested at a given time. On the other hand, NTFP exploitation also has drawbacks with regard to unpredictable harvests associated with the vagaries of the weather, commodity-type fluctuations in the price of products because of global demand and offer cycles, and the limited shelf lives of food products such as wild mushrooms.

Research needs

Scientific research should play a critical role in the expansion of the NTFP industry in Canada. The first issue to address is one of resource inventory. At this point, there are only a handful of studies dealing with NTFP production and most of the data scanty and regional in nature. Second, research should emphasize means to determine the relationship between environmental factors such as climate and NTFP production. The knowledge of Native elders should prove of immense value to scientists. Third, attempts should be made to develop tools for the domestication of NTFPs.

Conclusion

Although NTFPs contribute only a small fraction to Canada's overall economy they often represent a lifeline to rural economies. Because of sharp increases in the global demand in NTFPs, their exploitation is becoming more and more attractive for the economic development of rural communities. As Canadians become more aware of the NTFP potential, there is a need to further augment our knowledge base, through scientific research, in order to create a sustainable industry.

Nonwood forest products in Mexico: Current status and perspectives

Cuauhtémoc Tejeda Godínez
Marisela C. Zamora Martínez
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Introduction

Nonwood forest products come from the plants and wild fungi that grow in forest or forest-related lands, not including wood and fuelwood. They include all the vegetable and fungi products and the services from the forest areas.

About 1,000 nonwood products (leaves, fruits, glue, wax, fibers, soil, fungi, bark, etc.) are used, which belong to many differnt species present in various ecosystems across the country. Around 5,000 taxa of useful plants and 215 fungi species have been identified so far, which is a conservative total since Mexico has the fourth greatest level of biodiversity in the world and possesses all the vegetation types on Earth. In this context, several authors have estimated the existence of 30,000 phanerogamic species in Mexico, and between 120,000 and 140,000 fungi species (Table 1) (17,31).

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Even if these products are the only source of income in some regions (or in more general terms, an important complementary option for family economics during a part of the year), there is a very little systematized information about the production processes of each of them. This condition is favored by the nonwood forest resources characteristics themselves, such as periodicity, since many are annual and their production depends directly upon the prevailing climatological conditions in their natural areas. Most of them do not have stable production over time; this might be influenced by the variations in their marketing. These variations, in addition to the aspect of manual collection, make it difficult for the authorities responsible for the normal recommendations, control, and protection of the resource to keep track.

In terms of their economic significance, there are around 70 nonwood forest products that have rather constant marketing and are subject to official control. During the last 7 years, their production has been averaged around 68,000 tons. However, when each of the nonwood forest products is analyzed in a particular way, significant changes have been observed as a consequence of marketing demands.

Another relevant aspect of Mexican nonwood forest resources is that Mexico is a country with a great cultural array. There are 52 ethnic groups that possess a very rich traditional knowledge about their environment and its natural resources in order to satisfy their own food, health, housing, and clothing needs.

Objectives

The objectives of this paper are to:

- describe nonwood resources of Mexico based on diversity, utilization, marketing, and regional, economic and social importance.
- assess their problems and possible solutions.

Nonwood products diversity

Since pre-Hispanic times, the ecological complexity of Mexico has created a biological universe of a singular and diverse variety, and a source of multiple nonwood products. These products grow throughout the whole territory, from arid lands to the tropics (Fig. 1). The greatest commercial production is obtained from mild-weather ecosystems, with more than 50 percent of the total national production (38).

In the mild-weather regions, some of the most outstanding products are:

- forest soil, which is known as mountain soil;
- pine resin (*Pinus* spp.), which comes from 10 different species;
- edible mushrooms (around 200 species);
- walnut (*Juglans regius*);
- "laurel" leaf (*Litsea glaucescens);*
- moss (*Thuidium robustum*, *Polytrichum juniperinum*);
- hay (*Tillandsia* spp);
- *perlilla* rod (*Simphoricarpus microphyllum*);
- *zacatón* root (*Muhlenbergia macroura*);
- *doradilla* (*Selaginella lepidophylla*);
- *quelites* (*Chenopodium* spp.);
- willow (*Salix* spp.); and
- *taxcal* (*Juniperus deppeana*).

The utilization of nonwood resources in the arid and semi-arid zones is a collection activity that involves a great number of species. The most important of these, in social and economic terms, are:

- *candelilla* (*Euphorbia antisiphyllitica*);
- *lechuguilla* (*Agave lecheguilla*);
- *orégano* (*Lippia* spp.);
- *nopal* (*Opuntia* spp.);
- *palmilla* (*Nolina* spp.);
- numerous cacti (*Pereskiopsis* spp., *Hylocereu*s spp., *Mammillaria* spp., *Lophophora williamsii*, etc.);
- *maguey* (*Agave* spp.);
- *piñón* or pine kernel (*Pinus cembroides*);
- *gobernadora* (*Larrea tridentata*);
- *jojoba* (*Simmondsia chinensis);*
- *palo fierro* (*Olneya tesota*);
- yucca (*Yucca carnerosana*, *Yucca* sp.);
- *sotol* (*Dasilyrion* sp.);
- *damiana* (*Turnera diffusa*);
- *zarzaparilla* (*Smilax* spp.);
- *mezquite* (*Prosopis juliflora*); and
- *cortadillo* (*Nolina cespitifera*).

In the tropical regions of Mexico (dry and humid), the diversity of useful species is large, and consequently, the amount of nonwood products that are harvested is even greater. Regularly used for consumption at the local level are:

- *camedor* palm (*Chamaedorea tepejilote, Chamaedorea* spp.);
- *chicozapote* (*Manilkara zapota*);
- royal palm (*Scheelea liebmannii*);
- hat palm (*Sabal* sp., *Brahea dulcis*);
- *otate* (*Arthrostylidium pitteri, Bambusa* spp.);

Table 1.—*Actual and potential use of nonwood forest resources in relation to their type of ecosystem.*

Type of ecosystem	Total number of species[a]	Known species[a]	Commercial species used at present[b]
Tropical (deciduous and evergreen forests)	11,000	10,000	38
Mild-cold forests	10,000	7,800	53
Arid and semiarid zones	6,000	2,200	33
Aquatic and subaquatic vegetation	1,000	- -	- -
Wild herb vegetation	2,000	- -	- -
Total	30,000	20,000	124

[a] Source: (31).
[b] Source: (36).

- fat pepper (*Pimenta dioica*);
- *barbasco* (*Dioscorea alata*, *Dioscorea* spp.);
- *malanga de montaña* (*Xanthosoma robustum*);
- *cuatecomate* (*Crescentia alata*);
- *guarumbo* (*Cecropia obtusifolia*);
- *nanche* (*Byrsonima crassifolia*);
- *cuachalalate* (*Anphyterigium adstringens*);
- *pochote* (*Ceiba aesculifolia*);
- *guaje* (*Leucaena* spp.); and
- *querengue* (*Vitex mollis*).

In general, the diversity of nonwood forest products is considerable, especially considering that several of the collected plant species represent sources of multiple products, for example:

- *Byrsonima crassifolia*: its fruit is edible and is used in the preparation of soft drinks, and its bark is medicinal and used as a tanning material.
- *Cecropia obtusifolia*: the leaves are medicinal and are used as forage, the seeds are edible, and and fibers are obtained from the fruit.
- *Fouquieria splendens* (*ocotillo*): the flowers and seeds are both medicinal and edible.
- *Brosimun alicastrum* (*ramón*): used ornamentally and for fencing family orchards, its foliage and seeds are given to cattle as forage, the fruits are edible, and its latex has curative and galactogenous properties.

Data from several ecosystems reveal a more abundant existence of nonwood products compared with the number of identified species. In a tropical evergreen forest in the state of Oaxaca, 198 plant taxa were determined, to which 262 products were associated (47). Javelly (19) describes the presence of 400 useful plant species in the deciduous tropical forest of the state of Morelos, some of which have as many as eight uses and supply multiple nonwood products.

Other important nonwood resources, due to their wide diversity and distribution as well as for their cultural significance, are the medicinal plants.

In Mexico the existence of at least 1,200 plant species has been estimated. This number does not include lichens and fungi, which are subject to an intense harvesting.

In general terms it can be said that the diversity of nonwood forest products in Mexico is huge, and that the number of 5,000 useful plant species is rather small compared to the many products derived from them.

Harvested species

The great variety of nonwood forest products gathered in Mexico is valuable as products consumed by the harvesters and as trade goods for local and/or regional markets, from which there exist no reliable records. Nevertheless, the government agencies responsible for legislating the utilization of forest resources during the last 8 years have controlled those nonwood products commercialized in different Federal states and that must satisfy the gathering requirement of the Forest Law, according to the type of market in which they compete and the volumes they achieve.

In this respect, the records of nonwood forest products recall 124 plant species and fungi, that belong to three types of ecosystems: mild-cold weather (53), tropical (38), and arid/semi-arid (33) (Fig. 1).

Nonwood forest resource use and exploitation

As has been previously mentioned, the number of nonwood products currently harvested for self-consumption or local trade is by far more than the number of species involved. Figure 2 shows the plant parts used, the products they generate, and the uses they have, based upon harvesting records obtained by producers in the Natural Resources State subdelegations that belong to the Fishing, Natural Resources and Environment Ministry of the Mexican Federal Government (SEMARNAP).

Moreover, the nonwood forest products lists could be even longer and include coloring substances, pesticides, cosmetics, essential oils, and soap substitutes. Other uses include forage, veterinary, medicinal, ceremonial, flavoring, textile, etc.

Production and commercial value

Production

Since the production of nonwood forest resources in Mexico depends upon environmental conditions as well as national and international market demands, their value tends to vary when each product is analyzed individually. For example, white pine mushroom or *matzutake* (*Tricholoma magnivelare*) production during the 1996 rainy season exceeded 11 tons. In 1997, this volume diminished more than 80 percent due to a rainfall shortage in the producing regions (44).

However, the general trend of the nonwoods commercial production had very slight fluctuations in the 1989–1996 period (Fig. 3). Special attention is deserved by forest soil used in gardening and nursery plant production because great volumes are extracted with a low sales price. During the last 7 years, the volume of forest soil obtained has been estimated around 75,000 tons.

Medicinal nonwood products are another important group of these resources but few records exist, in spite of being ambitiously traded by large distributors. Production estimates calculate 350,000 annual tons of barks, stems, roots, inflorescences, fruits, and complete plants.

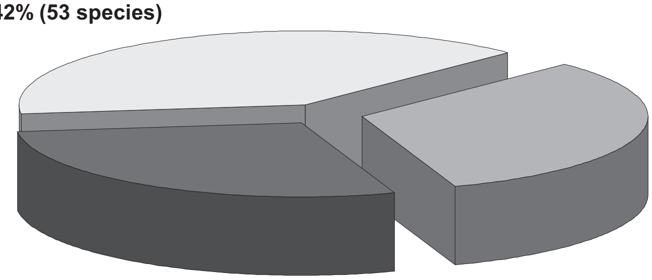

Figure 1.—*Number of species used by ecosystem (from 8-year official data records).*

Forest resources → Useful Part → Product → Use

Useful Part	Product	Use
1. Bud	1. Tar	1. Nutritional
2. Bark	2. Thinner	2. Craft
3. Flower	3. Rubber	3. Alcoholic beverage
4. Fruit	4. "Cerote"	4. Brushes
5. Foliage	5. Chewing gum	5. Abrasive substances
6. Sprouts	6. Bud	6. Wax
7. Leaf	7. Bark	7. Chewing gum
8. Latex	8. Extracts	8. Cosmetic
9. "Penca"	9. Fiber or "ixtle"	9. Lubricants
10. Propagules	10. Flower (quiote)	10. Sacks
11. Complete plant	11. Fruit	11. Tanning substances
12. Root	12. Foliage	12. Brooms
13. Rootlet	13. Flour	13. Small brooms
14. Branch	14. Leaf	14. Spices
15. Rosin	15. Juice	15. Foaming substances
16. Rhizome	16. "Mezcal"	16. Steroids
17. Seed	17. Palm heart	17. Tires
18. Stem	18. Pinecone	18. Foliage
19. Forest soil	19. "Penca"	19. Medicinal
20. Leaf soil	20. Complete Plant	20. Furniture
21. Rod	21. Root	21. Ornamental
	22. Branch	22. Paint
	23. Seed	23. Roofs
	24. Stem	24. Vegetables
	25. Tannins	25. Nursery
	26. Forest soil	26. Substrate soil
	27. Leaf soil	27. Stake
		28. Garden protection

Figure 2.—*Nonwood resources use (according to official records).*

Production value

During the 1989–1995 period, the annual average value of the total nonwood resources production in Mexico reached $21,696,000, which represents 7 percent of the total forest production value. At the same time, forest soil extraction reached an annual average value of $1,233,000 (Fig. 4).

It is important to take into account that production tends to vary from year to year, even within the same ecosystems, so that the economic contributions of the regions differ. Thus, for 1995, the mild-cold weather territories generated $6,364,000 profit, as opposed to $2,424,000 profit for the tropical zones (Table 2).

On the other hand, the unitary price of nonwood products also varies greatly from year to year (due to supply and demand) and between the different products. As was already mentioned, forest soil is very cheap, whereas some cacti might cost more than $150 per plant (14), and the top-quality white pine mushroom has been quoted up to $82 per kilogram (36).

Nonwood forest products of the arid/semi-arid ecosystem

The arid/semi-arid ecosystem exists in the Mexican highlands, including parts of the States of Queretaro, Guanajuato, Aguascalientes, Zacatecas, and San Luis Potosí. It also includes Durango, Chihuahua, Nuevo Leon, Coahuila, Sonora and the

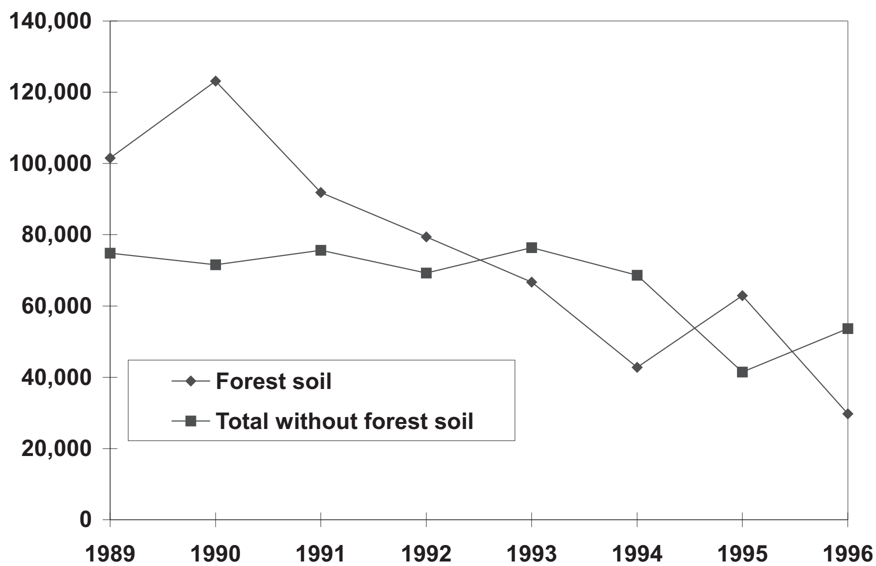

Figure 3.—*Nonwood production 1989–1996.*

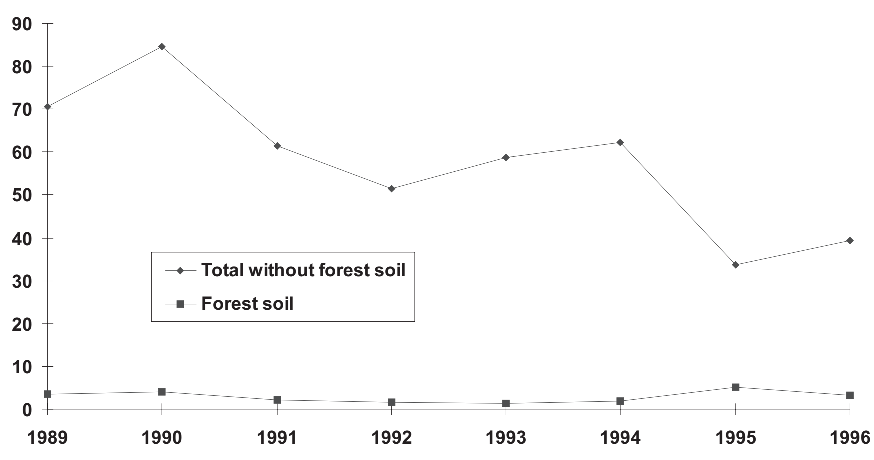

Figure 4.—*Nonwood production value 1989–1995.*

Baja California, and the smaller territory formed by the States of Mexico, Oaxaca, Puebla, Hidalgo, and Tamaulipas. It covers 30 percent of the country and 58.5 million hectares (Fig. 5).

In 1995, this type of land ranked second in nonwood production, generating 13,342 tons (29%) and an economic profit of $3,610,000 (32% of the national production) (Table 3 and Fig. 6).

Nonwood forest products of the mild–cold weather ecosystem

The mild-cold weather ecosystem is located at the mountain chains that cross the Mexican territory: the Sierra Madre Occidental, the Sierra Madre Oriental, the Eje Neovolcanico, the Sierra Madre del Sur, and the Sierra Madre of Chiapas (Fig. 7).

In 1995, this ecosystem generated the greatest nonwood forest resources production, with 55 percent of the total amount that year, which was equal to 22,663 tons and had an economic assessment of $6,360,000 (51% of the national production) (Fig. 8 and Table 4).

Nonwood forest products of the tropical ecosystem

The tropical ecosystem is located at the lowlands between the Sierra Madre Oriental and the Sierra Madre Occidental, the Balsas and the Papaloapan river basins, the Istmo de Tehuantepec, in the State of Chiapas and the Peninsula de Yucatan. It covers an area of 26.4 million hectares, which is 13.4 percent of the national territory (Fig. 9).

Table 2.—*Summary of nonwood production by ecosystem in 1995.*

Concept	Permissions granted	Permitted tons	Notification[a]	Notified tons	Affected surface	Tons produced	Economic assessment
		(tons)		(tons)	(ha)	(tons)	(million $)
Mild-cold weather ecosystem	13	190	313	3,682	151,696	22,275	6.36
Arid/semi-arid ecosystem	- -	- -	371	31,780	627,800	13,342	3.64
Tropical ecosystem	5	522	142	23,435	210,626	5,479	2.42
Subtotal without forest soil	18	712	826	59,097	990,122	41,096	12.42
Forest soil	29	99,809	- -	- -	330	62,872	1.97
Total	47	100,521	826	59,097	990,452	104,356	14.39

[a] Solicited document for the utilization of nonwoods based on the Mexican Official Procedures (NOM).

Figure 5.—*State distribution of the arid/semi-arid ecosystem in Mexico*

Table 3.—*Distribution of the arid/semi-arid ecosystem production in 1995.*

Product	Use	Producer states and regions	Production	Economic assessment	Average price	National production contribution	National economic contribution
			(tons)	(thousand $)	($/ton)	- - - - - - - (%)	- - - - - - -
Candelilla	Wax Chewing gum Cosmetics	Chihuahua Coahuila Region Lagunera Zacatecas	1,259	1,157.10	919.13	3.035	9.275
Lechugilla	Brushes Abrasive substances	Coahuila Nuevo León Tamaulipas	3,660	1,109.09	303.03	8.822	8.889
Orégano	Spices	Coahuila Querétaro Region Lagunera San Luis Potosi Zacatecas	946	499	527.76	2.280	4.002
Palmilla	Foams	Baja California	3,475	401	115.54	8.377	3.218
Jojoba	Cosmetics Lubricating substances	Baja California Sur Baja California	123	177	1,444.30	0.296	1.424
Nopal	Forage Edible vegetables	Coahuila Nuevo León San Luis Potosi Zacatecas	1,144	160	139.80	2.757	1.218
Yucca	Foams	Puebla	1,530	46.212	30.16	3.688	0.370
Maguey	Edible Alcoholic beverages Forage	Coahuila San Luis Potosi Zacatecas	762	19.5	25.64	1.836	0.157
Damiana	Medical	Baja California Sur Queretaro	19	18.48	972.12	0.046	0.149
Cortadillo	Brushes	Coahuila	346	13.03	37.87	0.834	0.105
Palma samandoca	Brushes Abrasive substances	Nuevo León	33	8.93	272.72	0.080	0.072
Palm		Baja California Sur	31	4.69	150.02	0.0075	0.037
Real palm or *abanico*	Roofs	Coahuila	1	0.151	158.48	0.002	0.001
Sotol	Alcoholic beverages Ornamental	Chihuahua Zacatecas	4	0.106	26.93	0.010	0.001
Choya	Ornamental	Sonora	1	0	0	0.002	0
Zarzaparrilla	Medical	Tamaulipas	8	0	0	0.019	0
Total			13,342	3,615.71	271.01	32.0915	28.981

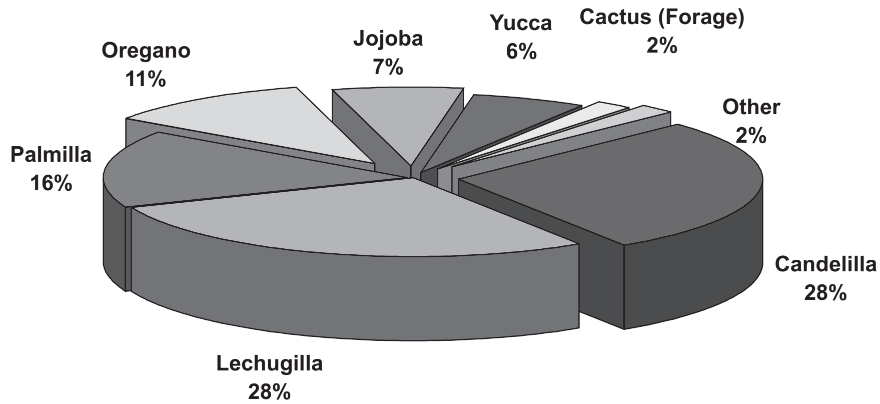

Figure 6.—*Major nonwood products of the arid/semi-arid ecosystem (percent of economic participation within the ecosystem, based on 1995 data).*

Figure 7.—*Distribution of the mild-cold weather ecosystem in Mexico*

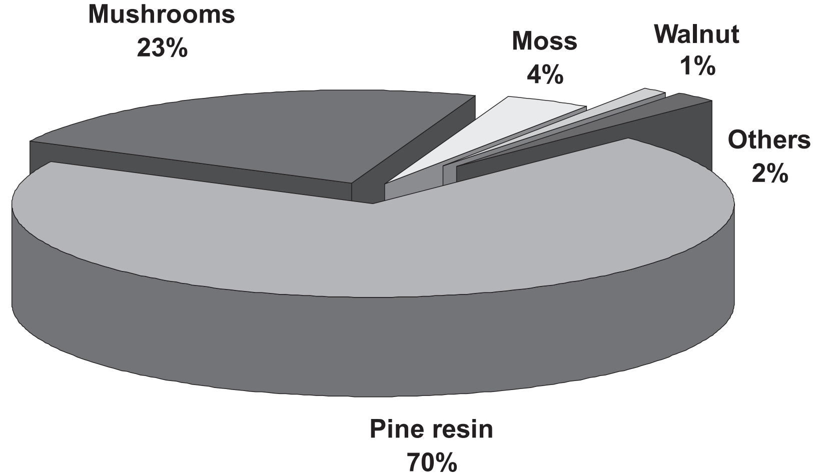

Figure 8.—*Major nonwood products of the mild-cold weather ecosystem (percent of economic participation within the ecosystem, based on 1995 data).*

