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Forestry Report: Japan

Tung-Bih Tsay

Information Report DPC-X-17
International Forestry Branch,
Canadian Forestry Service Headquarters

THE CANADIAN FORESTRY SERVICE
GOVERNMENT OF CANADA

The Canadian Forestry Service is the principal source of federal expertise in forestry. Its general objective is to promote the wise management and use of Canada's forest resources for the economic, social, and environmental benefit of Canadians.

The following are the main functions of the CFS:

1. Coordination of federal policies, for the promotion of better resource management and forest industry development.
2. Provision of scientific and technological leadership in forestry through research and development.
3. Provision and analysis of national and international statistics and information as a basis for policy formulation.
4. Development and certification of codes and standards for wood product performance.
5. Protection of Canada's forests from foreign pests.
6. Fostering the potential use of the forest resource for energy.
7. Contributing to the environmental objectives of the government of Canada.

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FORESTRY REPORT: JAPAN

by

Tung-Bih Tsay

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COUNTRY FORESTRY REPORTS

The World Forestry Information Group, as part of the Canadian Forestry Service's International Forestry Branch, has collected, in the course of its work, a considerable volume of literature on forest resource data, forest development, and forest management in other countries.

It was decided to summarize into reports the forestry information on several countries where the forest resource plays a significant role in the national economy. This report summarizes forest resource and related information on Japan.

Primarily intended for the Canadian professional forestry community, the information contained in the report can be used for

(1) briefing Canadian officials traveling abroad or receiving foreign visitors,

(2) studies of world wood supply and international trade in forest products,

(3) planning and evaluating Canada's participation in international forestry cooperative projects,

(4) background for policy decisions by Canadian federal and provincial governments, and

(5) answering inquiries from the Canadian forestry community and the general public.

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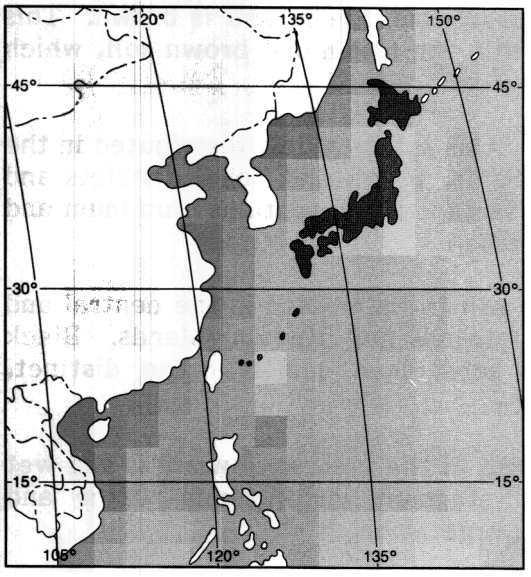
THE COUNTRY

Location and size

Japan comprises a curved chain of islands off the east coast of the Asian continent. The country consists of four large main islands: Hokkaido, Honshu, Shikoku, and Kyushu as well as the Ryukyu Islands and other small islands, stretching approximately 3 000 km from the northeast to the southwest (Map 1). Japan ranges between latitude 20°25'N (Torishima Island off Ogasawara Island) to 45°33'N (Soya Cape of Hokkaido Island) and from longitude 122°56'E to 153°59'E. The eastern USSR lies to the north and west, and the Democratic People's Republic of Korea, the Republic of Korea, and the People's Republic of China lie to the west.

The total area of Japan, 377 708 km^2, is slightly larger than one-third the area of Ontario (1 068 583 km^2). The total population is approximately 117 000 000 people (1980). Tokyo is the capital with a population of about 8.4 million (1980). The language is Japanese and the religions are Shintoist, Buddhist, and Christian.



MAP 1

Geology and physical features

The geological structure of Japan is composed of sedimentary strata from Paleozoic to Neozoic; plutonic rocks such as granite, diorite, gabbro in mozaic pattern; volcanic rocks such as andesite and basalt, and other various metamorphic rocks. In the northeast of Japan, the Tertiary stratum and volcanic cones are widely distributed. The Paleozoic and Mesozoic strata are of scattered occurrence. Southeast Japan is divided into an inner zone (Japanese Sea side) with many Paleozoic and Tertiary strata; and volcanic rocks and an outer zone (Pacific Ocean side) with Paleozoic and Mesozoic strata and metamorphic rocks located in strip form.

The chief physical feature is that most of Japan is mountainous. Nearly 74% of the land area consists of mountains and volcanic cones, which are diversified as a result of differential crustal movements. The landforms are steep with a height of 2 500-3 000 m. Mount Fuji is the highest point of land in Japan with a height of 3 775 m. On Shikoku and Kyushu Islands, the mountains are not very high, having an average height of less than 2 000 m. They have deep ravines and steep cliffs, making the valleys almost inaccessible and human traffic difficult in these areas.