Table 4.—*Distribution of the mild-cold weather ecosystem production in 1995.*

Product	Use	Producer states and regions	Production	Economic assessment	Average price	National production contribution	National economic contribution
			(tons)	(thousand $)	($/ton)	- - - - - - - (%)	- - - - - - -
Pine resin	Paints/ Cosmetics	Jalisco Mexico Michoacan	21,605	4428.03	204.84	52.080	35.491
Mushrooms	Edible	Mexico Hidalgo	31	1487.12	47973.20	0.075	11.92
Moss	Ornamental	Coahuila Distrito Federal Hidalgo Mexico Puebla Queretaro Tlaxcala	586	262.57	448.09	1.413	2.105
Walnut	Nutritional	Coahuila	34	58.78	1728.14	0.082	0.471
Hay	Ornamental Industry	Hidalgo Puebla San Luis Potosi Tlaxcala Coahuila Queretaro Nuevo Leon Tamaulipas	175	51.36	293.20	0.422	0.411
Perlilla rod	Home use	Mexico	94	41.06	436.51	0.227	0.329
Tule		Tamaulipas	50	22.12	442.10	0.121	0.177
Parra silvestre		Tamaulipas	39	7.12	184.21	0.094	0.058
Vara blanca	Ornamental	Morelos Mexico	22	3.48	174.45	0.053	0.031
Maguey	Drink	Guerrero	27	0.303	11.89	0.065	0.003
Total			22,663	6362.27	280.73	54.632	50.996

Figure 9.—*Distribution of the tropical ecosystem in Mexico.*

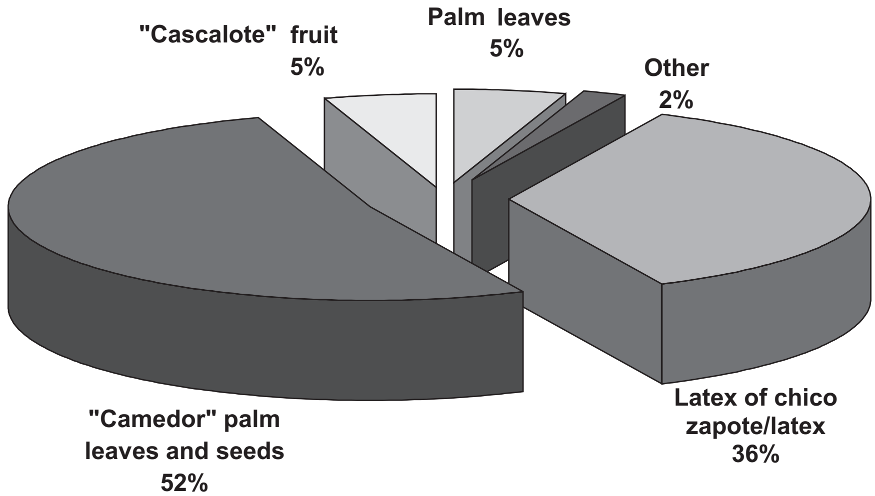

Figure 10.—*Major nonwood products of the tropical ecosystem (percent of economic participation within the ecosystem, based on 1995 data).*

Table 5.—*Distribution of the tropical ecosystem production in 1995.*

Product	Use	Producer states and regions	Production	Economic assessment	Average price	National production contribution	National economic contribution
			(tons)	(thousand $)	($/ton)	- - - - - - - (%)	- - - - - - -
Camedor palm	Ornamental nursery	Campeche Chiapas Hidalgo Oaxaca San Luis Potosi Tamaulipas Veracruz	1,700	1291.81	759.92	4.098	10.354
Chicozapote	Chewing gum	Campeche	211	895.15	4,242.42	0.509	7.175
Cascalote	Tanning	Guerrero Michoacan	475	130.75	283.58	1.145	1.049
Real palm		Oaxaca Tamaulipas	1,831	68.33	37.34	4.414	0.548
Common tropicals		Tamaulipas	478	61.06	127.76	1.152	0.490
Palapa	Roofs	Nayarit	438	26.51	60.60	1.056	0.213
Hat palm	Hats, petates	Oaxaca	137	20.30	148.31	0.333	0.163
Palapa palm	Roofs	Sinaloa	17	2.04	120.45	0.041	0.016
Otate or bamboo	Basket factory	Nayarit	23	1.74	75.75	0.055	0.014
Fat pepper	Spicea	Veracruz	1	0.272	271.81	0.002	0.002
Barbasco	Steroids	Veracruz	168	0	0	0.405	0
Total			5,479	2498	455.96	13.207	20.024

In 1995, it ranked third in nonwood production with 5,479 tons, equivalent to 13 percent of the national production and having an economic assessment of $2,490,000 (20% of the national production) (Fig. 10 and Table 5).

Nonwood product significance

Social meaning

Nonwood forest products gathering is relevant not only for the economic benefit derived by about 54,000 families that live in the forest areas, but also the use of these products in several regions of our country is part of the native culture.

Many of the nonwood resources are important in the diet of peasant families. Some are related to religious and/or civic celebrations of great significance to the community, as ornament elements or as integral elements of rites. Many products are used as tools or basic components in daily household duties (e.g., for cleaning, washing, brooms, kitchen articles, etc.) as well as in field labor (e.g., tool handles, sacks, hats, ropes, corrals, etc.).

In general terms, they constitute an alternative income for these families, as well as a source for satisfying essential needs, including food, housing, health care, clothing, and spiritual/magical/religious uses.

Economic importance

In spite of their ever-changing market, the nonwood products in Mexico provide a considerable relative income to the forest producer. Based on the statistics of SEMARNAP during 1995, the average annual income per producer was $227.27. Furthermore, it should be kept in mind that this profit comes from a rather short work season (e.g., 3 months for harvesting edible fungi) (Table 6).

Legislation

The regulation of the nonwood resources has been modified with changes in forestry legislation. Several premises have been considered as starting points:

- They are collected by low-income people.
- The legal proceedings should be easy and expeditious in order to avoid unnecessary expenses for the collectors themselves.
- The studies that support their use and the transportation controls cannot be similar to those for wood resources.
- The variability in their exploitation demands criteria that are based upon the impact they have on the resource.

In order to comply with these premises, at present the control of nonwood resources is done through the ten Mexican Official Norms (NOM, Normas Oficiales Mexicanas). These are grouped according to the form of utilization and with different regulation levels; they were made with contributions from collectors, scientific research institutions, industry advisors, commercial standards, and several federal government agencies (Table 7).

Table 6.—*Economic assessment generated by the most important nonwood products of Mexico in 1995.*

Product	Ecosystem	National production contribution	National economic contribution
		(%)	(%)
Pine resin (*Pinus* spp.)	Mild-cold weather	52.0	35
Mushrooms (*Tricholoma magnivelare* and others)	Mild-cold weather	0.1	12
Camedor palm (*Chamaedorea* spp.)	Tropical	4.0	10
Candelilla (*Euphorbia antisyphillitica*)	Arid/semi-arid	3.0	9
Lechuguilla (*Agave lecheguilla*)	Arid/semi-arid	9.0	9
Chicozapote (*Manilkara zapota*)	Tropical	0.5	7
Orégano (*Lippia berlandieri* and others)	Arid/semi-arid	2.0	4
Palmilla (*Yucca schidigera*)	Arid/semi-arid	8.0	3
Subtotal		78.6	89
Others		21.4	11
Total		100.0	100

Table 7.—*Legislation proceedings for nonwood resources utilization in Mexico.*

(The order follows the regulation level)	Authorization	Notification	Commercial documentation	Official Journal of the Federation* publication date
Forest soil	Yes or certificate after 30 working days	No	Yes, with SEMARNAP stamp	June 5th, 1996
Stems, bark, complete plants (except *candelilla*)	Yes, only for cacti and *Yucca* sp. (certificate after 30 working days)	Yes	Yes[a]	May 20th, 1997
Fungi	No	Yes (1 year)	Yes[a]	May 28th, 1996 May 6th, 1997, rectification
Pine resin	No	Yes	Yes[a]	May 30th, 1996
Roots and rhizomes	No	Yes	Yes[a]	June 24th, 1996
Leaves of the palm of forest vegetation	No	Yes	Yes[a]	May 28th, 1997
Grass roots (*cogollo*)	No	Yes	Yes[a]	June 24th,1996
Latex and similar materials	No	Yes	Yes[a]	June 26th, 1996
Branches, leaves, fruits, *pencas*, flowers, and seeds	No	Yes	Yes[a]	May 30th, 1997
Moss, hay and *doradilla*	No	Yes	Yes[a]	June 26th, 1996

[a] With number of the folio.

Industry and marketing

Industry

Established in eight states, the nonwood forest products industry is dedicated to five products: pine resin, *lechuguilla*, *palmilla*, *orégano*, and *candelilla*, with a capacity of 118,700 tons (Table 8).

Marketing

Most of the nonwood products do not require a transformation process, as they are traded after a careful selection. Such is the case for fungi and the leaves of the camedor palm. There are collection centers in the producing states where they are classified, stored, and put on the market.

Producers organizations

As a rule, seldom are associations of gatherers organized into unions to obtain and trade their products. They are usually dedicated to gathering, after which their stock follows a long path of intermediaries who apply some industrial treatment that might improve its presentation and take it to its final destination, which can be exportation (Fig. 11).

Table 8.—*Nonwood forest products industry in Mexico.*

Product	Number of industries	State	Capacity
			(tons)
Pine resin	19	Michoacan Jalisco	83,000
Lechuguilla	3	Coahuila Nuevo Leon	23,600
Palmilla	4	Baja California	7,600
Orégano	7	Guanajuato Jalisco Queretaro San Luis Potosi	2,600
Candelilla	2	Coahuila Nuevo Leon	2,500

Scientific research

The background knowledge is heterogeneous in relation to the scientific and technical support for the nonwood forest products, both from a qualita-

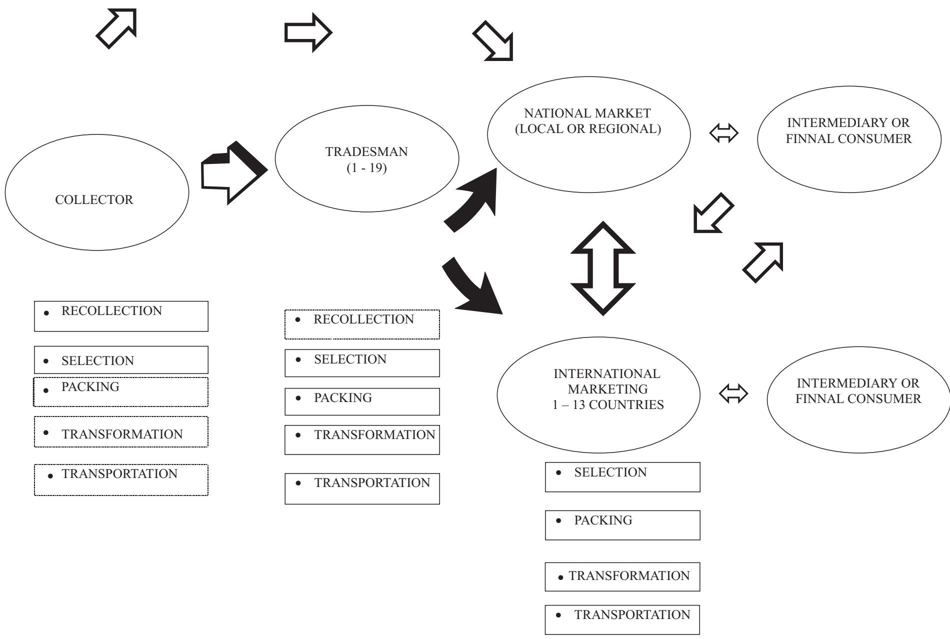

Figure 11.—*Scheme of the marketing of nonwood forest resources.*

tive and a quantitative approach. In this regard, there are outstanding species that traditionally have been collected and that have been marketing well for a long time, even if they have suffered frequent fluctuations.

Scientists of several research and higher studies institutions have paid attention to nonwood resources, or to useful plants in general, through ecological, ethnobiological, physiological, demographic studies, etc. These projects include taxonomy, distribution, (8,25,34), marketing (40), traditional knowledge (26,29,35,43-46), reproduction (9,37), and habitat characterization (4,41,43,46), as well as management methods of wild populations related to intensity, times, and techniques of harvesting (2,4,21,24,33,42), marketing (10,40), etc.

In spite of the knowledge generated by these scientific groups, their means to spread their findings are difficult and generally restricted to the scientific community, facts that do not favor their application at the productive level.

In this context, the following products are worth mentioning: resin, *barbasco*, *candelilla*, *lechuguilla*, *orégano*, *camedor* palm, *chicle* (chewing gum), *damiana*, *jojoba*, and rubber; also, there are known data on about 600 species of medicinal plants, whose wild populations are strongly impacted by the extraction that has been made of them in different regions of the country.

The case of edible fungi emphasizes the lack of knowledge of most of the personnel responsible for their utilization. It is important to underline that few formal records exist in relation to the productive potential of their wild populations, even in scientific institutions.

The former situation generates some irresponsible misconceptions of the present status of many edible fungi species; in some regions they could be overexploited and in others the opposite.

Ethnobiological studies

Ethnobiological investigations have received special attention during the last ten years, particularly through thesis dissertations for bachelor degrees at higher studies institutions. The most common tendency has been to work with several ethnic groups, thus producing many projects about the ownership of natural resources and their importance in the cultural context of social groups like the Maya, *otomíes, nahuas, tarahumaras, mixtecos, tarascos, purépechas, tzotziles, huastecos, totonacos*, and *zapotecos* (20,22,23,30,39).

Some documents then remain in an inventory or catalogue of useful plants at the regional level (e.g., the humid-warm regions of Oaxaca or Veracruz, the arid zones of Baja California, the higher mountain areas of Guerrero) (7,27,28,47).

The ethnomicological projects are more restricted with respect to fungi. Basically the native communities of the central part of the country have been studied, in particular the *otomíes*, *matlatzincas*, *nahuas*, and some of mixed origin (Distrito Federal and Hidalgo State) (3,15,13,16,29).

Management of natural populations

Research about the management of the natural populations of nonwood resources has been focused on the most important economic products, such as *orégano, jojoba, candelilla, lechuguilla, palo de arco* (arch stick), *damiana, vara blanca* (white rod), *barbasco*, palm, *palmilla*, edible mushrooms, forest soil, and resin (1,12,21,24,43,49).

Studies have made it possible to know the right times for collection and the best cutting intensity. For each one of the species of interest, ecological projects have described the habitat, productivity under natural conditions (mushrooms), phenological calendars, ecotype selection, and propagation techniques *in situ*.

Domestication

In the case of nonwood resources, the domestication of some plant species has had some problems; for example, some products are produced when a plant reacts to environmental stress, and this is lost through the cultivation process. However, there are investigations on the cultivation of species such as *barbasco* (18), *orégano*, *candelilla* (11), *jojoba*, *camedor* palm, pepper, *chicle* (chewing gum), *hierba del sapo* (weed of the toad) (*Eryngium foetidum*), *toronjiles* (*Agastache* spp.), cacti (cultivation *in vitro*), and orchids (cultivation *in vitro*).

Investigations include bioessays, seed germination, and nursery plant production (e.g., *cortadillo* and *sotol*).

Agroforestry

There are few cases in which agroforestry systems include nonwood products in Mexico. Worth mentioning are the contributions of Chavelas (6) who worked in the tropics with a multiple-use module, of forage plants (*Cnidoscolus chayamansa*, *Brosimum alicastrum*, *Leucaena esculenta*, *L. leucocephala*), spice plants (*Bixa orellana*), and nutritional plants (*Manihot esculenta*).

Some management plans have been designed with an agroforestry approach for the mild-cold weather zones; unfortunately, they have not been installed, as happened with the San Juan Tetla Forest Experimental Station (Instituto Nacional de Investigaciones Forestales, Agrícolas, y Pecuarias), which considered edible fungi production and native forage species simultaneously.

Comparative analysis between Mexico, Canada, and the United States

According to the Food and Agricultural Organization, four elements have been detected:

- The decline of internal and external economic factors, which limits imports and demands a more intense use of native natural resources.
- The potential benefits that come from nonwood forest resources utilization for the national and community economies for the conservation of the environment.
- The opportunities of new markets that has created the green movement in the western countries, and the new ethnic markets created by the migration of populations.
- The increasingly intensive search for new biochemical products for industries and pharmaceutical products.

Need for sustainable management of nonwood forest products

In general terms, the utilization of nonwoods is perceived as an extractive activity that does not demand regulations or a detailed knowledge of the species in question and those associated with it, its habitat, its reaction when collected, its natural regeneration, productivity, fostering practices, cultivation, and protection, etc. As consequence, this means that the direct income from their exploitation hardly supports the studies or surveys that might provide a better management for these resources.

Sustained management, undoubtedly necessary, requires the right assessments of the huge benefits that nature provides in order to invest some part of the species' profits in their own conservation.

Regional program of nonwood products for North America

The following action lines to design a nonwood forest products program for North America can be described:

- Exchange experiences in the quantification, utilization, and uses of nonwood products, and research forest resources of common interest.

Some products considered at risk are: yucca and cacti in arid/semi-arid zone, resin and fungi in mild-cold forest, and ornamental species and *chicle* in tropical forests.

- Identify markets, commercialization trends, and quality standards for the most important products or those with trading potential, in order to establish better communication links between collectors and consumers.
- Create a systematic nonwood forest resources information database.
- Write papers, technical handbooks and/or monographs.
- Provide or promote training about nonwood forest products management and conservation to rural communities and technical workers.

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Issues in developing and managing nonwood forest products in the United States

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Abstract

Lack of knowledge and well-organized information remains a major obstacle to the development of nonwood forest products industries. The impact of economic activity on populations of plants and fungi deserves close scrutiny. There is a need for an increased exchange of information and technology along with a national information network. Public policy changes are needed to foster sustainable development of nonwood forest products industries as one element of rural economic development and diversification. Basic information and scenario analyses that would support essential policy proposals are needed.

Background

Industries for wood products have developed differently than for nonwood forest products (NWFPs) in the United States. The NWFP industries have also followed different paths of development in different regions of the United States. Native Americans gathered food (fish, game, fruits, and berries), herbal medicine, fiber, and fuel from forests. Wood as timber was of secondary importance to Native American cultures—material for constructing totem poles, poles for nomadic housing, and canoes. Early colonists from England, France, Spain, and Russia relied heavily on the indigenous knowledge of Native Americans to survive unfamiliar inclement conditions. Native Americans first produced NWFPs such as maple (*Acer* spp.) syrup and fern fiddleheads, and used plants such as bloodroot poppy (*Sanguinaria canadensis* L.) and yerba santa (*Eriodictyon californicum* (Hook. & Hrn.) Torr.) for medicinal purposes. These products have passed into mainstream American culture.

With industrialization during the early 19th century, timber became important to the dominant English-speaking society in the United States as a vehicle for economic growth. Folkloric knowledge of Native Americans critical to sustaining early European settlements in the 17th and 18th centuries has been relegated to obscurity. The demand for timber to sustain rapid economic growth altered the societal perception of the dominant value to be obtained from forest ecosystems.

The exploitation of old-growth timber in the Pacific Northwest and California beginning in the mid-18th century coincided with Anglo-American

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settlement that displaced Hispanic-American and Russian governance on the west coast of the United States. Traditional uses of native plants in the American West, particularly for food, medicines, and fibers, were not as widely adopted into the culture of Western settlers as they had been by the east coast settlers in pre-industrial times. The indigenous knowledge of Native Americans and practitioners of that knowledge were marginalized. Aside from salmon, food needs for burgeoning populations in the American West were filled primarily by agricultural systems originating in the Eastern and Midwestern United States. By the end of the 19th century, markets for NWFPs were nearly unnoticed next to the dominant timber products industry (19).

Public concern for healthy timber and water supplies spurred the creation of the USDA Forest Service in the late 19th century. Prominent political leaders feared that future stocks of timber might not sustain the economic expansion of the United States. National Forests served as strategic reserves of timber and clean water. At the beginning of the 20th century, the best timber was already under private ownership, and timber harvesting was largely confined to private lands. Only after World War II did timber harvesting become a primary activity on Federal lands, to meet the increased demand for wood in housing and industrial uses. Maintaining timber harvest levels on Federal lands became a major National Forest planning objective through the 1980s. Since then, however, shifts in national attitudes about public land management have led to sharp declines in timber harvesting on public lands and a greater emphasis on management for healthy ecosystem functioning as the primary objective for forest management.

Marginalization of NWFPs continued throughout the 20th century. Plant medicine was not considered "modern." The American Medical Association worked to remove native medicinal plants one by one from the Materia Medica of the United States (5). In the Southeast, Southwest, and "Indian" country, however, economically marginalized rural people still maintained folkloric medical traditions (1,8,12,17). At the same time, largely unnoticed by forest managers, small new markets for NWFPs developed in the early decades of the 20th century: floral greens from the Pacific Northwest (6, 7,11) and medicinal plants such as witchhazel from the East entered mainstream American markets (5).

Nonwood forest products in the United States never attained a level of interest and concern that would lead to coordinated planning for their production as commercial commodities. National focus remained on timber production because of its economic importance and political influence of timber-related industries. Nonwood forest products were unnoticed by most Americans who were increasingly urban and out of touch with the production of goods from forests.

Demand by urban residents for recreation opportunities in federally administered forests, however, indicated the first shift away from the dominance of timber production in forest economies. Shifting public opinion continues to force major changes in the management of both public and private timberlands (24). The urbanized populace in the United States has culturally received "mental images" of untrammeled landscape of pristine, unmanaged forests and of the health benefits from recreation in natural environments. The desire for wilderness forests is at odds with timber production. Cultural and political conflict has ensued.

As environmental regulations have increased to protect the robust functioning of ecosystems, the amount of Federal land on which timber production is the primary management objective has decreased. Timber supply from public lands has become more politicized and more uncertain for industrial wood processors. A decline in wood production, increased mechanization of the timber industry, and an increased demand for "natural products" among urban Americans have prompted rural-based entrepreneurs to explore other sources of revenues in expanding recreation services and, more recently, NWFPs (15,16). In this phase of expanded harvesting of NWFPs in the United States, we do not yet know how NWFPs will fit into a changing economy and to what extent NWFPs can supplement or replace income from wood-related employment.

Industrial lands remain focused on timber as the primary output. When goods such as Christmas greenery or edible wild mushrooms can be produced without interfering with the main objective of wood production, and resource access and harvesting can be controlled, options for multiproduct forest farming are frequently pursued to augment incomes or to engender good will (20).

Nonindustrial forest landowners generally have more diverse management objectives than industrial timberland owners. Their objectives often include personal interests in wildlife, aesthetics, NWFPs, and recreation that go beyond the more focused timber interests of industrial forest landowners. The diversity of management and pattern of cash-flow may make some smaller landowners more interested in integrating the production of other goods into complex, well-planned forest farming systems. Traditions already exist with American ginseng (*Panax quinquefolius* L.), goldenseal (*Hydrastis canadensis* L.), and black walnuts (*Juglans nigra* L.), with timber remaining an important but not necessarily the dominant economic component (10,21).

There is also a growing demand for natural products, whether wild-grown or grown organically (25). American ginseng is perhaps the prime example where the wild harvested product commands a higher price than ginseng commercially grown in agroforestry conditions. Recent data from the U.S. Department of Commerce show the price for wild U.S.-exported ginseng to be almost four times the price of cultivated U.S.-exported ginseng. Scientists may be able to synthesize analogues of compounds present in medicinal plants, but drug companies do not capture the entire market for that compound. Many people believe that a plant root or leaf containing a suite of natural compounds is inherently better than an isolated compound produced pharmaceutically (9).

Issues affecting the feasibility of development of nonwood forest products industries

Because of differences in historic development, current industrial patterns, and public attitudes, the issues and policies that are important to the development of the NWFP industries are often very different from those that evolved to support and sustain the timber industry. The following sections discuss several issues that are of particular importance to the feasibility of the continued development of NWFP industries.

Basic knowledge of quantity, quality, and value of resources

Basic knowledge of the quantity, quality, and value of NWFPs is sketchy, poorly organized, and often wholly unavailable. Few mechanisms exist to gather basic production and market statistics on NWFPs either by government or private entities. As these products enter or reenter mainstream use, with major supermarket chains creating house brands of popular products such as ginkgo and St. Johns wort, the need for information for conservation, regulation, and business planning becomes much more acute.

The sheer number of species involved in the NWFP industry is an obstacle to an adequate understanding of the industry. Although there are 177 native tree species listed in *Silvics of North America* (2,3), a much smaller number of species account for a large majority of the natural resource base of the domestic timber industry. And because they are all trees, a lot of knowledge about management and use is common to many of these species. By contrast, there are many more species representing a wide range of plants and fungi in the NWFP industries. There are more than 2,200 native plant species from the United States and its territories with known historical medicinal uses. Perhaps 15 per cent of these are actually traded in national or international markets.

Geography is another factor that complicates achieving broad knowledge of the NWFP industries. The primary NWFPs tend to be different in each region of the United States. The listing of important NWFPs by region in Table 1 is illustrative.

Basic knowledge of market structure

The timber industry tends to have parallel markets for many products in regional, national, and international markets. This has led to standardization of product descriptions, grades, and selling mechanisms. The parallels are less common and less obvious in markets for NWFPs. For example, the markets for Christmas trees are generally regional markets with some potential for expansion to international markets. Fresh botanical material including Christmas trees, however, inevitably faces issues of unintentional movement of pests that must be overcome to expand that market. Other NWFPs like maple syrup have a strong regional demand as a base that has supported the industry through its expansion to the national market. In contrast, the primary markets for most mushrooms are international, with some opportunities to develop regional and national markets. Marketing methods and acquisition of market data will differ among these diverse industries.

Basic knowledge of plant properties

Because of the large number and diverse range of species involved in the NWFP industries, the requirements for basic knowledge of plant properties is daunting. Basic plant properties like chemical constituents are needed to determine what more common plant materials may substitute for less common ones in pharmaceutical, neutraceutical, and biochemical uses. This information will also be useful in exploring potential new uses for plant materials. The information that does exist needs to be summarized into a central accessible database for scientists, doctors, rural development people, and others. Priorities should be to first deal with high-valued species and those with multiple uses.

Basic knowledge of plant biology

Although some NWFP industries might exist indefinitely based on opportunistic harvesting of what grows incidentally while landowners pursue other management objectives, most NWFPs will ultimately depend on understanding plant biology well enough to augment production. This might be in the form of modifying management to increase *in situ* production, domestication and agricultural production, or agroforestry approaches (25). Once again, the broad range of species and geography make acquiring this knowledge daunting. In some cases existing knowledge has been lost as the oral traditions among Native American and non-Native American rural people have been lost.

Some basic knowledge may be gained by analogy with NWFP industries in other developed and developing countries: Japanese and Korean management of matsutake mushrooms; Russian, Finnish, and Baltic States management of berries, many wild edible mushrooms, and medicinal plants. Research to improve knowledge about phenology and ecological and physiological requirements for sustainable production has been spotty and nowhere near meets the need for information.

Basic knowledge of economics and processes of production

A basic distinction can be made between NWFPs that are essentially free goods and those that are scarce. For example, the fact that a product sells at a high price in the wholesale or retail market does not mean that it is scarce at the resource level. A common resource will sell at a price that covers the cost of harvesting and processing but not much more than that. If production costs are high this price could be regarded as high. Landowners will have little incentive to increase production through management unless that management can reduce harvesting costs sufficiently to return a profit. An

Table 1.—*Important nonwood forest products by region.*

New England, New York	Conifer boughs, maple syrup (*Acer saccharum* and other species), birch beer (*Betula* spp.)
Massachusetts, Wisconsin	Cranberries (*Vaccinium macrocarpon* Ait.)
Upper Midwest	American ginseng
North Carolina	Galax (*Galax urceolata* (Poir) Brummitt), tupelo (*Nyssa sylvatica* Marsh), basswood honey (*Tilia americana* L.)
Florida	Saw palmetto berries (*Serenoa repens* (Batr.) Small)
South	Numerous medicinal plants, naval stores (turpentine), pine needles for bedding and mulch, American persimmon (*Diospyros virginiana* (L.))
Missouri	Black walnuts
Montana, Idaho, Michigan	Blueberries and huckleberries (*Vaccinium* spp.), blackberries and raspberries (*Rubus* spp.)
Oregon, Washington	Wild mushrooms, conifer boughs
California	Acorns (from *Quercus* spp. and *Lithocarpus densiflorus* (Hook. & Arn.) Rehd.), bay laurel (*Umbellularia californica* (Hook. & Arn.) Nutt.), white sage (*Salvia apiana* Jepson), yerba buena (*Satureja douglasii* (Benth.) Briq), and yerba mansa (*Anemopsis californica* (Nutt.) Hook. & Arn.)
New Mexico, Arizona	Pine nuts, especially (*Pinus edulis* Engelm.), acorns (*Quercus gambelii* Nutt.), and Porter's licorice root (*Ligusticum perteri* Coult. & Rose)

example of this is Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco) boughs for Christmas greens. Douglas-fir is so abundant that landowners cannot expect to receive compensation beyond that required to compensate them for the expense of harvesting and any growth loss that might occur. Noble fir (*Abies procera* Rehd.) boughs are an example of a scarce resource. Substantial fees are paid to landowners for the right to harvest noble fir boughs. Thus landowners have an incentive to manage noble fir stands to increase the yield and quality of boughs.

Mechanisms for information sharing

Even in those cases in which information is known, mechanisms are needed to make the information available to landowners and harvesters. Market information is available from extension specialists representing Federal-state partnerships. The quality of state-based extension programs differs considerably among the states. West Virginia, Minnesota, Idaho, and Washington are examples of states that have pioneered NWFP extension efforts for rural residents. A link among states to share extension information would help reduce redundancy and create better coverage of all products.

Extension programs need to take into account information not only about existing and potential markets, but also information that facilitates economic supply such as technology guides to the processes and steps that are necessary for responsive and sustainable supplies of desired products. How-to guides are needed about mushroom and fruit drying, packaging options, ways to preserve floral greens, etc. Expanded extension services would contribute greatly to business startups.

Social implications of policy choices

Researchers are just now beginning to describe the behavior of different user groups who access common stocks of NWFPs in the United States. Most work on this comes from France (4) and Quebec (13), with reference to *Vaccinium* species, and from Alaska with both forest and marine resources (14, 22,23). Work is also underway in the Pacific Northwest and the central Lake States. We know that there are various motivations for harvesting NWFPs. In addition to purely commercial motivations there are cultural traditions, subsistence, and recreational motivations. We have only sketchy and anecdotal evidence about what social groups are involved, the numbers of people with different motivations, and the conflicts that occur (18).

We also have limited knowledge of the effects that harvesting NWFPs have on communities of place and communities of interest. Conflict about allocation and use of resources arises when the resource is in short supply or resource uses overlap spatially or temporally. Without better information, we are unable to deal with policy issues that address important social questions. Questions relating to social equity include relative priorities for subsistence resource use, commercial use, and recreational use. And on public lands, who has the right to set priorities? How do nationwide goals, such as conservation of biological diversity and counteracting global warming, relate to goals of local communities located close to public lands?

Another social issue is the role of government in providing opportunities for postmodern hunter-gathering. Does a lifestyle of unobtrusive or even clandestine harvesting of NWFPs deserve governmental or societal support? Or is the role of government to insist on regulation and disclosure of harvest yields and values of NWFPs from public forests? There is a conflict between increasing regulation (not supported by many rural residents) and increasing resource access and development (heartily supported by many rural residents).

Remnant traditions often remain alive long after the original impetus for the tradition no longer exists. Although there are still people for whom wild foods provide critical nourishment, people may gather huckleberries or other foods more for traditional cultural continuity than nutritional necessity. The value of culture and continuity may exceed all other values in the eyes of some people. Although we do not know how to assign an economic value to this, assigning value is more a social and political question than an economic question.

A major uncertainty in public forest management involves rights accorded to Native American tribes in their treaties with the U.S. government dating to the 1850s. No tribe has tested the extent of full force of treaty rights to date, but several tribes in the Pacific Northwest are poised to seek co-management responsibilities for Federal forest lands. Similar activities are occurring in the Great Lakes area.

Policies that affect development of NWFP industries

Transfer of NWFPs resources from Federal lands to harvesters is often an awkward and cumbersome process. The National Forest System in the United States is about 100 years old. The original commodity impetus for National Forests was timber; so only timber policy is well developed. The tradition of rural cooperatives and tenure arrangements such as one finds in Asia or Europe, or among Native Americans, is largely absent among other Americans. There is no national consensus or tradition of tenure rights set forth in permits, leases, or stewardship agreements. The need for crafting new institutions is acute, but we do not have a societal consensus on how to proceed.

The trend is toward greater regulation and imposition of fees—to the dismay of people who were able to harvest forest products unfettered in the past. Recreational foragers resent displacement by commercial foragers who harvest in large quantities. There is concern that populations of fungi could be depleted and the opportunities for recreational mushroom picking diminished. For many people, growing publicity about NWFPs and their expanding commercialization represents a loss of freedom and a decline in quality of life.

One of the mechanisms that is necessary for any industry to develop is the ability to protect resources from theft. Products that have high value per unit of volume or weight are more likely to be targets of thieves. Regulation of transport and sale of such NWFPs needs to be sufficiently effective to maintain the property rights of legitimate land managers and NWFP businesses. Otherwise, land managers will have no incentive to manage their lands to enhance the production of NWFPs. In fact, without reasonably enforceable property rights, land managers may avoid such products and focus their efforts on products where they can protect their property rights more easily. Examples of efforts to combat illicit harvests of NWFPs include legal requirements in the states of Oregon and Washington that buyers of NWFPs check for valid harvest permits from harvesters.

Another basic requirement for a viable industry is the development of quality standards that make markets work efficiently and protect markets and consumers. This is sorely needed in the United States. The German-language pharmaceutical literature has reported considerable mislabeling and dilution of medicinal herbs coming from the United States (26). Having a reputation as an untrustworthy supplier could result in exclusion of American products from important European markets.

Another central issue for NWFP industries is certification of sustainable management and harvesting practices. Consumers in some markets place more value on goods produced under guidelines established for organic production or sustainable wild harvesting. Native American groups, for example, may be able to gain market share for products harvested, processed, and manufactured from NWFPs species by advertising their cultural traditions and production methods to consumers.

Federal government agencies such as the research arm of the USDA Forest Service have been slow to fund research on NWFPs. Pharmaceutical companies in the private sector have been critical for research in medicinal species. Companies have funded the recent effort by the New York Botanical Garden to sample native species in National Forests for a broad range of pharmaceuticals. Consultants in the private sector conduct market research as well but tend not to reveal information to the general public. Public funding of traditional research and of other methods of acquiring relevant information such as interviewing long-time harvesters (5) is an important avenue for influencing the development of NWFP industries.

Conclusions

Lack of knowledge and well-organized information remains a major obstacle to development of NWFP industries. National and regional overviews of economic activity in these industries are needed. In particular, the impact of economic activity on populations of plants and fungi deserves close scrutiny. Effects of commercialization on individual species need to be addressed across multiple geographic scales. Protection of rare species related to more widespread commercial species is critical now. Species in the genera *Arnica* and *Echinacea* are good examples of species threatened by inadvertent harvesting.

There is a need for increased exchange of information and technology. This cannot happen, however, without a public or private sector institution that has as its mission to increase exchange of information and technology. That institution does not yet exist in any coordinated form. A national information network is needed.

Public policy changes are needed to foster sustainable development of NWFP industries as one element of rural economic development and diversification. It is too early, but nonetheless urgent, to bring forth a list of specific proposals. Basic information and scenario analysis that would support needed policy proposals are needed.

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Fiber Supply

Canada's fiber supply: A look toward the 21st Century

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Bill Wilson

Abstract

This paper offers a brief overview of Canada's forest products supply picture and a discussion of the factors which will determine its future. The paper focuses on the economic supply, driven by price, and, therefore, global demand for Canadian forest products. It is suggested that the future of Canada's economic forest supply is strongly linked to technology. Global scarcity of certain types of forest products continue to drive this technology, and, with it, challenge Canada's traditional sources of competitive advantages.

Canada's fiber resource

North America represents roughly 16 percent of the globe's land area, and an equivalent share of the world's forests (FAO, 1997). At 997 million hectares (ha), Canada makes up 45 percent of North America's land base, with the United States adding another 45 percent and Mexico the remaining 10 percent. Figure 1 shows that 42 percent of Canada is forested, of which more than half, or 245 million ha, is timber productive. As will be discussed, the extent of this timber productive land is very sensitive to economic conditions and technology. Canada's harvest in 1996 was roughly 1 million ha.

Unlike the United States and Mexico, Canada's timber land is largely public, in provincial government control (94% in Canada as compared to 45% and 5% for the United States and Mexico, respectively). In terms of control of productive timber land, 90 percent is in public hands in Canada, with timber rights granted through a rather complex form of tenure arrangements. This compares to 27 percent for the United States and only 5 percent for Mexico (FAO, 1997).

Canada's growing stock is nearly 25 billion cubic meters (m^3) (78% softwood), as,compared to 22 billion in the United States (57% softwood) and 1.8 billion in Mexico. Over 40 percent of this growing stock is located in British Columbia, with an average stand density of over 200 m^3/ha, compared to less than 100 m^3/ha for the rest of Canada (Fig. 2). Within British Columbia, there are two distinct growing areas. The coast is typified by much higher than provincial average stand densities and a multitude of softwood species such as douglas-fir, hemlock, amabilis fir, sitka spruce, yellow cedar, and red cedar. The interior is much more typical of the rest of Canada, containing primarily a spruce-pine-fir (S-P-F) mix (Canada's boreal forest). The 22 percent hardwood resource in Canada is mostly located in mixed stands found in southern Quebec and Ontario with commercial species that include maple

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and oak. However, with the growing demand for lesser known hardwood species such as aspen and poplar for both oriented strand board and high fiber hardwood pulp, the economic hardwood supply is expanding throughout Canada.

While Canada's allowable cut has been fairly consistent at levels approaching 250 million m^3, harvests have increased substantially over time (the 1996 harvest was 178 million m^3). In recent years there has been a drop in B.C. harvests against increases in the rest of Canada. The reduction in the B.C. harvest volumes is a response to a variety of factors including changing social expectations on forestland use (about 96% of B.C. is public land), the initial transition to an ecosystem-based forest management regime, and a corporate response to increases in delivered log costs and product prices. In addition, the B.C. government has completed a detailed review of the allowable cut in each of the major timber licenses. From the cost side, the B.C. coast is typified by old-growth timber stands with difficult harvesting conditions, and has seen considerably greater than average increases in both logs stumpage costs and other costs associated with local initiatives that have strived to protect non-timber values of the forests.

Figure 3 illustrates the relatively small amount of pulpwood harvested in Canada, reflecting the predominant use of residual wood chips from sawlog processing as fiber furnish for pulp. In addition, the bulk of the roundwood pulp logs are hardwood used in mechanical pulping.

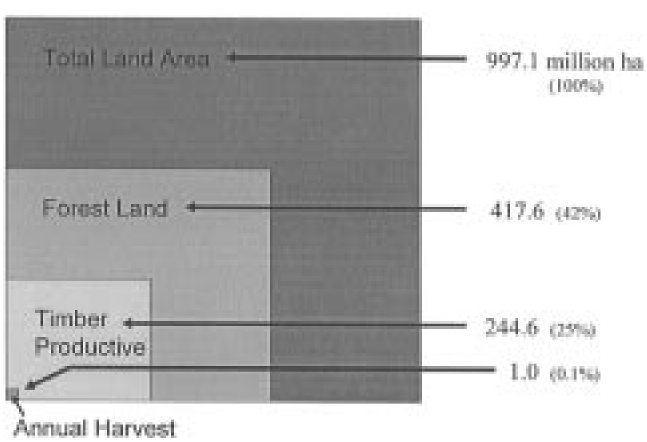

Figure 1.—*Canada's land base.*

Finally, Figure 4 puts Canada's growing stock and harvest into a global perspective. The considerable potential of the Russian timber stocks is apparent in both the softwoods and hardwoods.

Markets for Canada's wood products

With wood product supply that far exceeds domestic demand, Canada is largely export oriented. Canadian exports represent 51 percent of global trade in softwood lumber, 33 percent of global trade in wood pulp, and 52 percent of global trade in newsprint (1995). Figures 5 through 7 break these exports down by region of origin, destination, and

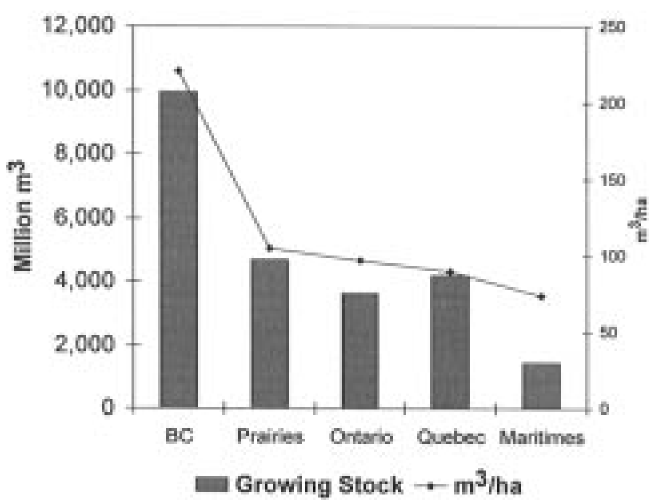

Figure 2.—*Timber growing stock. Source: FAO, 1997.*

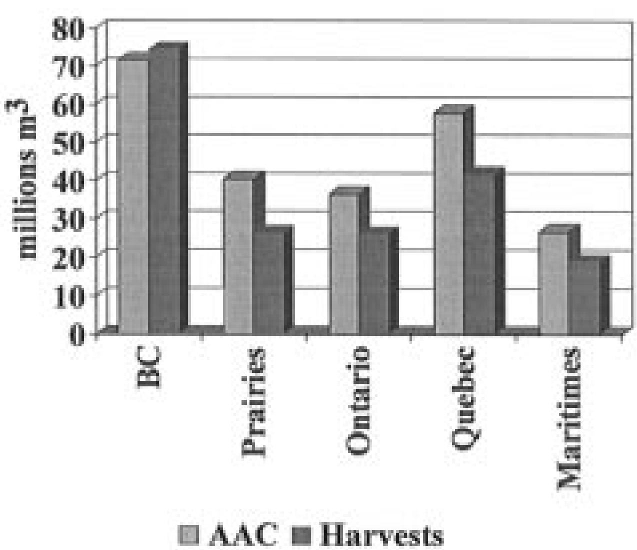

Figure 3.—*Timber harvest, 1995. Source: Canadian Forest Service.*

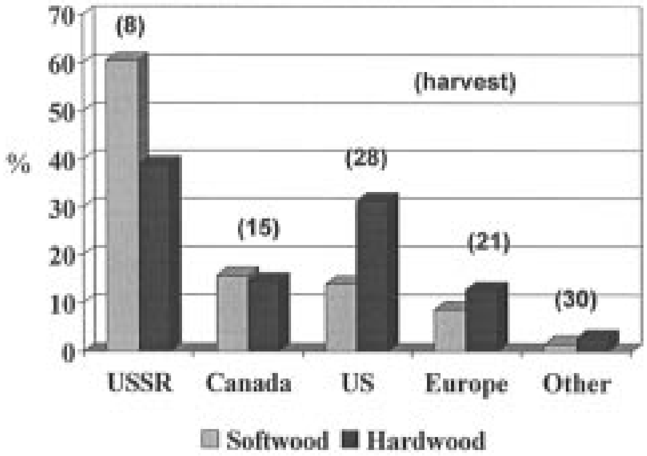

Figure 4.—*World growing stock/harvest. Source: FAO, 1997.*

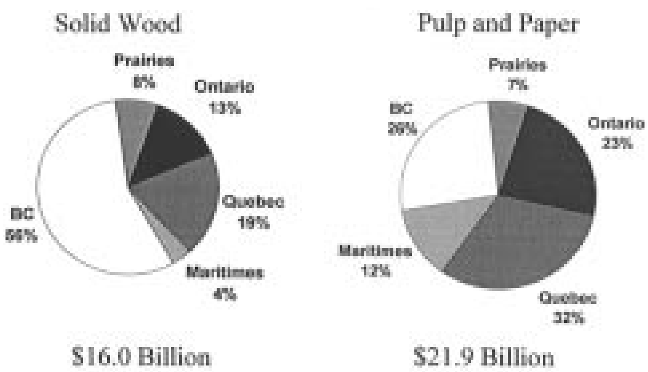

Figure 5.—*Canadian exports by value, 1996. Source: Statistics Canada.*

product. The message shown in these figures is that Canada has been predominantly a commodity exporter, and primarily to the United States.

The forest products industry is key to Canada's economic performance and growth, being the largest contributor to the balance of trade (exports minus imports); at roughly 35 billion Canadian dollars annually, this is larger than energy, automotive, agriculture, chemicals, and machinery combined (Fig. 8).