The Japanese coastlines show significant features that contribute to the beauty of the scenery. The seashores were formed as the land sank and seawater covered the low valleys creating many good harbors along the coast, particularly in the northwestern part of the Nagasaki prefecture. The marine terraces are found mostly in the eastern parts of Japan and along all the coast of Hokkaido.

Rivers are short and rapid. In a rainy or typhoon season, the water overflows the banks, causing frequent flooding.

Forest soil

Japan is a pluvial country with steep topography. Temperatures vary from subfrigid in the north, to subtropical in the south. Such physical factors greatly influence the formation of forest soils. The main types of forest soils in Japan are:

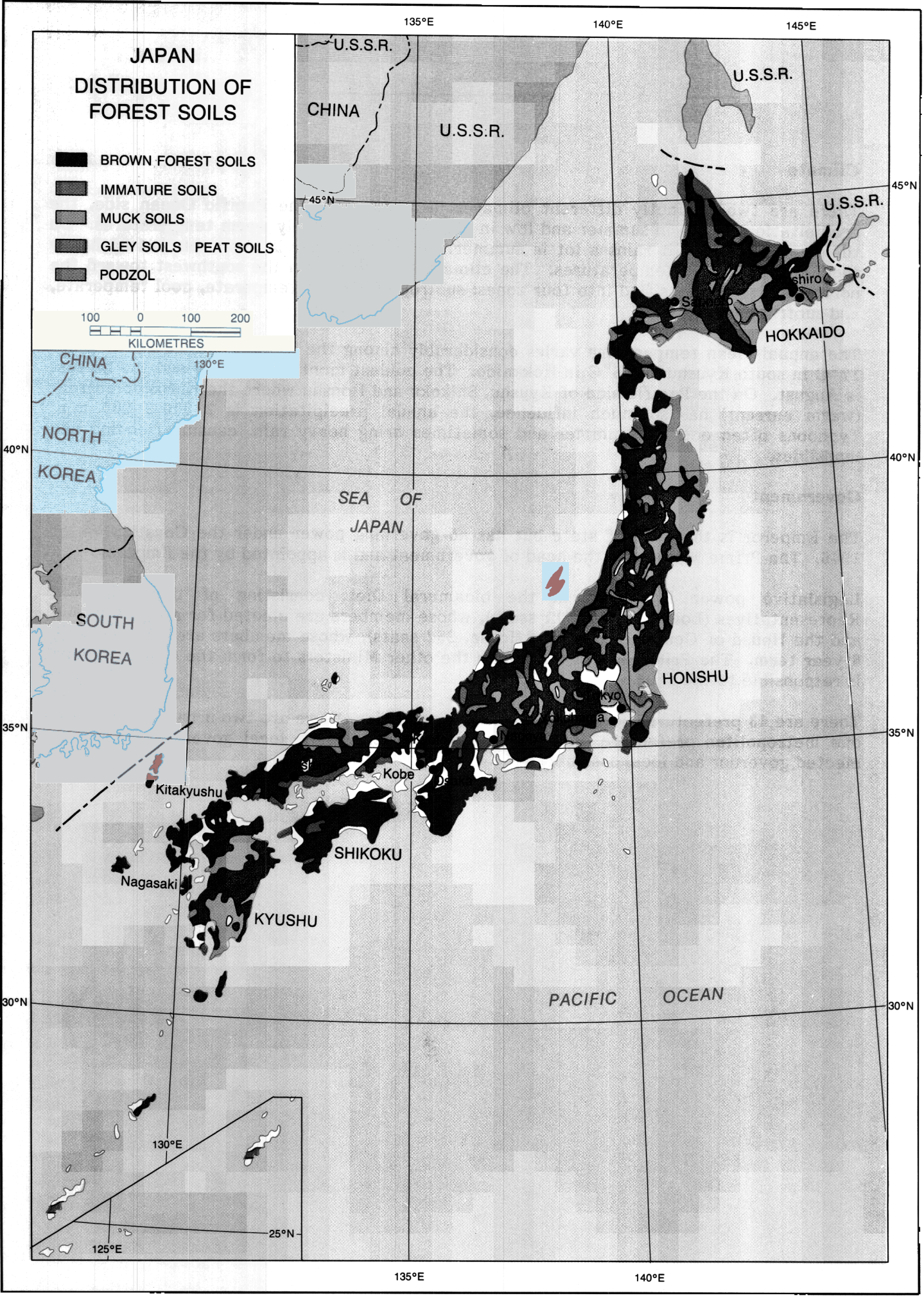
(1) Podzol: this soil is formed under the subalpine forest (subfrigid zone forest) as found in the northeastern part of Hokkaido, and northeast and central parts of Honshu. Under cool and humid conditions, decomposition of litter is not well developed; rough humus is thickly deposited and acidic (pH 3-4). Iron and aluminum are leached in the A-layer and are whitish gray in color. The B-layer, with accumulation of leachates is reddish-brown. The soil is strongly acidic.