Figures 9 through 13 summarize the Canadian markets for lumber. In the case of the United States, it is noteworthy that Canada totally dominates U.S. imports (with supply shifting to Quebec and Ontario), and that U.S. repair and renovation continues to grow as an end-use of this product. While historically an important market, the western Europeans have imposed restrictive non-tariff barriers against the importation of Canadian green lumber. Finally, the importance of the Japanese market is demonstrated. The Japanese market is particularly

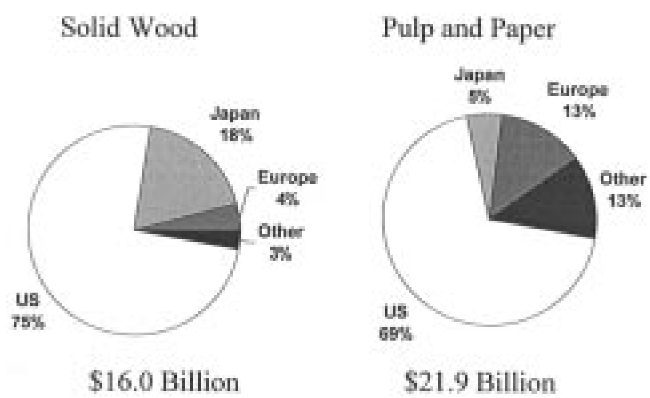

Figure 6.—*Canadian exports by value, 1996. Source: Statistics Canada.*

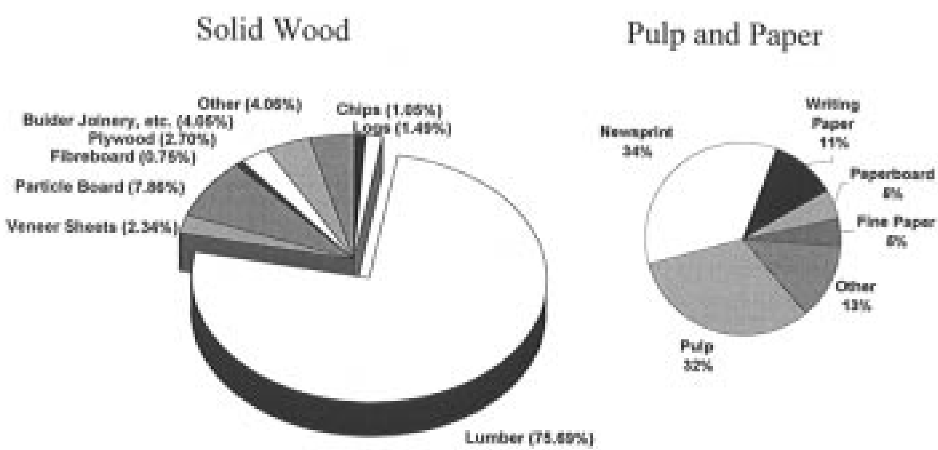

Figure 7.—*Canadian exports by value, 1996. Source: Statistics Canada.*

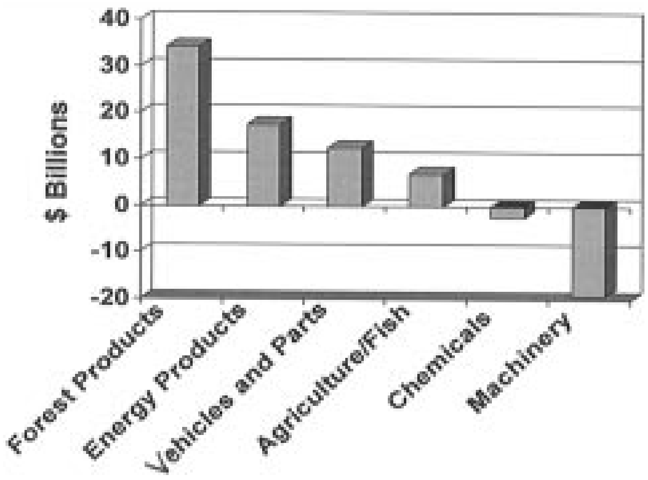

Figure 8. *—Canada's balance of trade. Source: Council of Forest Industries, 1997.*

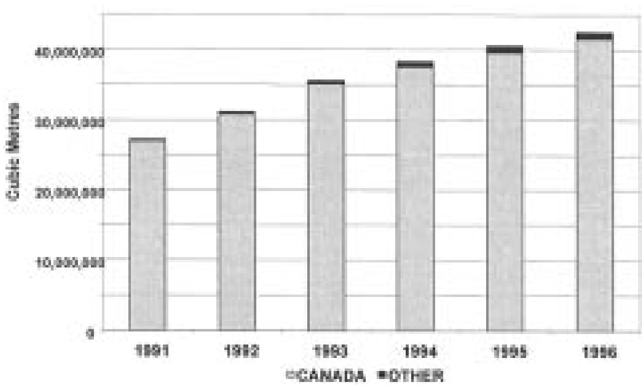

Figure 9.*—U.S. softwood lumber imports. Source: U.S. Bureau of the Census.*

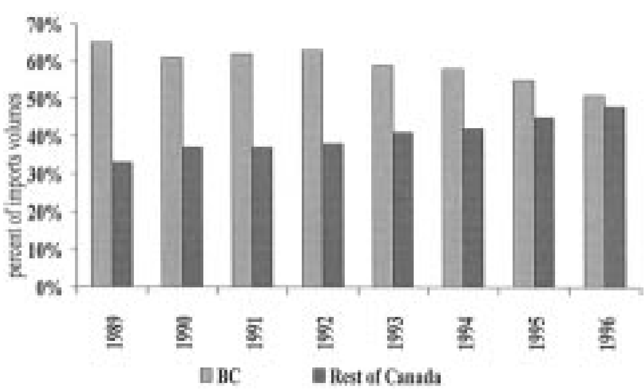

Figure 10.*—U.S. lumber imports from Canada. Source: U.S. Bureau of the Census.*

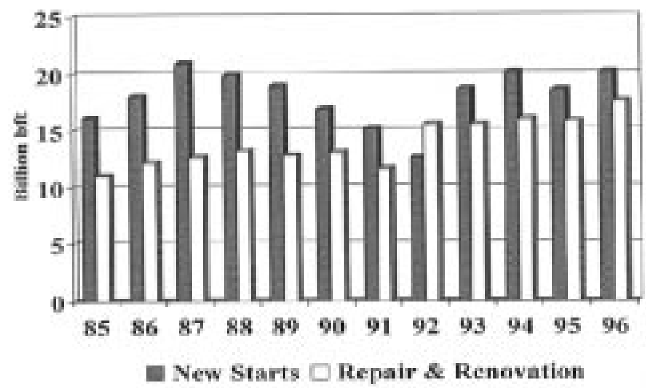

Figure 11.*—U.S. softwood lumber consumption. Source: Resource Information Systems, Inc.*

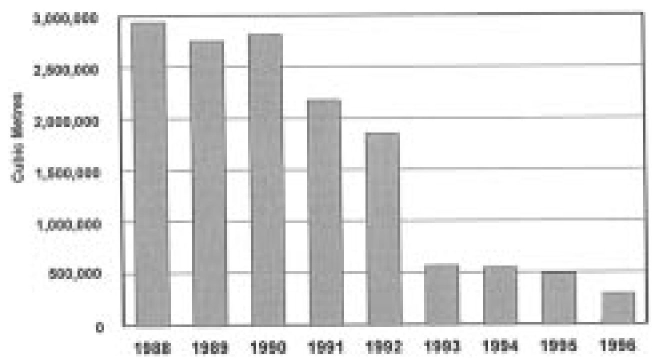

Figure 12.*—U.K. imports of Canadian softwood lumber. Source: Statistics Canada.*

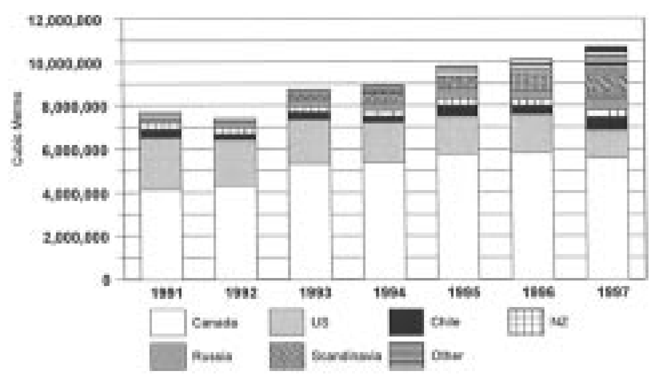

Figure 13.*—Japanese lumber imports. Source: Japan Tariff Association.*

significant to the financial viability of the high-cost B.C. coastal lumber production.

While Canada does have an obvious dependence on the United States commodity lumber, pulp, and newsprint markets, it should be pointed out that there have been strong inroads into other higher value markets. This includes the diversification to

Japan (largely solid wood products; note the price premiums shown in Fig. 14 for even S-P-F dimension lumber) and much of Western Europe (largely pulp and paper). In addition, trends in the shipments of value-added wood products are all strongly up, including panels, mouldings, builder's joinery, doors, windows, flooring, and manufactured homes or components (examples offered in Figs. 15 and 16). Against lumber exports of over $12 billion in 1996, exports of such value-added products approached $3.5 billion, up from less than $2 billion in 1993 (Statistics Canada).

The future of Canada's fiber supply

When thinking about the future of a country's fiber supply, it is the economically available supply that is of ultimate interest. Looking back at Figure 1, this is asking how large the timber productive rectangle will be in the future, shown for 1995 to be at 245 million hectares.

There are a number of factors that can affect the extent of Canada's timber productive land base, all ultimately related to price (value and costs). For example, if the price of construction lumber for the U.S. housing market goes up, the underlying value of logs rises and the timber productive rectangle expands (log producers can afford to go deeper into the woods and/or utilize smaller or lower quality logs). Conversely, if product value falls, the economic timber supply contracts. Cost has the same effect; lower the cost of timber/lumber/paper/pulp production through capital and/or technological innovations, and the economic supply expands. Raise the cost through more strict environmental regulations or stumpage, and the economic supply contracts. Forest economists often refer to such a supply area as the extensive margin.

In addition to the extensive margin, one needs to consider the intensive margin, or the process of increasing the timber supply per hectare through silviculture (again, through the injection of capital and/or technology). Like the extensive margin, this too is largely driven by price (expected return on the silvicultural investment versus the added costs).

It is not the intent of this paper to offer economic forecasts of Canada's fiber supply. Rather, a discussion is offered on the many variables that have been or are likely to act on Canada's extensive and intensive margins.

If price is indeed the driving variable to existing and expected timber supply, then a good place to start in discussing the future is Canada's past exist-

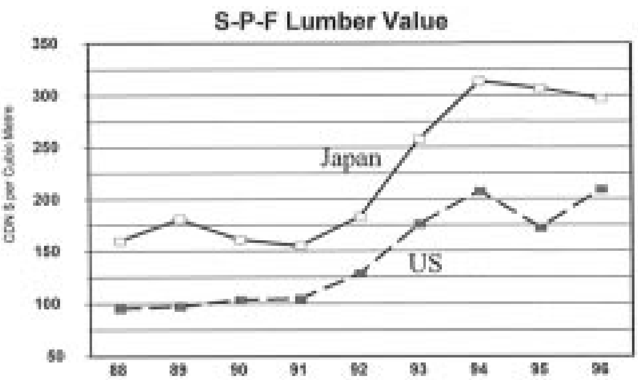

Figure 14.—*Canadian softwood lumber exports. Source: Statistics Canada,*

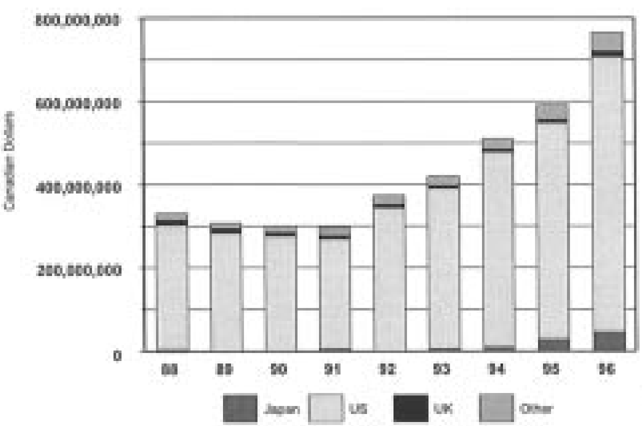

Figure 15.—*Canadian exports of joinery, etc. Source: Statistics Canada.*

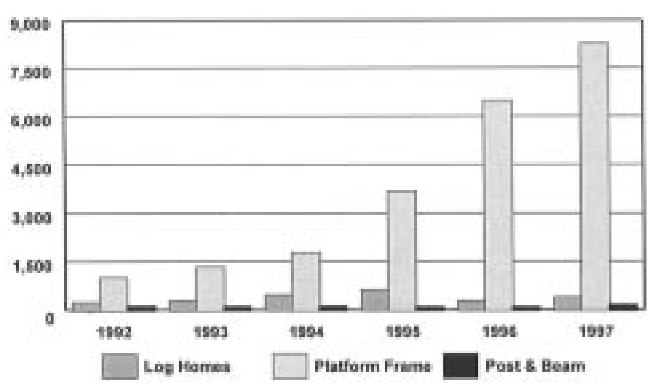

Figure 16.—*Japanese imports of manufactured homes. Source: Council of Forest Industries.*

ing, and expected competitive advantage in producing various forest products. The price is, after all, nothing more than the point where supply and demand meet, sellers striking a deal with the buyers. Canadian forest products have been and are in high demand. But why has this been the case, and are there factors that can cause this to change?

To begin, Canada has been blessed with an abundant supply of high-quality old-growth timber. The cost of extraction has not been relatively high, and it was possible, indeed lucrative, to supply a large U.S. market with minimally processed commodity lumber and pulp at a relatively low price. But the key to profitability in this market is low fiber cost.

With the introduction of engineered wood products, however, and the ability to produce high performance structural members with lower and lower quality fiber over time, it is unlikely that Canada will be able to maintain this competitive advantage. Canada is not the place to grow the least expensive fiber, giving way to more southerly, fast-growing plantations. Even with old-growth stands, where the fiber is part of a natural endowment, increased harvesting costs have combined with environmental and political pressures to give Canada (particularly in the West, Fig. 17) some of the highest delivered log costs in the world.

The harshest reality of all regarding Canada's continued ability to maintain the historical market shares is that forest product trade has become increasingly global. The formerly lucrative market in Western Europe, for example, has been met with increased production in Scandinavia and even the Baltics (Fig. 18). While still dominant as a softwood lumber supplier in Japan, increased competition comes from engineered products and new sources of lumber supply, such as Scandinavia (Fig. 19). World trade has become less of one where minimal transportation costs wins the day, and more of one where serviceability, flexibility to market wants, and price relative to exchange rates determines choices (Figs. 20 and 21).

The emergence of engineered wood products has played such an important role in the structural change we are seeing in the global marketplace that it bears repeating. I-beams have greatly reduced the need for wide dimension straight boards, a source of competitive advantage for Canada in the past. Similarly, finger-jointing has eliminated the need for length, and has created a market for mill-ends. Parallel-strand lumber, made originally from plywood manufacture waste, offers a very strong structural member that is also aesthetically pleasing. Glulam beams are capturing market share from once dominant large dimension lumber and logs from British

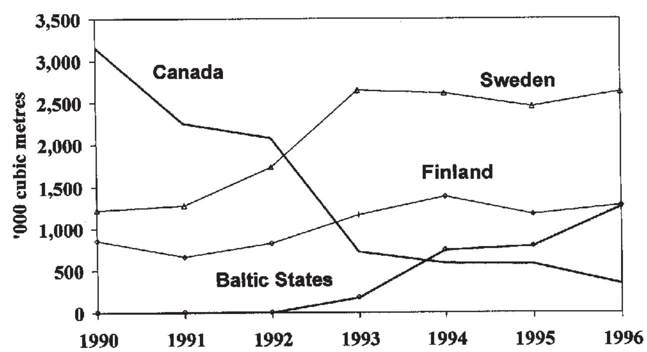

Figure 18.—*U.K. imports of softwood lumber. Source: Eurostat.*

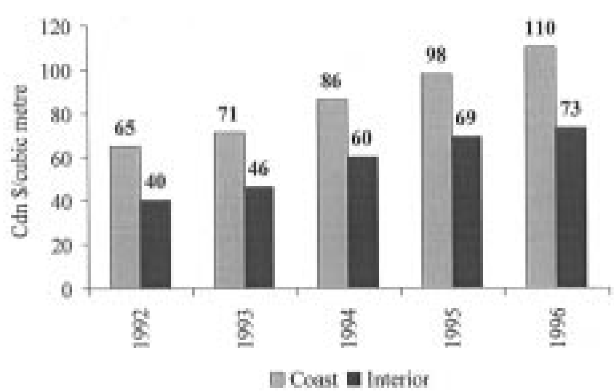

Figure 17.—*B.C. logging costs. Source: B.C. Ministry of Forests.*

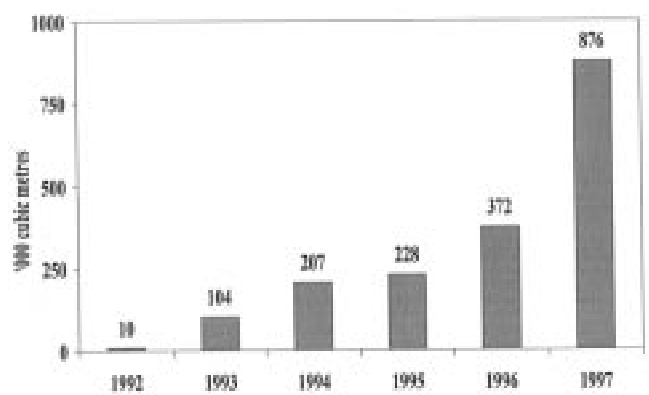

Figure 19.—*Sweden comes alive in Japan. Source: Japan Tariff Association.*

Columbia and the U.S. Pacific Northwest (Fig. 22). As a final example, Forintek Canada Corp. is in the process of developing a panel product made from bark, with advantages of natural moisture and insect resistance and low cost of manufacture.

The main message here is obviously that technology is driving wood supply today, and will increasingly do so as we move into the next century. Such technology can be broken down into three components. The first is wood saving technology, where sawmill equipment is being designed to increase recovery and quality (and lower costs). Further, technology has been developed to utilize smaller and smaller tree diameters. The second component is wood extending technology, including engineered product development. Oriented strandboard offers a use for previously under-utilized hardwoods—the ability to pulp hardwood. Engineered structural members can use mill wastes. Advances in paper making technologies have reduced the volume of long length fiber from northern bleached softwood kraft pulp that is required to blend with shorter length fibers to meet paper performance needs. Finally, the third component is wood increasing technology. Where the first two are ways of increasing the extensive margin, this technology increases the intensive margin. The growth in plantation and fiber farms offers a good example, as do advances in growth rates, hardiness and value through intensive silvicultural practices and biotechnology. Current annual growth rates for New Zealand radiata pine sawlogs average 22 m^3/ha/year but the next generation of cloned trees is forecast at 32 m^3/ha/year.

Ironically, much of this technology has threatened Canada's historical competitive advantage based on an abundant natural timber endowment. Not only is the willingness to pay for large dimension timber and virgin fiber pulp decreasing, if the future of forest products comes down to the ability to produce the least expensive fiber, Canada may be looking at a future with fiber imports and/or technology exports (Fig. 23).

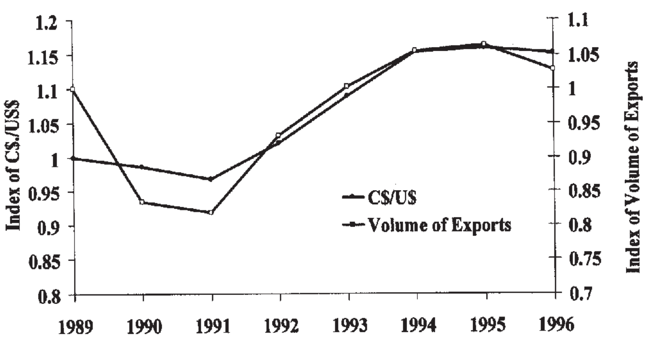

Figure 20.—*B.C. softwood lumber exports to the United States.*

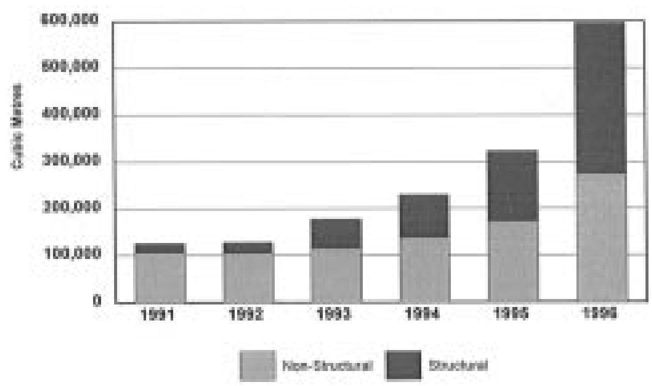

Figure 22.—*Japanese imports of laminated lumber. Source: Japan Tariff Association.*

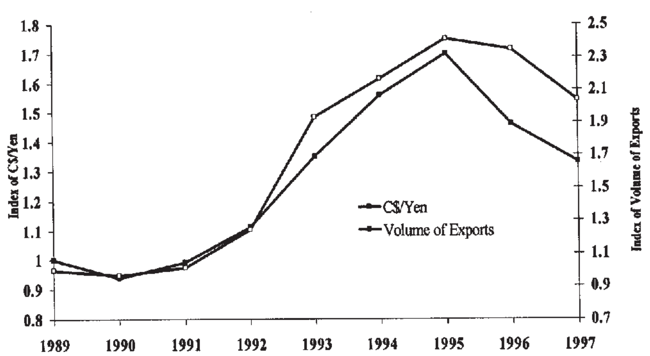

Figure 21.—*B.C. softwood lumber exports to Japan.*

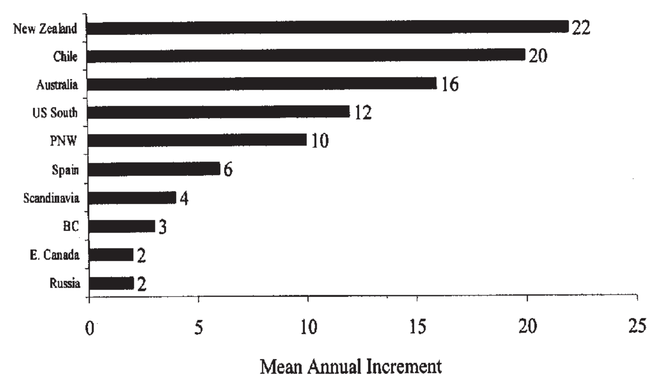

Figure 23.—*Softwood growth rates. Source: FAO.*

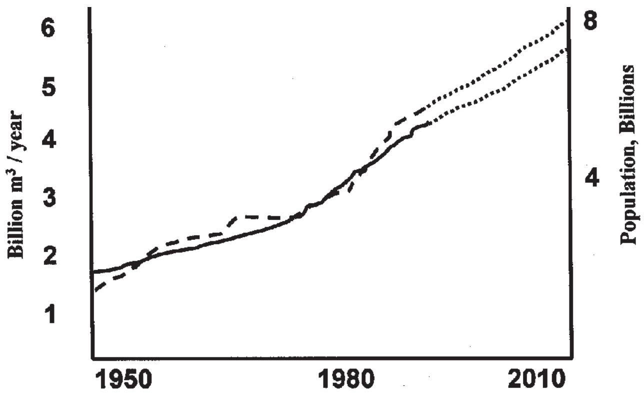

Figure 24.—*Global harvest vs. population. Source: FAO.*

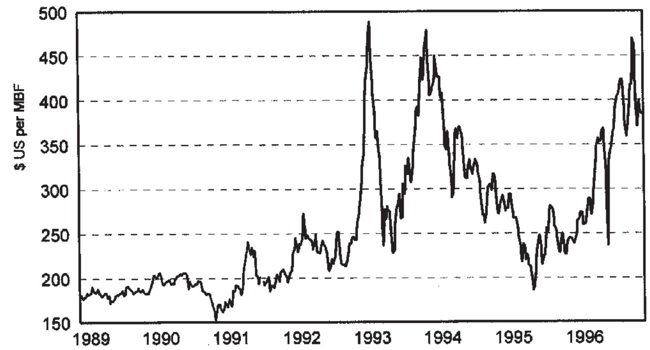

Figure 26.—*Price volatility. Random Lenght S-P-F lumber futures. C.M.E., Spot Contract Weekly.*

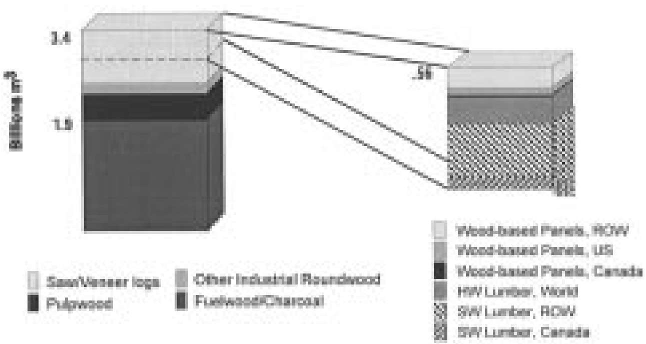

Figure 25.—*Global fiber production. Source: FAO.*

In a world where the population is still growing rapidly, there are those that would argue that the growth in total wood product demand will negate any concerns about the future. The World Resources Institute estimates that world demand for wood is increasing at an annual rate of 75 million m^3. In comparison the annual allowable cut in British Columbia is about 71 million m^3. As shown in Figure 24, wood demand and population growth have indeed been strongly correlated. The caution to this, however, is that technology always reacts to scarcity, and the willingness to pay adjusts accordingly. If technology creates a demand for fiber as opposed to logs and lumber, it must be noted that there will not likely be a shortage at any point in the future (due to the three technology drivers discussed). In addition to this technology, huge increases in the world's existing fiber can be achieved through reduction in the use of fuel wood (Fig. 25). Indeed, the fuelwood harvest is about 1.2 times the industrial harvest.

Finally, it must be noted that in addition to Canada's competitive position with other fiber suppliers, there will always be the challenge of non-wood substitution in our markets. This has been witnessed in parts of the U.S. South for example, where steel studs for housing have been making strong in-roads, largely attributed to the price volatility of wood studs (Fig. 26). Fortunately, wood does have a very strong environmental advantage; Forintek Canada, the Canadian Forest Service, and others have devoted considerable research efforts to measuring the relative environmental impacts of different building materials.

The trend of non-govermental organizations and the private sector to increasingly push for policy vehicles which provide them with a stronger role in development and implementation has contributed to an international dialogue on forest certification. The rapid emergence of the certification vehicle is an additional layer of principles and criteria on the more traditional command and control functions of government in forest management. There is evidence that consumers have signalled a willingness to modify their consumption behavior in favor of a product with a reduced environmental legacy (albeit there is little indication of a willingness to pay more).

Canada, with an abundance of natural timber stands, is in a relatively unique position in comparison with the rapid-growth plantation forests of Europe and Scandinavia. This harvest of natural stands will present a challenge to negotiators in pursuit of a level playing field in forest management and forest product certification.

If Canada is to have a future economic fiber supply (wood, pulp, and paper products as opposed to an economic wilderness), it will be because the industry moves beyond what has largely been a production-oriented era. This will require a knowledge base of what global consumers want, and identifying where Canadian fiber supply is particularly well suited to meet this demand. Canada will always enjoy a location advantage to the large U.S. housing market, but will this be enough? Are our other traditional markets changing? Due to a number of factors, our traditional high-end Japanese market, for example, appears to be moving away from a demand for appearance toward a demand for performance and price. Is there a fit for Canadian fiber in this scenario? Can we find niches in Western Europe that cannot be met with Scandinavian fiber? Will other new geographic markets emerge that suit Canadian products? Can we move beyond our traditional housing end-use markets (including commercial buildings)? Where the fit for Canadian fiber to and end-use demand is not optimal against our competition, can product research and development solve the problem?

To survive, to have a future fiber supply that is in demand, these types of questions will have to be answered, leading to a successful, new market-oriented, technology-driven era.

Wood fiber: Starting point of the pulp and paper industry in Mexico

José B. Pontones

Mexico has an important industrial infrastructure to produce pulp and paper, represented by 3 pulpmills, 7 pulp- and papermills, and 67 papermills. Notwithstanding this important infrastructure, the lack of sufficient wood fiber raw material is an important limitation for its development, provoking between \$0.8 and \$1.2 million of pulp and paper imports each year. In addition, supply limitations of virgin fibers cause important trends in importing secondary fibers for recycling, with some availability and usage limitations. Fast-growing forest plantations are the immediate resource for fibrous raw material for the pulp and paper industries in Mexico. Weather, soil, and land availability in Mexico, with special reference to the tropical areas with large extensions of agricultural use lands, bring an important opportunity for fast-growing forest commercial plantations. In the next two decades, these plantations will supply over three times the current national forestry production (6.8 million m^3 of wood). The forest plantation's wood supply, in addition to recycled raw materials with the appropriate technologies, assert the stability and sustainable development of the pulp and paper industry in Mexico, with a sufficient volume for domestic trade and for export, making use of the NAFTA opportunities for Mexico, and making use of the great strategic geographical position of Mexico with respect to global trade.

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Wood fiber supply and demand in the United States

Kenneth E. Skog
Peter J. Ince
Richard W. Haynes

Abstract

The USDA Forest Service is preparing a national assessment of supply and demand for wood fiber resources in the United States. Based in part on preliminary results of this assessment and partly on our 1993 Assessment, this paper outlines trends and gives an outlook for demand and trade for timber and fiber products, changes in technology, and wood fiber resource supply. We use the term wood fiber to include timber for solid wood products, pulp and paper products, and recycled paper for paper products. Demand for solid wood products and paper and paperboard products will be driven by growth in population, gross domestic product (GDP), and personal disposable income (PDI). The growth rate of these indicators is sustained but slowing. Population, GDP, and PDI are projected to grow about 1 percent, 2.7 percent, and 2.5 percent per year, respectively, through 2005. Growth will be slower through 2050. Population growth will be 0.5 percent by 2050, and GDP and PDI will average 1.9 percent growth per year. Despite continued strong growth in GDP and PDI per capita, consumption of forest products per capita will slow, stop, or actually decline for some solid wood products but will increase for engineered products and slow for paper and paperboard products. Consumption of wood fiber products will continue to shift from lumber and plywood to engineered wood products, such as oriented strandboard and laminated veneer lumber, and to fiber-based panels, and from solid wood products to paper and paperboard products. The United States is a net importer of forest products. Preliminary analysis suggests net imports of paper and paperboard could continue to decline relatively with a faster growth of exports. Timber supply for solid wood products will continue to shift from larger softwoods to smaller softwoods and hardwoods. Paper and paperboard fiber supply will continue to shift away from residue use (because of lower residue production from lumber and plywood mills) toward recycled paper use and greater roundwood timber use. Timber supplies are projected to increase 43 percent between 1991 and 2040. The most striking shift during this time is the shift toward supply

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coming from farm and other private sources—a growth of 67 percent versus a growth of only 17 percent from other types of ownership. This shift could result in a significant change in the direction and content of forest management and policy debates in the coming decades. Harvest of hardwoods will increase substantially in the South. With expected increasing prices for pulpwood, short-rotation hardwood plantations may expand, with most growth occurring after 2010. Pulpwood and woodpulp imports are projected to increase, but imports remain small relative to domestic supply. Technology is expected to continue to adapt to changing fiber supply with shifts toward engineered wood products using smaller diameter trees and hardwoods and shifts toward paper and paperboard processes that use more hardwood and recycled paper.

Introduction

The past decade has seen a number of changes in U.S. timber supply prospects. Some of these changes have reduced prospective timber harvests. Others have encouraged various parts of the forest products industry to find and use alternative sources of supply.

Most of our perceptions are that these changes result from increasing environmental regulations and that they involve reductions in timber supply. The most controversial have been the changes in federal timber harvests. The federal harvests have decreased in some places by as much as 90 percent. The current outlook is that National Forest harvest will fall by two-thirds between the late 1980s and 2000. This decrease results from a number of policy changes including habitat protection for the spotted owl and the red cockaded woodpecker, ban on development of current roadless areas, and reductions in below cost timber sales. Projections of total National Forest harvest are 1.17 billion $ft.^3$ for 2000 and 1.28 billion $ft.^3$ for 2040 (33 and 36 million m^3, respectively). Most of this decrease is in five states (Montana, Idaho, Washington, Oregon, and California), and most of this decrease has already occurred.

In addition to environmental regulations, there are other changes that will significantly impact our timber needs and timber use patterns. These include the changing influence of population and economic growth on growth of product demand, the changing mix of products produced to meet needs, the changing technology to make products more efficiently, and the shift among timber supply sources from public to private ownerships, from sawtimber to nonsawtimber, and from softwoods to hardwoods.

The Forest and Rangeland Renewable Planning Act of 1974 requires periodic long-range assessments of timber supply and demand that provide information for stewardship and management decisions in both the public and private sectors. The latest assessment was completed in the fall of 1993 (2). The next assessment is to be completed in early 2000. This paper is based primarily on the 1993 assessment with some preliminary projections for the paper and paperboard industries from the 2000 assessment.

First, we will present an overview of prospective forest products demand and resultant wood fiber demands. Second, we will discuss changes in technology that are affecting wood fiber demand and supply, and finally we will discuss the associated trends in timber and recycled fiber supplies.

Demand

Determinants of demand

One way to view forest products demand is in terms of trends and projections of per capita consumption. Economic theories of natural resource use often assume that resource use increases as population and income grow.

Population growth is projected to slow during the next 50 years, from about 1 percent per year currently to 0.5 percent per year by 2050 (Fig. 1). Gross domestic product (GDP) and personal disposable income (PDI) are projected to grow 2.7 percent and 2.5 percent, respectively, through 2005. But GDP and PDI growth decline to an average of 1.9 percent per year between 2005 and 2050 (5).

Consumption of solid wood products, pulp and paper products, and fuelwood were growing at nearly the pace of economic growth (GDP) from the 1960s until the mid 1980s (Fig. 2). The consumption of solid wood products, paper and paperboard products, and roundwood used for fuel has more than doubled since 1960—from 100 million metric tons to about 215 million metric tons in 1996. Much of this increase is due to the fuelwood consumption increase in the late 1970s and 1980s. This total does not include the tonnage of black liquor from pulping, which is used for fuel.

Since the 1980s, solid wood products consumption has grown at about the pace of population, and paper and paperboard products consumption has grown faster than the population but slower than the GDP (Fig. 2). The growth rate for solid wood products per capita per year is projected to remain at the current level of about 0.32 metric tons (0.74 m^3) per capita or decline slightly by 2040 (Fig. 3). Growth in per capita consumption of pulp and paper is slowing but is projected to rise from about 0.33 metric tons in 1996 to 0.41 metric tons in 2040 (Fig. 3).

Solid wood products.—Residential construction is expected to continue to dominate demand for lumber and panel type products. Housing starts are expected to increase from 1.4 million units annually in the 1990s to about 1.7 million units by 2010, and then decline to 1.5 million by 2040. Early next century, lumber and panel demand for residential repair and remodeling is expected to overtake demand in new construction. These two end uses consumed 50 percent of the lumber and 60 percent of the structural panels in 1990, but these proportions are expected to decline to 45 percent and 48 percent, respectively, by 2040, while consumption in other end uses will increase, such as nonresidential construction, manufacturing, and shipping.

Paper and paperboard products.—Consumption of paper and paperboard has been driven by population and per capita GDP, as well as substitution of other products for paper and nonpaper products, such as plastics and electronic media. For sev-

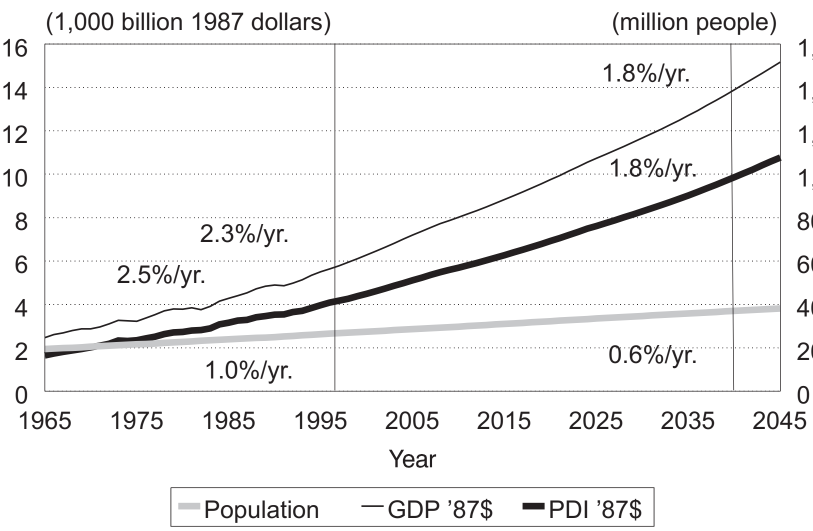

Figure 1.—*Population, gross domestic product, and personal disposable income for the United States.*

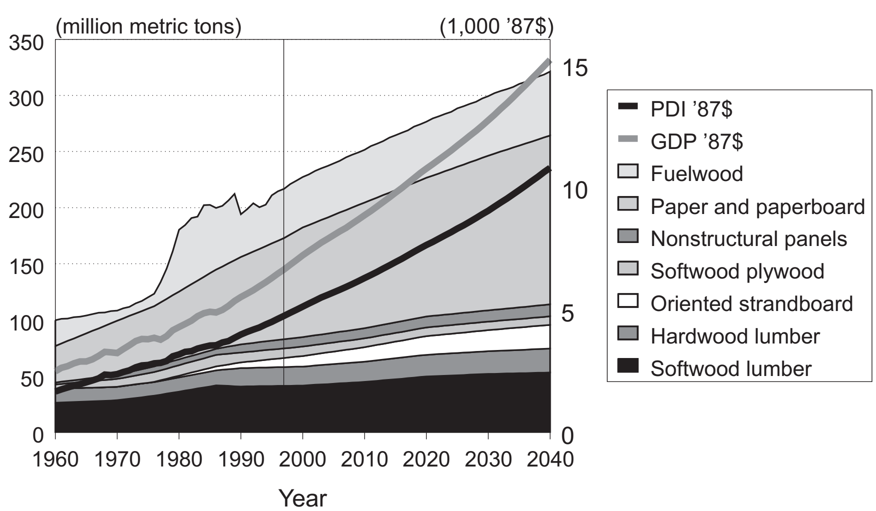

Figure 2.—*Consumption of forest products in the United States.*

eral decades, overall growth in paper and paperboard consumption had kept pace with growth in GDP. But growth is now well below the rate of GDP growth, although it still exceeds the rate of population growth.

Roundwood requirements for consumption

Consumption of roundwood for solid wood products, pulp and paper products, and fuelwood has grown more slowly than consumption of products because of increased paper recycling and improvements in production efficiency. Per capita consumption of roundwood for forest products was 2.3 m^3 in 1950, declined to a low of 1.7 m^3 in 1970, reached 2.3 m^3 in 1988, and is currently 2.1 m^3 (Fig. 4).

Per capita roundwood consumption is projected to decline slightly during the next 50 years. This view of the future shows less reliance on solid wood products manufactured from logs but greater reliance on engineered and reconstituted products for structural applications. It assumes a greater use of recycled fiber. In spite of this, total roundwood consumption required for U.S. products is expected to grow 0.6 percent per year to 750 million m^3 (26.5 billion $ft.^3$) by 2040, up from 550 million m^3 (19.4 billion $ft.^3$) currently (Fig. 4).

Perhaps more important than the slowing of growth has been the change in the composition of product consumption. Between 1960 and 1996, the

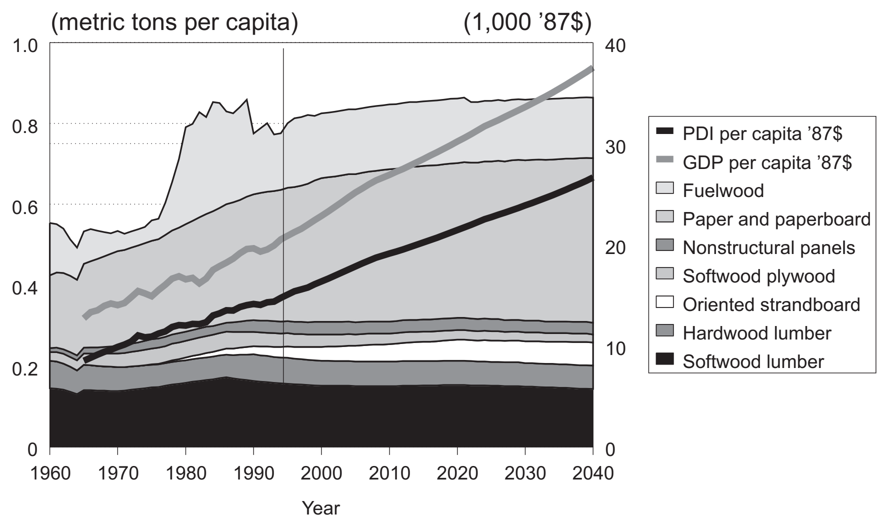

Figure 3.—*Consumption of forest products per capita in the United States.*

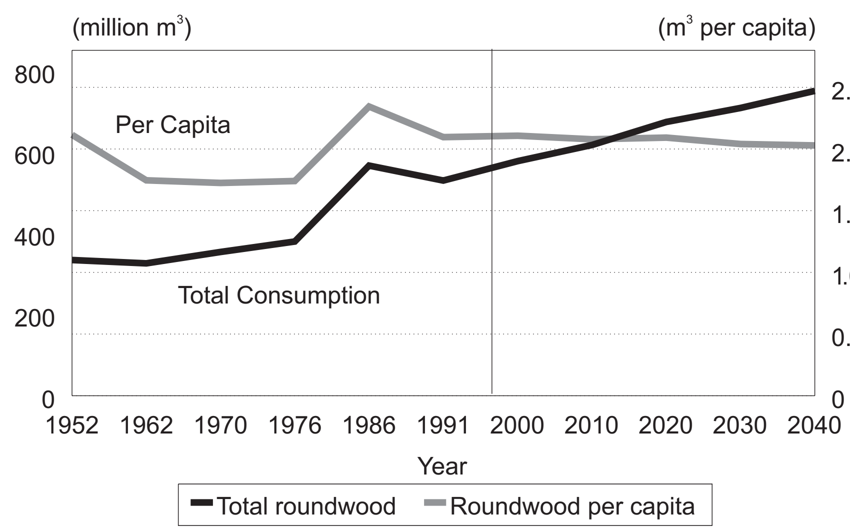

Figure 4.—*Roundwood required for U.S. forest products consumption.*

share of lumber dropped from 38 percent to 27 percent, the share of paper and paperboard increased from 33 percent to 42 percent, and the share for panels increased from 6 percent to 11 percent (Fig. 3). The fuelwood share was at 23 percent in 1960, increased to about 30 percent in the 1980s, and has now declined to 20 percent. Paper and paperboard consumption has increased the most in absolute amount—from 33 million to 89 million metric tons.

Recycled paper and mill residue requirements for consumption

The fiber sources for U.S. paper and paperboard production have shifted from roundwood to mill residue and, most recently, to recycled paper between 1960 and 1996: from 60 percent roundwood, 12 percent mill residue, 20 percent recycled paper, and 8 percent imported wood pulp to 50 percent roundwood, 19 percent mill residue, 25 percent recycled paper, and 6 percent imported wood pulp. The share of recycled paper used as a fiber source is projected to increase through 2040, to 36 percent, while the roundwood share and residue share are projected to decrease to 30 percent and 13 percent, respectively (Fig. 5).

Production of forest products

The United States is a net importer of both solid wood and pulp and paper products. For solid wood products, we are a major importer of softwood lumber but a net exporter of hardwood lumber. The amount of U.S. roundwood required for domestic production has increased 1.7 percent per year since 1960 from 289 to 520 million m^3, whereas total roundwood required for consumption has increased 1.6 percent per year since 1960—324 to 550 million m^3. Per capita roundwood harvest for U.S. production is about 2.0 m^3 (71 $ft.^3$).

Solid wood products.—In the 1990s, softwood species comprised about 76 percent of all lumber produced. Total softwood lumber production rose from 41 million m^3 in 1960 to 51 million m^3 in 1996. The increase has been even greater for structural and nonstructural panels and engineered wood products—from 8 to 26 million m^3.

Pulp, paper, and paperboard products.—Paper and paperboard production and production capacity have been increasing in the United States for most principal product grades, and production is projected to increase in the future. Growth will be tempered somewhat by a projected gradually slower growth in population and a slower growth in demands relative to GDP. The bulk of projected growth in paper and paperboard capacity is concentrated in the printing and writing grades and in containerboard.

Trade in forest products

The U.S. fiber requirements are increased by the fiber needed for export products. Pulp, paper, and paperboard dominate U.S. exports (Fig. 6). We are also a net exporter of hardwood lumber. These exports increase requirements for hardwood sawtimber. The demand for paper and paperboard exports

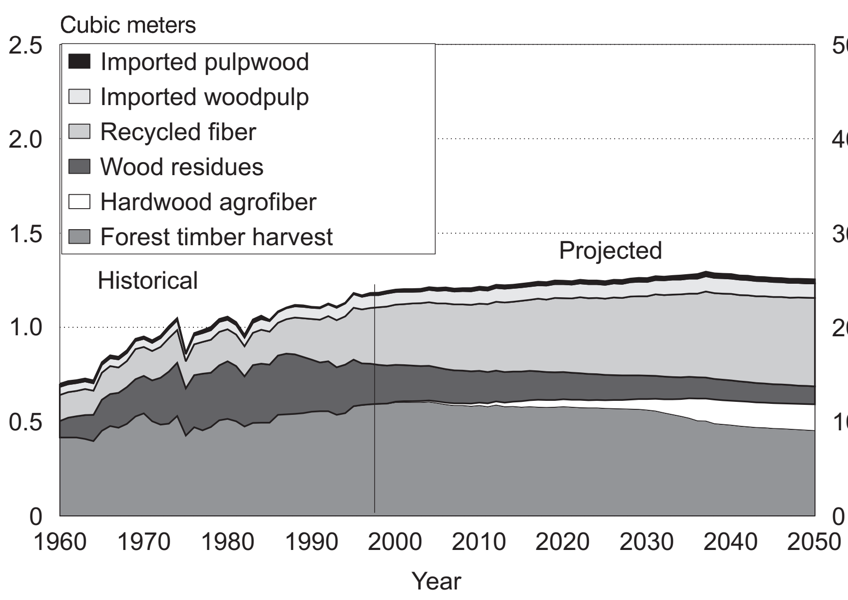

Figure 5.—*Per capita use of wood and wood fiber in United States pulp and paper industry, 1960–2050.*

has been growing faster than the demand for solid wood products, although both have been increasing in value terms (Fig. 7).

Changes in exports are strongly influenced by conditions in our export markets and by relative U.S. competitiveness. Five of the top 10, and 9 of the top 20, trading partners for U.S. forest products exports are Asian countries. In 1996, these countries accounted for about 40 percent of the value of U.S. solid wood and pulp and paper exports. The recession, or even slow growth, in these countries will have a continuing effect on U.S. exports. At the same time, 3 of the top 10, and 6 of the top 20, trading partners for imports are also Asian countries. Currency revaluation, which has already occurred for the most part, makes imports from these countries more competitive in U.S. markets.

U.S. fiber requirements are reduced by the type and amount of fiber that would have been needed to make products imported. The leading imports are softwood lumber and newsprint (Fig. 6) from Canada. Imports of Canadian softwood lumber provide more than 30 percent of U.S. softwood lumber consumption. These imports decrease requirements for softwood sawtimber and softwood pulpwood. Hardwood lumber imports have been and are projected to remain below 5 percent of total hardwood lumber consumption.

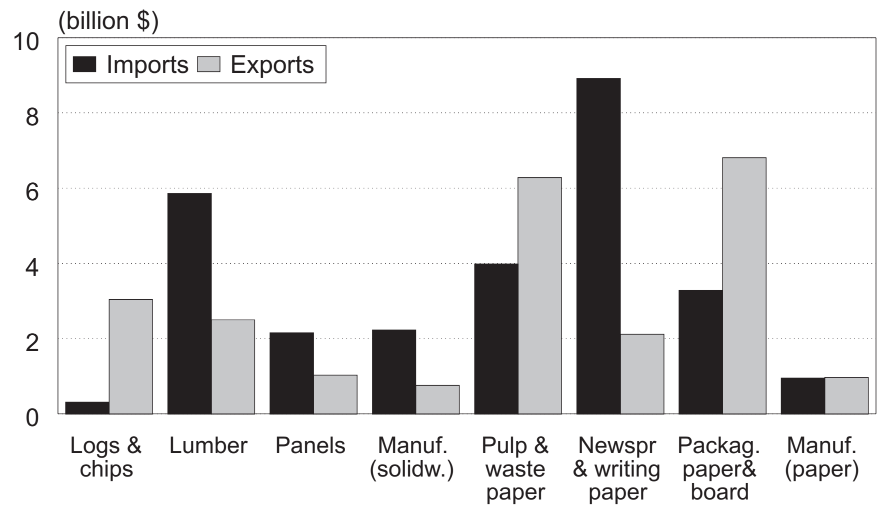

Figure 6.—*U.S. forest products trade, 1995. Value of trade by commodity group.*

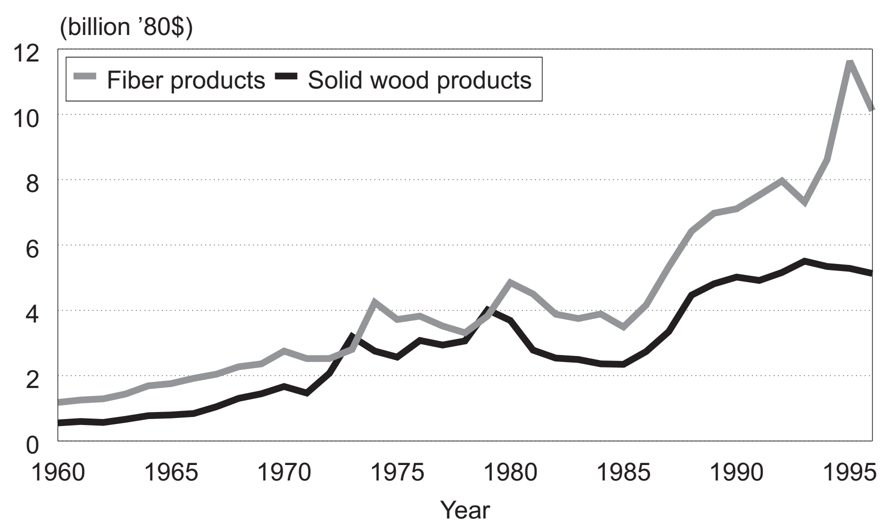

Figure 7.—*United States forest products, exports, 1960–1996.*

Technology change

There have been several major technology changes affecting wood fiber requirements:

- a shift in production from solid wood products toward paper and paperboard products, with an associated shift from sawtimber to pulpwood (Figs. 2 and 15);
- a shift among solid wood products from lumber and plywood to other composite panels and engineered lumber (Fig. 8), with an associated shift from softwoods to hardwoods and from larger diameter to smaller diameter trees (Fig. 9);
- a continuing increase in log conversion efficiency for solid wood products (Fig. 10), with a resultant decline in availability and use of mill residue for pulp, paper, and paperboard production (Fig. 12);
- a shift in pulping from softwoods to hardwoods; and
- a shift from virgin wood to recycled fiber (Figs. 11 and 12).

Changes in the pulp and paper industry are projected to have the greatest effects on fiber requirements. Shifting technology, shifts among product grades produced, shifts in trade, and shifts in recycling rates have led to some specific changes in relative quantities of fiber material inputs.

When we look at fiber inputs (cubic meters) per unit of paper and paperboard output (metric tons) over timber, we see significant changes in the mix of

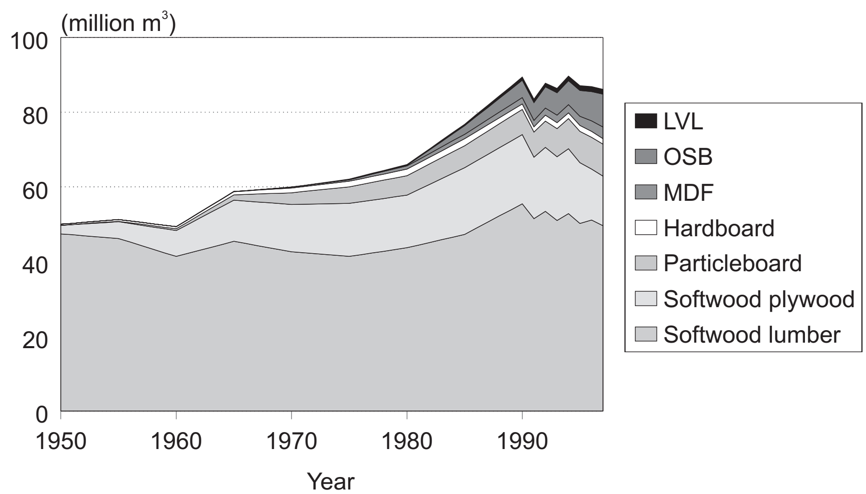

Figure 8.—*Lumber and composite wood product production.*

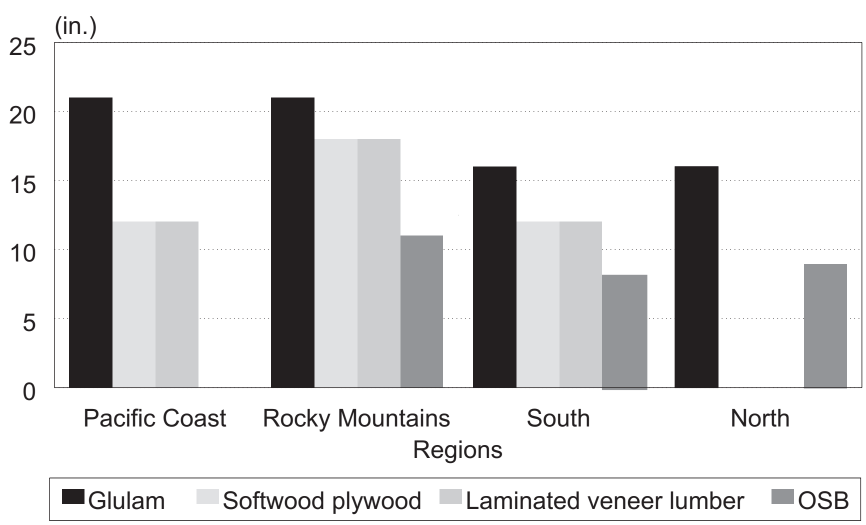

Figure 9.—*Average diameter of logs used for glulam, softwood plywood, LVL, and OSB.*

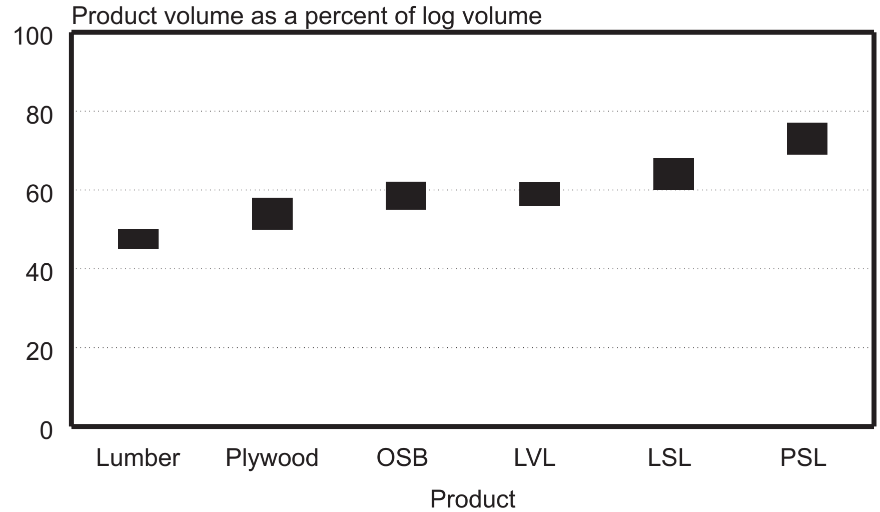

Figure 10.—*Estimated log conversion efficiency by product.*

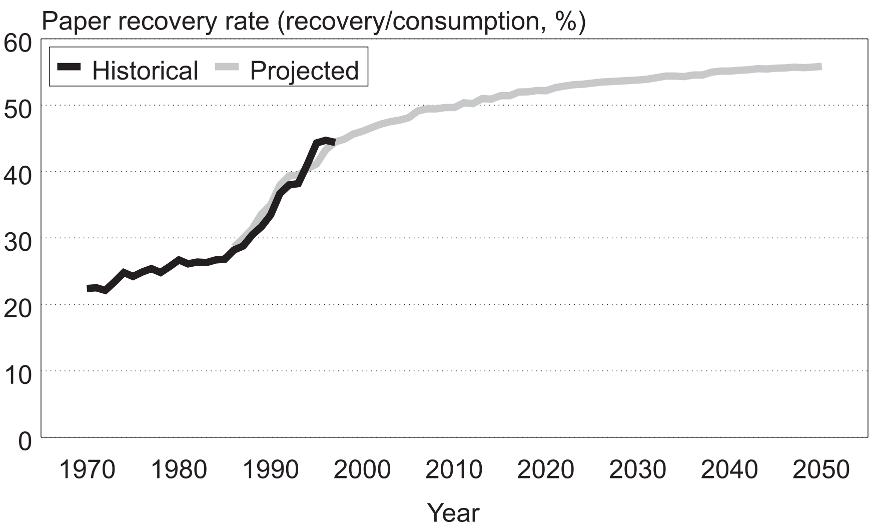

Figure 11.—*Historical and projected U.S. rate of paper recovery for recycling, 1970–2050.*

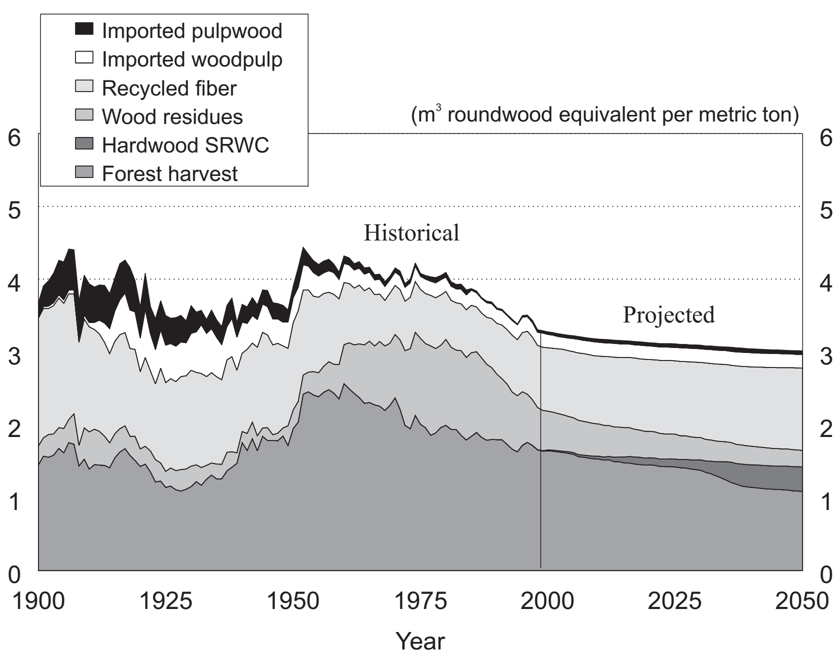

Figure 12.—*Historical and projected fiber raw material use per ton of pulp, paper, and paperboard produced in the United States, 1900–2050.*

fibers used and a decrease in fiber requirements per unit output. (Fig. 12).

Looking back over the past century, we see that recycled fiber was once much more important than today (rag stock provided a large share of fiber input in the early part of the century). The expansion of large-scale kraft pulping since the 1920s has increased the use of roundwood and wood residues. Total fiber input per ton of product output is projected to gradually decline into the future. Residue use in particular will decline with declining availability of wood residues in U.S. markets. Roundwood will remain the dominant fiber input, followed by recycled fiber (Fig. 12).

Significant changes in pulp and paper production technology, historical and projected, are exemplified by changes in processes used for linerboard production (Fig. 13). The U.S. linerboard production capacity is distributed historically among three principal process categories:

- unbleached kraft board with pre-1980s press technology, called "old press;"
- unbleached kraft board with post-1980, improved press technology, with wide-nip or extended-nip press sections in the paper machines, called "new press;" and
- so-called "recycled linerboard," made from 100 percent recycled fiber (Fig. 13).

The unbleached kraft board made with the old press and new press technologies may also include some recycled fiber, but the new press technology permits higher proportions of recycled fiber, as well as higher proportions of hardwood fiber (30% or more is typical in the new press technology, compared with less than 10% in the old press technology).

Future linerboard production capacity is projected to be dominated by unbleached kraft board, with the new press technology continuing to replace the old press technology. The amount of linerboard made entirely from recycled material (recycled linerboard) is also projected to increase, but recycled linerboard will remain only a fraction of total linerboard capacity. It is projected that other product grades, such as in tissue, newsprint, and corrugating medium, will be made with a greater percentage of recycled fiber.

Industrial wood productivity

The amount of industrial wood products produced by the United States per unit of roundwood input (industrial roundwood productivity) has improved by 39 percent between 1900 and 1998 (Fig. 14). Fuelwood is excluded from both roundwood input and product output. Productivity has increased most rapidly since about 1950 particularly due to gains in the use of wood residues and recycled wood fiber for wood and paper products. Further improvements are projected and will contribute to keeping roundwood requirement growth at or below the rate of growth in population.

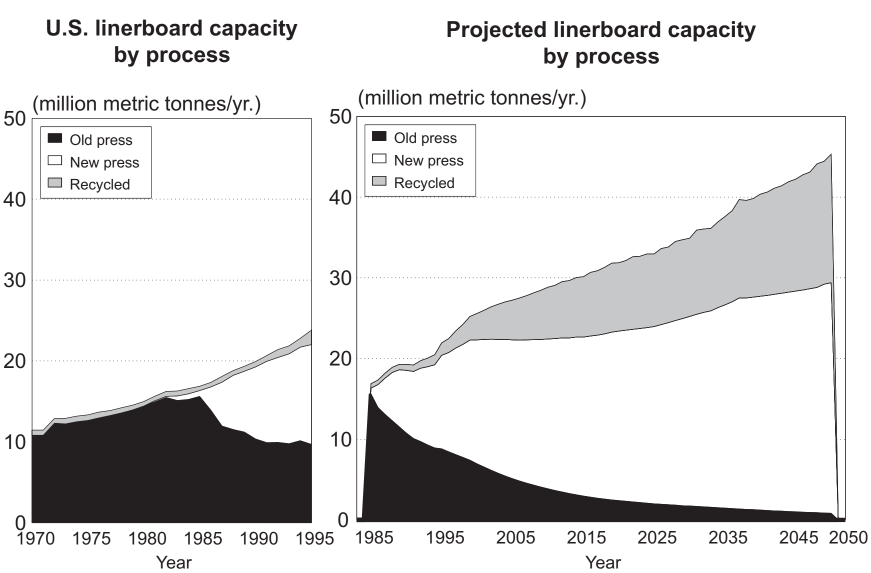

Figure 13.—*U.S. linerboard capacity by process. Projected linerboard capacity by process.*

Description of fiber supplies

Fiber supplies include roundwood from timber harvest, wood residue from primary wood products processing, recycled paper and wood, and imported wood fiber and wood pulp. We discuss timber supplies for all products, then separately focus on the pulp and paper industry to highlight the importance of recycled paper and wood residue as fiber sources.

Projected timber supplies

Softwood timber harvest has increased by more than 50 percent during the last four decades. It is projected to increase by an additional 35 percent, to 415 million m^3 (14.6 billion $ft.^3$), by the year 2040 (Fig. 15, Table 1). This slower projected growth in demand for softwood timber is due to slower growth in domestic demand, increased use of recycled fiber, increasing use of hardwoods, and the shift of inventory, particularly in the South, to younger age classes of trees. The Pacific Northwest and the South are expected to remain the two most important timber producing regions for softwoods in the United States (Fig. 16). Total timber harvest during the next 50 years is projected to grow from 501 to 718 million m^3 (18.1 to 25.3 billion $ft.^3$), or 0.7 percent per year (Fig. 15).

The timber harvest projections can be split into two components: sawtimber and nonsawtimber (Fig. 15). The distinction is in how the timber is

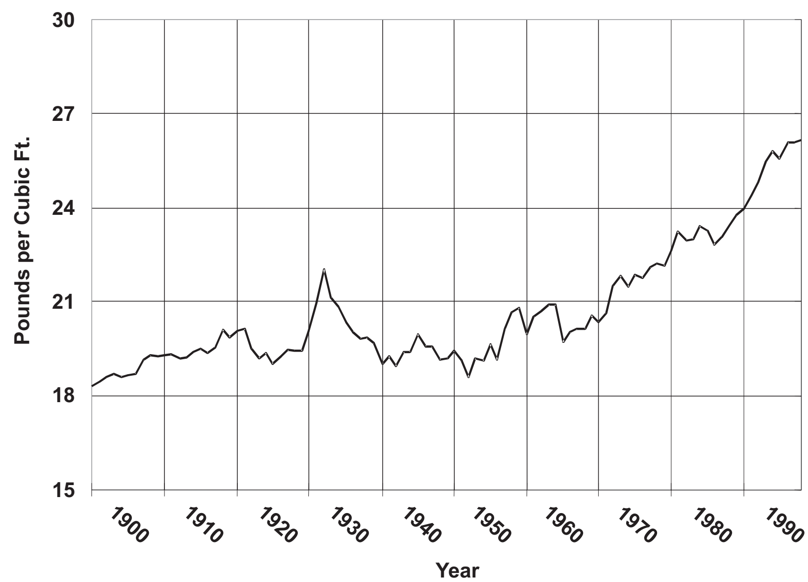

Figure 14.—*U.S. industrial wood productivity—pounds of industrial wood product output per cubic foot of industrial roundwood input, 1900 to 1998.*

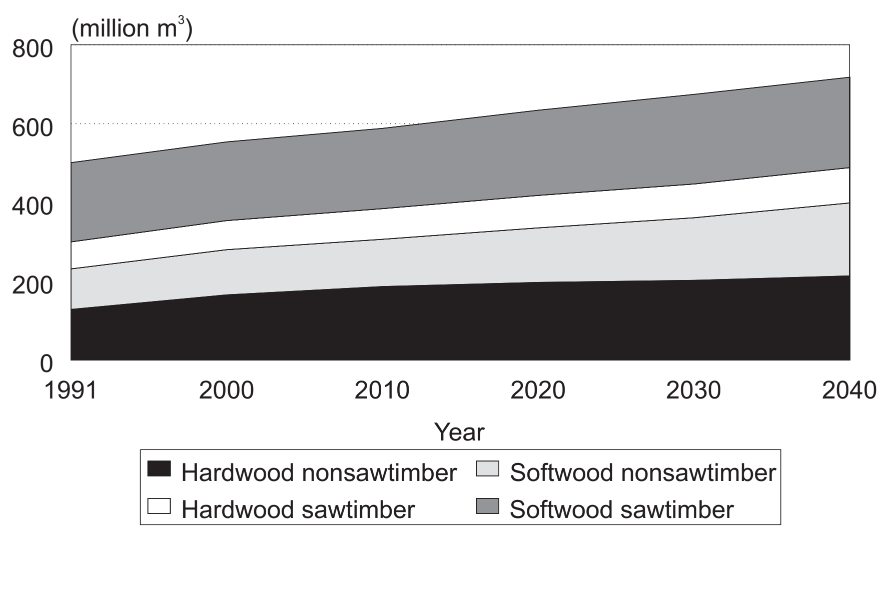

Figure 15.—*U.S. timber harvest by species and type.*

Table 1.—*U.S. timber harvest by selected year.*

Type, region, and source		Harvest 1991	2000	2010	2020	2030	2040
		(million m^3)					
Softwood sawtimber							
Region	North	9.7	11.8	13.4	13.7	13.6	13.4
	South	81.2	103.4	107.8	115.1	121.8	116.7
	Rocky Mountain	24.2	22.6	20.6	21.2	22.3	24.4
	Pacific Coast	86.1	61.9	62.0	66.1	69.5	74.9
Source	National Forest	37.9	19.0	19.5	20.1	20.7	21.2
	Other government	15.8	18.2	18.9	19.1	19.3	19.4
	Forest industry	81.2	72.5	74.8	88.1	100.2	96.4
	Farm and other private	66.3	90.0	90.6	88.8	87.1	92.5
Total softwood sawtimber		201.2	199.8	203.8	216.1	227.2	229.4
Softwood nonsawtimber							
Region	North	17.0	22.5	26.9	29.0	29.9	30.2
	South	68.4	74.0	72.5	84.9	101.5	123.7
	Rocky Mountain	4.0	4.4	5.0	5.7	6.4	7.6
	Pacific Coast	12.9	13.6	15.3	18.5	20.9	23.7
Source	National Forest	9.9	6.9	7.1	7.4	7.6	7.9
	Other government	5.9	6.9	7.5	7.7	7.8	7.8
	Forest Industry	37.4	40.7	42.1	53.1	64.4	72.5
	Farm and other private	49.1	60.1	63.0	70.0	78.8	97.0
Total softwood nonsawtimber		102.3	114.5	119.7	138.1	158.7	185.2
Hardwood sawtimber							
Region	North	35.2	34.3	33.9	34.3	34.8	35.9
	South	29.5	34.9	39.6	43.5	45.9	48.6
	Rocky Mountain	0.1	0.1	0.1	0.1	0.1	0.1
	Pacific Coast	3.9	4.3	4.6	5.1	4.9	5.0
Source	National Forest	2.5	2.4	2.5	2.7	2.7	2.8
	Other government	3.1	3.1	3.1	3.1	3.1	3.1
	Forest industry	11.3	10.2	8.5	8.4	8.9	9.6
	Farm and other private	51.9	57.9	64.1	68.8	71.0	74.1
Hardwood nonsawtimber							
Region	North	69.1	86.1	95.0	102.5	110.7	122.2
	South	53.0	72.4	83.1	85.3	81.4	80.5
	Rocky Mountain	1.1	1.3	1.6	1.9	2.2	2.4
	Pacific Coast	5.5	5.9	6.7	7.2	8.2	8.3
Source	National Forest	5.9	5.5	5.7	6.0	6.2	6.5
	Other government	5.5	5.5	5.5	5.5	5.5	5.5
	Forest industry	20.5	22.8	21.1	21.3	23.0	24.9
	Farm and other private	96.8	131.9	154.0	164.2	167.9	176.5
Total hardwood nonsawtimber		128.7	165.7	186.3	196.9	202.6	213.4

Table 1 (continued).—*U.S. timber harvest by selected year.*

Type, region, and source	Harvest 1991	2000	2010	2020	2030	2040
	(million m³)					
Total softwood harvest	303.5	314.3	323.5	354.2	385.9	414.6
Total hardwood harvest	197.5	239.3	264.5	279.9	288.3	303.1
Total sawtimber	269.9	273.3	282.0	299.1	313.0	319.1
Total nonsawtimber	231.0	280.2	306.0	335.1	361.2	398.7
Total U.S. harvest	500.9	553.6	588.0	634.1	674.2	717.7

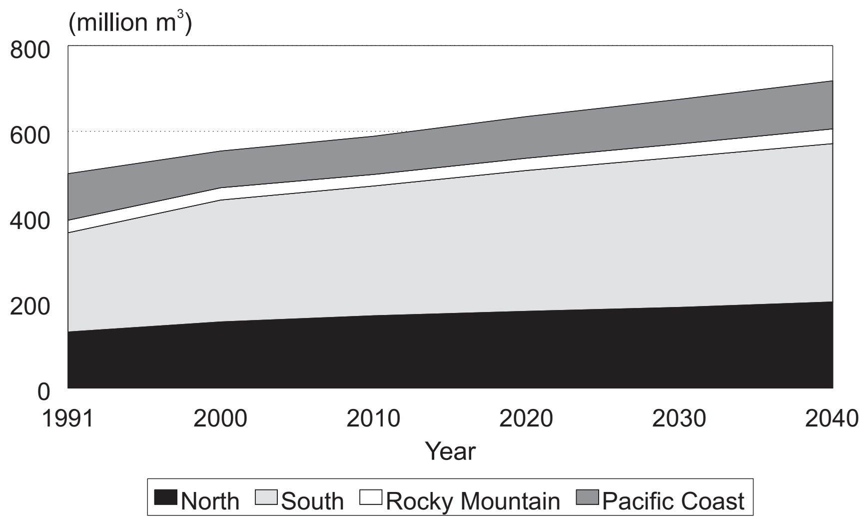

Figure 16.—*U.S. timber harvest by region.*

used and does not reflect size. Sawtimber includes parts of harvest used to manufacture lumber, plywood, miscellaneous products (for example, posts, poles, and piling) and does not include roundwood used for pulpwood, fuelwood, and chips. Table 1 and Figures 16 and 17 show harvest projections by region (North, South, Rocky Mountain, Pacific Coast) and timberland owner (National Forest, Other Government, Forest Industry, Farmer, and Other Private). Table 2 shows the average diameter of timber harvested on private timberlands.

Recent reductions in western harvests due to declining cutting on public lands and the limited availability of merchantable timber on private lands is clearly seen in the Pacific Coast states (Fig. 16). By 2040, all western regions will see some resurgence in harvests as private young-growth inventories reach merchantable ages. In the South, after nearly three decades of growth, softwood harvests will roughly stabilize in the 2000 to 2015 period. Stumpage prices will rise, and growth in regional solid wood product output will stall as a result. After 2015, growth in softwood harvests will resume, reflecting the maturation of large areas of plantations. Harvest will increase in the North, primarily of hardwood nonsawtimber.

Key projected supply shifts include:

- a relative shift toward the South and North and away from the West (Fig. 16);
- a relative shift toward softwood and hardwood nonsawtimber and away from softwood and hardwood sawtimber (Fig. 15); and
- a shift mainly toward farm and other private ownerships, and to a lesser degree toward forest

Table 2.—*Average diameter at breast height of timber harvested on private timberlands in the RPA Assessment regions.*

	Average diameter							
	Pacific Coast		Rocky Mountain		North		South	
Year	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood
	(cm)							
1976		76		43	34	29	35	33
1986	42	47	48	24	36	30	31	25
1990	42	45	44	24	36	30	31	27
2000	43	42	36	24	34	31	29	24
2040	42	39	32	24	36	31	27	23

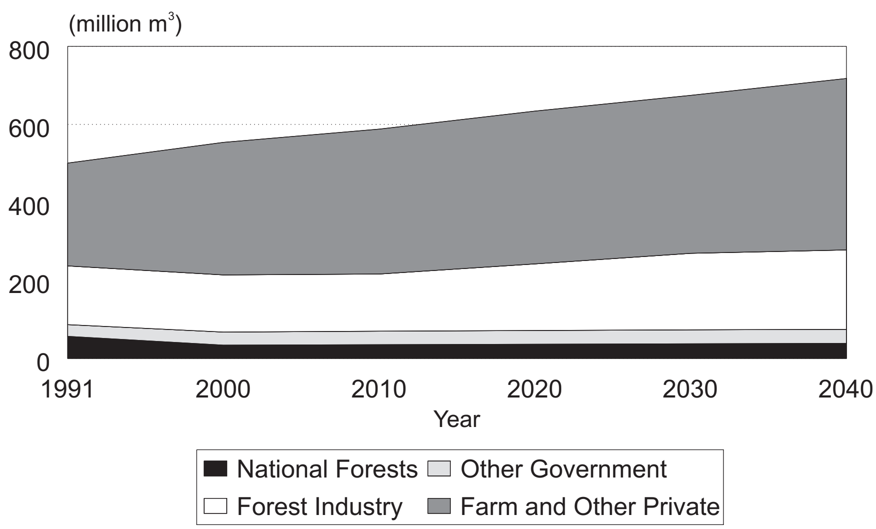

Figure 17.—*U.S. timber harvest by ownership.*

industry ownerships, and away from government ownerships.

Shifts by region.—Regional shares of timber harvest change modestly but noticeably during the projection period. Western regions consistently decline in importance, since only in a few cases will private harvests grow sufficiently by 2040 to compensate for public harvest reductions during the 1990s. The combined South and North, in contrast, rise from 59 percent of total U.S. harvest in 1991 to some 80 percent by 2040. The largest gain is in the South (from 50% to 58%) and occurs primarily in the final decades of the projection. Hardwood harvest is expected to increase in all regions, although not uniformly. The largest increases are in the South where growth in both hardwood lumber and pulpwood production pushes up the harvest. The lowest rate of growth in the East is in the north-central subregion.

Nonsawtimber-sawtimber shifts by region and ownership.—The shift toward nonsawtimber hardwood and softwood is focused on the North and South, but there are important differences in sources between hardwoods and softwoods.

- Hardwood nonsawtimber supply is large and projected to grow for both the North and South, but growth is projected to be fastest in the South (Fig. 18).
- Softwood nonsawtimber supply is much larger in the South than the North and is projected to grow much faster in the South (Fig. 19).
- Hardwood nonsawtimber supply is predominantly from farm and other private land where very fast growth is projected (Fig. 20).
- Softwood nonsawtimber supply is about evenly divided between farm and other private land and forest industry, and both sources are expected to grow substantially (Fig. 21).

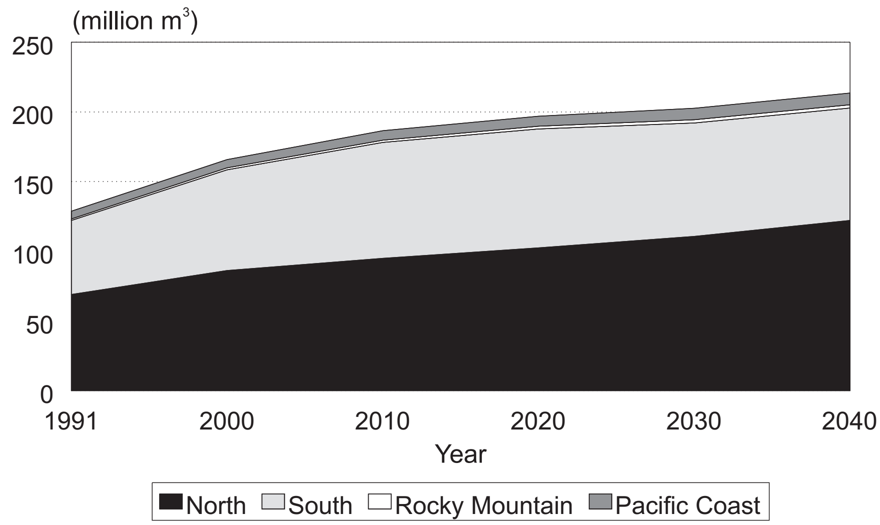

Figure 18.—*U.S. hardwood nonsawtimber harvest by region.*

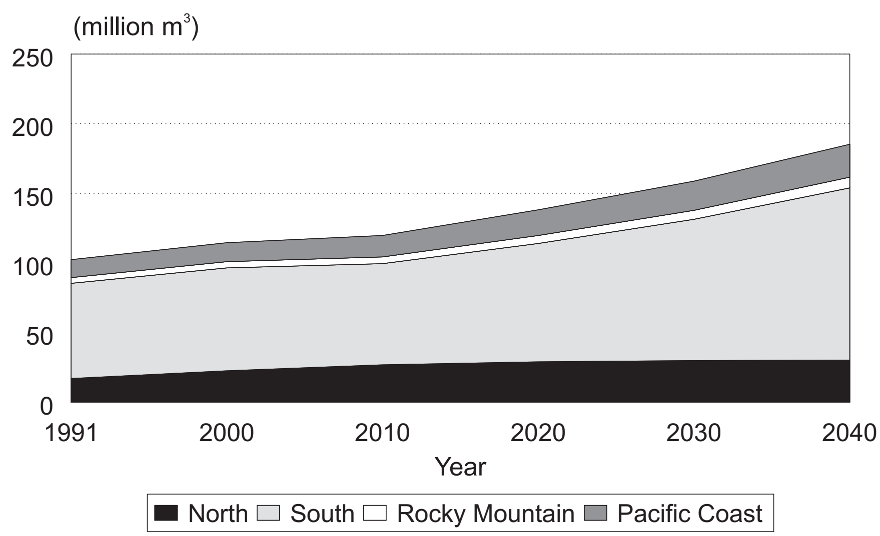

Figure 19.—*U.S. softwood nonsawtimber harvest by region.*

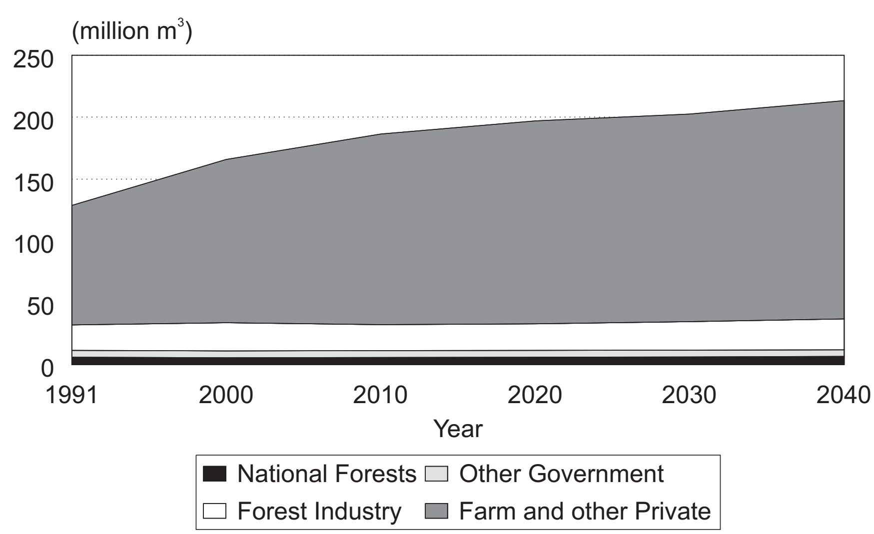

Figure 20.—*U.S. hardwood nonsawtimber harvest by ownership.*

Overall, hardwood nonsawtimber growth is projected for both the North and South almost exclusively from farms and other private land, and softwood nonsawtimber growth is projected to come predominantly from the South and would be about evenly divided between industry, farms, and other private land.

Preliminary projections for the RPA Timber Assessment to be completed in 2000 suggest short-rotation woody crops (SRWC) may provide a notable portion of pulpwood supply, particularly in the southeastern United States. The potential use of SRWC fiber is shown in Figures 5, 12, and 22, which indicate the composition of fiber sources for pulp and paper production. The SRWC fiber is not shown in the general roundwood tables (Figs. 15 to 21). These general roundwood tables are from the 1993 RPA Assessment update.

These changes in harvest are accompanied by shifts in the average diameter of trees harvested. Projected average harvest diameters of timber on private timberlands in the various assessment regions are shown in Table 2. Future harvests are expected to decrease in size in most regions in both

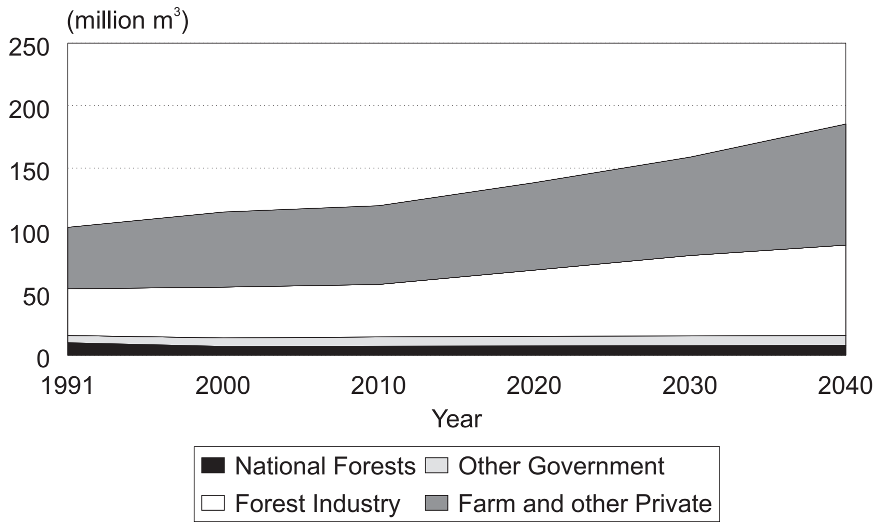

Figure 21.—*U.S. softwood nonsawtimber harvest by ownership.*

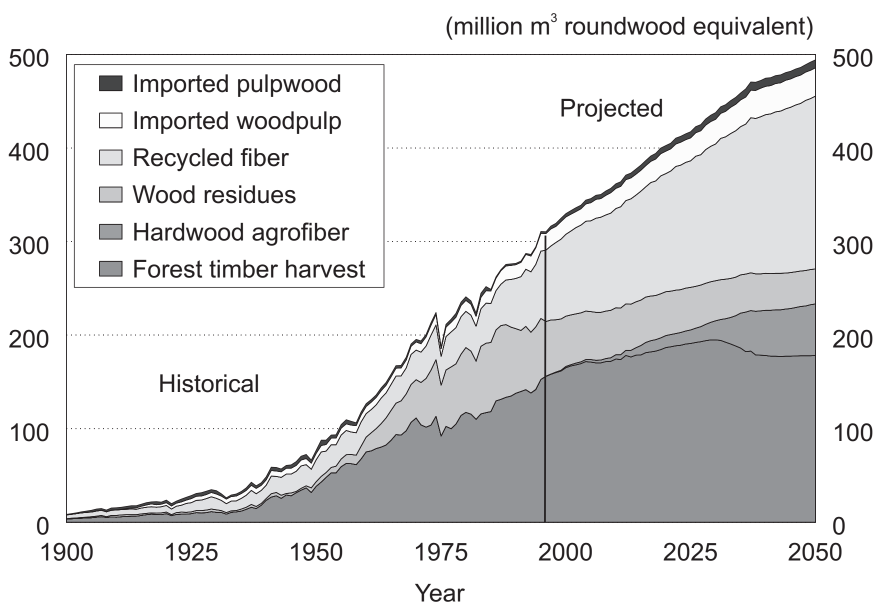

Figure 22.—*Consumption of wood and fiber raw materials in pulp, paper, and paperboard production in the United States, 1900–2050.*

hardwoods and softwoods, but these changes will be smaller than those experienced during the past two decades. In the Pacific Coast region, reductions in average harvest diameters in the past reflected the shift in the concentration of cutting from old-growth to second-growth stands that regenerated naturally following early cutting. In the South, size reductions have accompanied the shift from stands of natural origin to more intensively managed plantations. In the future, average harvest diameters on the Pacific Coast will continue to fall as cutting shifts heavily into intensively managed plantation stands. Table 2 shows that the proportional changes in size are about the same in both the South and Pacific Coast states.

Recycled paper and mill residue supplies for pulp, paper, and paperboard

Growth in the use of roundwood fiber for paper and paperboard is slowing, from 2.0 percent per year from 1960 to 1996 to a projected 0.8 percent per year from 1996 through 2020. The use of recycled paper fiber continues to grow at a faster pace, 2.1 percent per year through 2020, although its pace of growth is slowing as well, down from 3.1 percent per year from 1960 to 1996. Wood residue supplies are projected to decrease in absolute volume slowly as production of solid wood products become more efficient. Roundwood pulpwood provided 65 percent of fiber in 1960. With the increase in recycled paper use, this share decreased to 50 percent in 1998. Preliminary projections suggest roundwood share (excluding SRWC) could decrease to 46 percent by 2020 and 36 percent by 2050, while SRWC fiber share could increase from less than 1 percent in 2000 to 11 percent by 2050 (Fig. 22).

The role of recycled fiber is increasing compared with that of roundwood. In 1997, recycled fiber contributed the roundwood equivalent of 80 million m^3 to paper and paperboard production or about 14 percent of the level of roundwood harvest. Recycled fiber is projected to contribute 128 million m^3 roundwood equivalent in 2020 or about 20 percent of the year 2020 level of harvest.

Summary

The general outlook for forest products is that consumption growth will be slowing. Solid wood products consumption and fiber requirements will grow at or slightly below the rate of population growth. Paper and paperboard growth will be somewhat greater but not at historic rates, which matched GDP. Given this slowing growth, the industry will be changing in a continuing search to find the lowest cost wood and alternative sources of supply (such as recycled fiber). There will also be substitution of alternative building materials and technologies for traditional hem-fir lumber and plywood. The pulp and paper industry is facing more rapid increases in demand than solid wood industries and is more rapidly changing fiber sources toward recycled paper and hardwoods.

Timber supplies are projected to increase 43 percent between 1991 and 2040. The most striking shift during this time is the shift to farm and other private sources—a growth of 67 percent from 264 to 440 million m^3 per year versus a growth of only 17 percent from other ownerships from 237 to 278 million m^3 per year. This shift could result in a significant change in the direction and content of forest management and policy debates in the coming decades.

Timber supplies are also projected to come increasingly from nonsawtimber sources in the South and North. These increases depend on significant shifts in supply sources in the South and North. In the South, forest industry land and farm and other private lands are projected to notably increase supply of both softwoods and hardwoods, with emphasis and greatest growth in harvest on farm and other private land. In the South, there is also the potential for significant pulpwood supply from short rotation woody crops. In the North, nonsawtimber harvest growth is focused more on hardwood increase and will come almost entirely from farm and other private land. Projection of these trends relies heavily on two assumptions:

- private landowners will respond to price incentives to manage and harvest as they have in the past; and
- industry will continue to relocate and invest in new technological capacity in the South and North in response to cost incentives as they have in the past.

Recycled paper supply is projected to grow more rapidly than timber supply, increasing the recycled paper share of the overall fiber supply. Mill residue supply is projected to decrease with more efficient production of solid wood products.

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Certification

Certification: A U.S. perspective

Thomas A. Snellgrove

Certification of forest management and labeling of forest products are significant realities in the forestry arena. It is difficult to predict the direction of specific events within the broader picture, but it is highly unlikely that certification and labeling will simply go away. Although market recognition of labeled products is an important factor, with much current attention currently being paid to that aspect, in the long run certification and labeling will more likely be driven by environmental concerns and/or the fear of consumer backlash and bad press. Awareness and concern over environmental issues may cycle, but the influence of environmental considerations on resource management will continue (4,5,7,8).

One of the first things that I encountered from personal discussions and from reviewing the literature is that there is no single perspective on certification within the United States. This is not surprising considering the diversity of interests and views that surface in something as important—and contentious—as management and use of natural resources. The closest statement of policy that I uncovered are the conclusions of the International Conference on Certification and Labeling of Products from Sustainable Managed Forests (1). Conclusions from that workshop covered the breadth of forestry activities within the United States, but were noncommittal in supporting any particular approach to certification and labeling. Subsequently, these "findings" were embraced by the State Department as the official U.S. position. In this paper I use existing literature for discussing the background and the issues.

There remains a great deal of confusion about the concepts and details surrounding the broad topics of certification and labeling. Several of the issues that foment confusion include the alternative systems being proposed, the differences between public and private land ownership, and the relationship between certification and the use of national-level Criteria and Indicators developed through the Montreal Process.

Alternative systems

Currently, four broad (only approximately comparable) approaches to certification are being proposed within the United States (3,5). All of these systems incorporate, to varying degrees, the basic concepts of setting standards and measuring performance. However, different stakeholders working toward different objectives, not surprisingly, developed different approaches.

- The Forest Stewardship Council (FSC) uses a performance-based approach with on-site measurements and third party certification, and is generally supported by environmental groups.
- The International Organization for Standards (ISO) is a system-based approach that relies on management systems to improve environmental performance. It uses a third-party auditor to determine if organizational goals are met.
- The Sustainable Forestry Initiative (SFI) of the American Forest & Paper Association uses a set of principles and a series of implementation

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guidelines, objectives, and performance measures and relies on annual reports from member companies to detail their compliance. A panel of experts audits compliance using data from the annual reports. There is no on-site inspection by third parties, thus it is referred to as second-party certification. Membership in AF&PA is contingent on compliance with SFI.

- The Green Tag approach is intended to be a simpler method, but does not preclude a landowner from working with other certification agents. This approach is based on three elements: 1) landowners must have a forest management plan, 2) they must use the management advice of a professional forester, and 3) the land they own must be maintained in a forested condition. This approach was developed with small landowners in mind, targeting our single largest ownership class, the nonindustrial private forests.

Private versus public lands

Another concern involves land ownership and the appropriateness of certifying public lands that are guided by statutory requirements and public mandates. Certification within the United States has generally been viewed as a private sector issue, but the linkage of certification to sustainable forest management clearly has implications for forest management on all lands. Opponents of commercial timber harvesting on National Forests and other federal lands have significant reservations about certifying these lands. Others oppose certification of public lands based on the perceived need to avoid implying that the government has any connection with the certification process. Because of these concerns, no federally managed forest lands have yet been brought forward for assessment of their potential certifiability.

Many people and interest groups remain cautiously optimistic that certification will promote sustainability across all forest ownerships and jurisdictions, and several states and municipalities have moved ahead aggressively with certification. In fact, the sum of public lands certified under the FSC approach now exceeds the total of private lands certified. For example, Pennsylvania and Minnesota have well over 1 million acres already certified, New York is in the process of assessing the potential of certifying about 1 million acres of state forests, and Michigan and Wisconsin are in the initial stages of possibly certifying substantial acres of their lands. The Menominee Tribe in Wisconsin has certified about 500,000 acres of their lands. A couple of municipalities in California and Michigan have lands certified. Regardless, a host of legal and institutional concerns, not withstanding the aforementioned opposition, suggests that certification of federal lands (if and where appropriate) will probably not move in sync with private lands.

Certification versus criteria and indicators

The relationship between certification and the national-level criteria and indicators for sustainable forest management (C&I), developed through the Montreal Process, is not clearly understood. Efforts to evaluate and/or promote the sustainability of forest land management have led to a variety of international, national, and local initiatives with a broad array of objectives. The result is confusion of concepts, terminology, and processes (2). Table 1 summarizes key differences between C&I and certification (2).

Related concerns

Above and beyond some degree of posturing by groups advocating or opposing certification, there are some very real concerns. Specific issues include:

- The quality of science. The scientific underpinning for some of the standards is often unclear or not established (6).

Table 1.—*Key differences between criteria and indicators (C&I) and certification.*

	National Level C&I	Certification
Scale of assessment	National—all forest ownerships	Management unit or site
External verification	Not applicable	Some approaches
Periodicity	Periodic assessment of trends	Single point in time with follow-up analysis
Performance standards and/or thresholds	None	In most approaches
Temporal dimension	Assesses the present based on past trends	Assesses past and present management

- The cost of certifying forests and potential corrective actions on the ground: certification costs have been estimated at about $0.16 per acre for the initial process and $0.06 per acre for annual audits. Fixed costs associated with certification make it potentially too expensive for small landowners, but methods are being developed to minimize costs to smaller landowners (6,7).
- Consumer recognition of "green products" and willingness to pay: currently there is not much demand from the final consumer. Most demand is from industrial and retail companies (6,7).
- A variety of difficulties related to chain of custody: there has to be strict chain of custody compliance for products sold with an ecolabel indicating third-party certification. This can be a major problem for many industry sectors that access raw materials from many sources and can not afford to segregate those sources. In the United States, small landowners make up a large proportion of the wood fiber supply, which complicates any attempt to document fiber sources (4).
- Assurance of a linkage between labeling and on-the-ground results: translating certified products back to tangible benefits toward improved resource management may prove to be elusive.

Conclusions

Of the various systems being advanced for setting standards and certifying compliance within the United States, none are a panacea and none will likely end the debate over managing forests. They were developed or evolved along different lines with somewhat different stakeholders and different objectives in mind. Each has problems but, more importantly, each has advantages. Attention should be focused on looking at the compatibility of the various systems, tapping into their comparative advantages, and determining how to tailor the respective systems to various applications as appropriate.

A couple of points can be taken from this issue thus far. First, perceptions of the public, particularly the public as consumers, make a difference. Second, responses to these perceptions will be most successful and enduring if they are based on explicit standards and measures of performance.

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Forest management certification in Canada

Tony Rotherham

Introduction

Forest management certification is now a mainstream topic of discussion among forest managers and forest products buyers. There are several important points to consider:

- There are many different types of forest ecosystems around the world.
- Forests in each country are managed according to different laws, human needs, cultures and values, land use history, and ownership patterns.
- There are several approaches or types of standards that can be used (e.g., prescriptive, objective, design limitation, or management system).
- There are many types of wood supply systems used by industry to provide raw logs or chips to forest products processing plants.

The bottom line is that one approach will not fit all situations. A forest certification program may include an agreed standard, third-party audit, chain of custody, and label. The forest certification programs now offered do not necessarily include all of these elements.

There are also two avenues to take in the development of forest management standards and administration of audits and certification:

- Inside the national and international standards systems and, subject to their rigorous systems of standards development and approval, use of properly accredited certification bodies and trained/accredited auditors; and
- Outside the national standards systems.

The Canadian situation

Canada has eight forest regions each with a characteristic mix of tree species. There are some 40 commonly used commercial species of trees. We have a great variety of forest soils, climate and elevation, and a wide range of ecosystems.

Canada's 416 million hectares of forest land is approximately 50 percent commercial quality, multiple use forest and 50 percent forest that will remain in a wilderness state for the foreseeable future. Under the Constitution, forest management is a provincial responsibility. The 10 provinces have 10 sets of generally similar, but not identical, forest legislation. Although 94 percent of Canada's forest land is in public ownership, some 20 percent of the wood supply comes from the 6 percent of highly productive, accessible, privately owned forest land.

Approximately 180 million m^3 of roundwood is harvested each year. Canada's forest products industry produces about 30 million tonnes of pulp and paper, 60 million m^3 of sawn lumber, and 8 to 9 million m^3 of wood-based panels. These products are valued at approximately US$35 billion, with 70 percent being exported.

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In the United States, some 73 percent of forest land is in private ownership with the balance of 27 percent roughly split between state and federal ownership. The U.S. industry is roughly twice the size of Canada's. In Mexico, most of the forest land is owned by the communities. There is a very different ownership pattern between these three countries, and a terrific variety of forest ecosystems from the tropical wet and seasonal forests of southern Mexico to the boreal taiga of northern Canada and Alaska.

There are three fundamental reasons why Canadian forest products companies may seek certification for their forest management system:

- Customer assurance that forests are well managed;
- Business benefits from improved management efficiency; and
- Public assurance that forests are well managed.

Because Canadian industry has such a high degree of dependence on wood from publicly owned forests (80%), it is essential to maintain a high degree of public confidence in the management of these forests.

Canadian Standards Association (CSA) Sustainable Forest Management Standard

In 1994, the Canadian forest products industry, acting through a coalition of 22 industry associations, approached the CSA and requested it to develop a Sustainable Forest Management (SFM) system standard based on ISO 14001 EMS.

Table 1.—*A quick comparison of ISO EMS and CSA SFM.*

	ISO EMS	CSA SFM
Commitment and policy	✓	✓
Planning	✓	✓
Forecasting		✓
Implementation	✓	✓
Measurement and evaluation	✓	✓
Review and improvement	✓	✓
Continual improvement	✓	✓
Public participation		✓
Canadian SFM criteria and critical elements		✓
Third-party audit of the EMS	✓	✓
Third-party audit of on-the-ground performance		✓

The choice of ISO 14001 as the foundation for the CSA/SFM standard was made based on the following factors:

- Similarity to ISO 9000;
- International recognition;
- Acceptability to industry producers and customers; and
- Management system approach.

The forest products industry in Canada, especially the pulp and paper sector, has widely implemented ISO 9000, and the same corporate management systems can be used with ISO 14001.

The CSA established a 32-person Technical Committee with roughly equal representation from regulators, producers, science and academics, and the broader public interest.

In 1996, the Technical Committee finished its work. The draft standard went through a process of public discussion in four centers across Canada. There was also a public review through mail-in comments, six pilot tests and, finally, a ballot among the members of the Technical Committee. The draft was unanimously approved after the resolution of a few comments by Committee members. In September 1996, it was approved as a National Standard of Canada by the Standards Council of Canada. The structure of the standard is outlined in Table 1 together with a comparison of the structure and elements of ISO 14001.

The four principal elements which have been added to the ISO 14001 framework are:

1. ***The Canadian SFM criteria and 21 critical elements.***—These have been approved by the Canadian Council of Forest Ministers (CCFM) and cover six elements of sustainable forest management. These criteria have been drawn from the Montreal Process, one of eight intergovernmental SFM C&I processes in which 110 forested countries participated. The following six CCFM SFM criteria (and 21 accompanying explanatory critical elements) provide forest managers with a road map to sustainability:

- Conservation of biological diversity;
- Maintenance and enhancement of forest ecosystem condition and productivity;
- Conservation of soil and water resources;
- Forest ecosystem contributions to global ecological cycles;
- Multiple benefits to society; and

- Accepting society's responsibility for sustainable development.

2. ***Public participation.***—Local stakeholders will help to develop a set of values and management objectives based on the six CCFM criteria. These will be built into the management plan.
3. ***Forecasting.***—Computer GIS-based forest level models can be used to ensure a good match between the forest managers' objectives and the projected forest that will be developed through the implementation of the plan. If simulated forecasting indicates that there is a poor match, the management plan can be changed to improve the match.
4. ***Third-party audit of on-the-ground performance.***—Some ISO 14001 auditors state that audits of performance are part of an ISO 14001 EMS audit. Others will state that only the environmental management system is audited and that a company's own monitoring data will be checked. There are some differences of opinion here that may be based on interpretation or on national audit requirements. One thing is clear: there is no ambiguity in the CSA SFM standard. On-the-ground performance against management objectives and targets will be audited.

The CSA standard is designed to be applied to a defined forest area. It can be one block of forest or several blocks or ownerships grouped together. It is applicable to relatively large groups of small ownerships where all owners/managers have agreed to work together to implement the standard. It is easiest to implement on a single, large forest management unit.

Forest tenure systems

The publicly owned forest lands in Canada are the main source of wood for industry. Public lands are the only source of wood in some very large areas of the country. There are two systems by which companies gain access to wood from public lands. Both involve long-term licensing agreements with provincial governments.

Area agreements

One form of license gives a company responsibility for practically all aspects of long-term management of a defined forest area. Area agreements are ideal for the application of the CSA SFM standard because one organization has responsibility for all aspects of management.

Volume agreements

The other form of license gives companies the right to a given volume of wood each year from a larger area of forest that is managed by the provincial government. The company may have responsibility only for harvesting and reforestation.

Implementation of the CSA standard on volume agreements is more challenging due to the division of responsibility. In some cases a company may decide to implement ISO 14001 because the scope of the environmental management system can be limited to the operations actually controlled by the company and need not cover long-term management planning if that is handled by another organization. As a result, we find some Canadian companies implementing the CSA Z808/Z809 SFM standards and others implementing ISO 14001 EMS.

A new technical report, ISO 14061, on the implementation of ISO 14001 on forest management operations, was published by ISO in September 1998. This report contains a lot of useful information to help forest managers use ISO 14001 to improve their operations.

Certification in Canada: What progress is being made?

The latest CPPA survey indicates that nine companies are well advanced in the implementation of the CSA standard. These implementation projects cover some 7 million hectares and 11 million m^3 AAC. An additional seven companies are starting the CSA process and 12 companies are implementing ISO 14001. Six companies are doing both so there is some overlap.

Two or three Canadian companies are going to ask for an FSC audit as a result of severe pressure from ENGOs in their European markets.

There is one FSC certification in Canada—a 20,000-hectare block of private land in Ontario. It is interesting to note that this property has neither a management plan nor a forest inventory. These are the sort of practices which are common in some certification systems operating outside national standards systems.

It is my belief that a $400 billion U.S. industry with $125 billion in international trade should be dealing only with professionally run, rigorous standards systems that are administered by national standards institutions. Audits should be carried out by teams of auditors with the required accreditation, training, and technical competence. Certification should be granted by properly accredited certification organizations. The business should not be run by people who make up the rules as they go along. Conflict of interest must be avoided. Auditors should audit. They should not develop standards.

The Forest Products Society exists to develop and share science and technology. The objective is to make our industry more efficient and our products more useful to people. This is done through the use of many technical, chemical, and mechanical standards. Our industry, whether solid wood or pulp and paper, cannot work without the application and use of many standards. These standards set and describe the technical specification of our products. Voodoo science is no more useful in running a business than voodoo economics.

If we are going to extend the use of standards and certification to the forest management side of our business, it must be founded on good science, responsive to people's needs and values, and administered in a professional, rigorous way.

In my view, we should be using standards which are developed and administered within our national and international standards systems.

The certification of sustainable forest management in Mexico

Heliodoro Sánchez-Pimentel

Introduction

Good forest management strives to attain sustainability of the resource and the production of better goods and services. Proper use and conservation of the forests, with management stemming from an ecological ethic, has become the basic premise for developing national standards of sustainable forest management in Mexico.

The relationship between forest activities and the environment has caused growing concern. Public opinion and those responsible for policy formulation are more conscious of the importance of the benefits that forests provide and that these benefits are either disappearing or in grave danger. Policy makers also now realize that many forest-related activities are or can be harmful to the environment. Damage to the forests can be caused by badly planned or executed silvicultural interventions or by overexploitation of the resource with possible repercussions on biological diversity and climatic change. Damage to the forest resource can also occur due to pollution caused by transportation and industrial activities. These effects have impinged on commerce, principally in the area of international trade.

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We can observe a bi-directional process in the sense that international commerce has repercussions on the environment while some environmental protection measures affect commerce. Certification is among the measures that affect commerce due to concern over environmental problems. Perhaps the truth is that commerce affects the environment, but is not the principal cause of environmental problems, since demographic pressures, poverty, and problems related to land tenure all figure in as principal causes.

Thus, social and economic concerns have been generated by commercial deregulation of the forest resources, yet the same process of commercial deregulation has opened new expectations on the part of private industry in relation to the exportation of forest products.

Although opposite currents exist in relation to the influence of certification and labeling of forest products, these factors will increase market incentives for promoting sustainable management and augment the value of goods and services derived from forests, thereby benefiting rural communities.

Background

When silvicultural application began in Europe approximately 300 years ago as an instrument of forest cultivation to reach sustained yield, it did not foresee that environmental demands and technology would become of interest to society in general.

Today we know that the concept of sustained yield represents only one indicator of maintenance of the productive capacity: other indicators include the health and vitality of the forest. Sustained yield is an incomplete concept in comparison to sustainable management, which requires indicators to evaluate the maintenance and conservation of water, soil, biodiversity, carbon storage, and other ecosystem functions.

The search for answers to society's environmental demands, being conducted by international non-governmental organizations and observers that have access to a great quantity of information, has forced the worldwide organization of groups of countries that are working on the definition and implementation of criteria and indicators of sustainability as well as appropriate management techniques that are socially beneficial and economically feasible for the world's forests.

In 1987, The Brundtland Commission, using the United Nations as a forum, published their report in which all countries were urged to adopt sustained development of forest resources, as the only way to prevent species extinction and strive for permanence of the resource.

Various international organizations have initiated a series of actions intended to develop and promote sustainable development, establish indicators for its evaluation, and recently, guidelines for the certification of products produced from the resource. Sustainable development is the management and conservation of natural resources and the orientation of the technological and institutional change to ensure the continued satisfaction of the needs for present and future generations.

The process of developing criteria and indicators of management to measure sustainability has led to revised concepts, laws, rules, and norms of production, protection, conservation, and promotion, as well as to changed social and economic understanding of the factors that impinge on the ecosystems.

Mexico's participation in the international movement toward sustainable management of forests includes:

- Definition of the country's position in different international forums on the matter and the existence of a monitoring system for the processes.
- Official collaboration in the process of developing indicators for the evaluation of sustainable management of temperate and boreal forests.
- Implementation and adaptation of the criteria and indicators for sustainable management of Mexico's forested areas.
- Responsibility for and coordination and implementation of these criteria and indicators through the Secretary of the Environment, Natural Resources, and Fisheries (Secretaría de Medio Ambiente, Recursos Naturales y Pesca-SEMARNAP).
- Official participation in international forums on sustainable management of tropical and arid ecosystems.

Certification in Mexico

For Mexico, SEMARNAP has established instruments to guarantee forest sustainability through a New Forest law, which has as its purpose the conservation, protection, and restoration of forest resources and biodiversity, since sustainable management of these resources, will contribute to the socioeconomic development of their owners.

The General Law of Ecological Equilibrium and Environmental Protection (Ley General del Equilibrio Ecológico y Protección al Ambiente-LGEEPA) calls for the preservation, restoration, and protection of the environment. It intends to promote the participation of indigenous communities in the development of the forest culture and the promotion and protection of the forest.

Another fundamental aspect of the forest policy is the guarantee of technical support, which translates into improved management conditions for sustainable forest improvement and natural resources conservation, but also recognizes that many of the causes of degradation and nonsustainable improvement of ecosystems, take place outside of the forest sector.

Among others, the principal challenges for silviculture in Mexico, are reducing the rate of deforestation, recouping the forest frontier, provisioning the demand for forest products, increasing forest productivity and forest plantation areas, improving goods and services that the forests can provide, and contributing to the eradication of poverty among forests inhabitants. It is important to consider the market value of forest resources, and security in land tenure, as well as the assignment of financial resources and the promotion of an environment favorable to investment in forests. Consumer demand that wood products come from sustainably managed forests should also be taken into account.

In Mexico, all the forest improvements currently must be considered sustainable. Forest certification, the chain of accountability, and plans for product labeling have been developed to proportion market incentives with the goal of promoting sustainable forest management for environmental and socioeconomic benefits. The plans are designed to provide consumers with means of certification they can trust and to endorse the producers' published compliance with a minimum standard.

Certification will augment the value of the goods and services derived from forests, benefiting rural communities, but it will remain voluntary on the part of the forest owners and those responsible for forest management, who want access to markets that request it.

In light of the previous statements, the current plan is designed to improve forest management in Mexico through the development of consensus certification standards and the creation of a national capacity to conduct certification auditing. National and international confidence in this process will increase when national standards are developed to complement international principles and criteria.

In Mexico, institutions already have been established for the development of sustainable forest management standards, such as the Commission for North American Environmental Cooperation (Comisión de Cooperación Ambiental para América del Norte) and the Forest Model Program between Mexico and Canada (Programa de Bosque Modelo entre México y Canadá).

The Forest Stewardship Council (FSC), founded in 1993, is an independent non-government organization (NGO), that currently offers an available international system for forest management certification through a package that includes forest management standards, international accreditation for certificates, a system for labeling products from a certified source, and a communication program for promotion. In Mexico, this NGO is registered as a civil non-profit organization, with international connections that already have initiated the consultation process, with the support of governmental (SEMARNAP) and non-governmental entities, which will help make possible the development, validation, and establishment of standards and capacity for accredited certification in Mexico.

SEMARNAP has followed the FSC's international initiative with much interest since its origins, even helping to install related offices in the city of Oaxaca. SEMARNAP considers certification to be an "Instrument that can revolutionize the origin of products and the forest industry and create the patterns of consumption that have been generated and developed in all the world." To achieve certification, different levels of government will be required to consider other actions like establishing better control of forest improvements and creating conditions in which the forest sector really contributes to reaching sustainable development.

Thus we agree that the objective of certification should be the promotion of responsible environmental management that is socially beneficial and economically viable through forest management. The forest producers recognize that they will receive market benefits upon certification, which is an incentive to improve products derived from forest management.

Certifying institutions and producers

Presently, a world movement toward certification exists, encountering diverse conditions in different countries including Mexico, which is fourth in the world in terms of the amount of square hectares covered by certified forests.

In Mexico, the FSC has become an international entity for the accreditation of certifying organizations, with the object of guaranteeing the authenticity of certifications. Certifying organizations in Mexico include SGS Forestry, Smart Wood, and Rainforest Alliance, USA.

The advances that Mexico has made in the process of certification can be seen in the organizations that have earned certificates of sustainability: the Society of Forest Producers of Quintana Roo (Sociedad de Productores Forestales de Quintana Roo) and the Zapotec Chinatec Union (Unión Zapoteco Chinanteca) in the state of Oaxaca, Nuevo San Juan in Michoacán, and Abastecedores de Noram, S.A. (for the San Juan y Echeverría ejidos) in the state of Durango. These certified forest production units comprise a total land surface area of 125,027 Has (Table 1).

The Unified Production Towns (Pueblos Mancomunados) of the State of Oaxaca, with a land surface area of 19,803 Has, has received precertification (Table 2). This classification means that the organization participates in a formal field evaluation by SmartWood, surpasses minimum environmental silvicultural and social criteria, agrees to periodic random inspections, and agrees to a schedule of continuous improvements in their forest operations.

Likewise, in the State of Durango, the following organizations have solicited certificates, but have yet to be evaluated: Abastecedores de Noram, S.A.; u.c.d.f.i. Topia, S.C.; U.A.F. Santiango Papasquiaro, S.C.; Salto de Camellones; Vencedores; San Diego de Tenzaenz; San Pedro Villa Corona; San Manuel Villa Corona; and S.P.R. El Huehuento. Zona Maya y Chak-Temal in Quintana Roo, Guachochi in Chihuahua, and Zacualtipan in Hidalgo are at the same point in the certification process, as well as UNOFOC in three States-Jalisco, Guerrero, and Campeche (Table 3).

National tendencies

In Mexico, sustainable forest management is enforced through the forest policy, which has translated into modifications of the Forest Law and into the establishment of support programs for the production and implementation of sustainability criteria and indicators that carry official responsibility.

Mexico's effort to make sustainable improvements has been driven by the impact of information from places in the world that have suffered from devastation of their forest resources. Mexican delegations have participated in different forums and obtained information that have turned forest policy toward principles of sustainability.

In particular, Mexico can consider the following concepts as criteria for certification:

Table 1.—*Certified production units.*

Organization	Location (State)	Type of forest	Total surface area (ha)	Ejidos
Sociedad de Productores Forestales de Quintana Roo	Quintana Roo	Tropical	86,215	Nonbec Tres Garantas Petcacab Caoba
Unin Zapoteco Chinanteca	Oaxaca	Mixed Temperate	21,901	Comaltepec Capulalpan Xiacui La Trinidad
Nuevo San Juan	Michoacn	Mixed Temperate	11,000	Nuevo San Jáun
Abastecedores de Noram S.A.	Durango	Mixed Temperate	5,911	San Juán de Aguinaldos Echeverra de la Sierra
Total			125,027	

Table 2.—*Precertified production units.*

Organization	Location (State)	Type of forest	Total surface area (ha)	Ejidos
Pueblos Mancomunados	Oaxaca	Mixed Temperate	19,803	Santa Catarina Lachatao. Santa Martha Latuvi. Benito Juárez. San Miguel Amatlán San Antonio Cuajimoloyas San Isidro Llano Grande. Santa Mara Yavesa Neveria
Total			19,803	

- The procedures of sustainable management certification must be voluntary, clear, non-discriminatory, practical, of low cost, and have international credibility.
- The criteria employed must be compatible with international norms such as UNCED, Helsinki, Montreal, Standards 150 14001/14004 and others.
- Criteria should be compatible and not over-regulatory in relation to the legal framework, the institutional covenants, the financial systems, and incentives.

Certification must urge in a more determined manner the sustainable use of natural resources, specifically of the forests, at a world level.

The principal instruments for achieving sustainability are a clear, well-integrated, forest policy with laws, medium- and long-term programs, and the necessary resources for its implementation. In Mexico a defined forest policy exists, with a recently reformed Forest Law, a medium-term Sectorial Program, and new instruments for incentives and promotion, such as PRODEFOR, PRODEPLAN, and PRONARE.

Advances in long-term planning, implementation of new regulations, and the complementing of present programs with new support schemes and additional resources should help guarantee conservation and sustainable development of the forest resource.

Also, it is necessary to define the criteria, indicators, and forms of certification to enable the measurement and achievement of forest sustainability in a slow but consistent manner.

Certification is becoming an indispensable element of the international market, and represents the possibility of better payment for products to proprietors and consumers.

The certification of national producers has been established in a relatively short timeframe, especially for the temperate cold-climate forests, so one

Table 3.—*Production units yet to be evaluated.*

Organization	Location (State)	Type of Forest	Ejidos
Abastecedores de Noram S.A.	Durango	Mixed Temperate	El Encinal Mil Diez El Centenario San Isidro.
Zona Maya	Quintana Roo	Tropical	Laguna Kana Yoactun Naranjal X-Hazil
U.C.D.F.I. Topia S.C.	Durango	Mixed Temperate	Topia
U.A.F. Santiago Papasquiaro S.C	Durango	Mixed Temperate	Ciénega de Salpica el Agua
Salto de camellones	Durango	Mixed Temperate	Salto de Camellones
Vencedores	Durango	Mixed Temperate	Vencedores
San Diego de Tenzaenz	Durango	Mixed Temperate	San Diego de Tenzaenz
San Pedro Villa Corona	Durango	Mixed Temperate	San Pedro Villa Corona
San Manuel Villa Corona	Durango	Mixed Temperate	San Manuel Villa Corona
S.P.R. El Huehuento	Durango	Mixed Temperate	S.P.R. El Huehuento
Guachochi	Chihuahua	Mixed Temperate	Samachique Seyurachi
Zacualtipan	Hidalgo	Mixed Temperate	Asoc. Pequeños Product Zacualtipan
UNOFOC	Jalisco	Mixed Temperate	Barranca del Calabozo
UNOFOC	Guerrero	Mixed Temperate	San Miguel de las Cruces
UNOFOC	Campeche	Tropical	Miguel Colorado Nuevo Becal 20 de Noviembre
CHAK-TEMAL	Quintana Roo	Tropical	Laguna Om

can assume that this practice will become commonplace in the future.

A strength of certification is the fact of that the FSG is a world-wide organization that is at the vanguard of the certification process, and has a presence in Mexico, which permits it to be near the resources in which they are involved.

As for the implementation and use of certification in Mexico, without a doubt the official position will be one of support, but not of direct responsibility, provided that the forest public administration maintains its well-delineated responsibility of establishing requisites for expediting permissions and controls.

In summary, we in Mexico feel that certification is a very positive "green label" that can fulfill future requisites in forest resource management plans.

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