(2) Brown forest soil: this soil covers most of Japan's hilly zone and is formed under warmer climatic conditions. Generally, it is weakly acidic (pH 4.5-6.5) with intrusion of humus. The surface layer is dark brown but the subsoil is brown. This soil type is most important for forestry, especially the less moist brown soil, which is good for the growth of sugi *(Cryptomeria japonica)*.

(3) Immature soil (also called "yellow and red soil"): this soil is widely distributed in the warm areas of Kyushu, Seto Inland Sea coast, Sanin, Kinki, and Tokai districts and formed under warm and humid conditions. The surface layer contains aluminum and iron. The soil is dry and physically poor in nutrients.

(4) Muck soil (also called "black soil"): this type of soil is distributed in the central and eastern part of Hokkaido and the foothills of volcanos and other highlands. Black surface soil is thick and its boundary with subsurface soil is often distinct. Permeability and ventilation are poor.

(5) Gley and peat soil: this type of soil is distributed in the valleys, lowlands, and wet or lakeshore areas normally associated with stagnant underground water and containing a great deal of organic material from vegetation.


JAPAN
DISTRIBUTION OF
FOREST SOILS
BROWN FOREST SOILS
IMMATURE SOILS
MUCK SOILS
GLEY SOILS PEAT SOILS
PODZOL
100 0 100 200
KILOMETRES
U.S.S.R.
CHINA
U.S.S.R.
U.S.S.R.
U.S.S.R.
45°N
45°N
HOKKAIDO
CHINA
130°E
NORTH
KOREA
40°N
40°N
SEA OF
JAPAN
SOUTH
KOREA
HONSHU
35°N
35°N
Kobe
Kitakyushu
SHIKOKU
Nagasaki
KYUSHU
30°N
30°N
PACIFIC OCEAN
130°E
25°N
125°E
135°E
140°E
135°E
140°E
145°E

MAP 2

Climate

There are two distinctly different climates in Japan. On the Pacific Ocean side, the precipitation is high in summer and low in winter with relatively warm temperatures. On the Japan Sea side, it rains a lot in summer. Winter weather is characterized by heavy snowfall and severe temperatures. The climate of Japan from the southwest toward the northeast can be classified into four zones: subtropical, warm temperate, cool temperate, and subfrigid.

The annual mean temperature varies considerably among the regions, with an average of 17°C in south Kyushu and 6°C in Hokkaido. The coldest month is January and the hottest is August. On the Pacific side of Kyushu, Shikoku and Honshu where the Kuroshio current (warm current) has so much influence, the annual precipitation is 2 000-3 000 mm. Typhoons often occur in summer and sometimes bring heavy rain, causing flooding and landslides.

Government

The Emperor is the head of state but has no governing power under the Constitution of 1946. The Prime Minister is the head of government and is appointed by the Emperor.

Legislative power is vested in the bicameral Diet, consisting of the House of Representatives (Lower House, 511 seats), whose members are elected for a 4-year term; and the House of Councillors (Upper House, 252 seats), whose members are elected for a 6-year term. The Prime Minister appoints the other Ministers to form the Cabinet which is responsible to the Diet.

There are 43 prefectures across the country. In addition, there are two urban prefectures, one metropolitan prefecture and one territory. Each of the local governments has an elected governor and local assembly.

FOREST RESOURCE

Forest area

The forest area of Japan is about 25 million ha or 68% of the total land area (377 708 km^2). In comparison, world forests cover about 30% of total land area. However, because of the high population density in Japan, the per capita area of forests is only 0.2 ha, which is one-sixth of the world average.

The ownership of forests can be divided into three groups: national forests, 7.9 million ha (31%); publicly owned forests, 2.5 million ha (10%); and individually owned forests, 14.8 million ha (59%) (Table 1). Most of the national forests are under the administration of the Forestry Agency of the Ministry of Agriculture, Forestry, and Fisheries (Fig. 1, Map 3).

The forest area is divided into plantations, natural and other forests (such as bamboo and grove). The plantation area is 9.4 million ha (37% of total forest area) and increasing. The natural forest area is 14.4 million ha (57% of total area) (Fig. 2).

Growing stock and wood volume

The total growing stock is 2 186 million m^3 (Fig. 3) with plantations of 798 million m^3, natural forests of 1 386 million m^3, and others of 2 million m^3 (unstocked land, bamboo, grove, and leftover area). The unit volume per ha in plantations is 85 m^3 and 96 m^3/ha for natural forests. Based on species type, the softwood species are 1 215 million m^3 and the hardwood species are 971 million m^3. The growing stock of the national forests is 805 million m^3, and that of the public-private forests is 1 381 million m^3. Wood volume per ha in national forests is 101 m^3/ha and 80 m^3/ha for private-public forests.

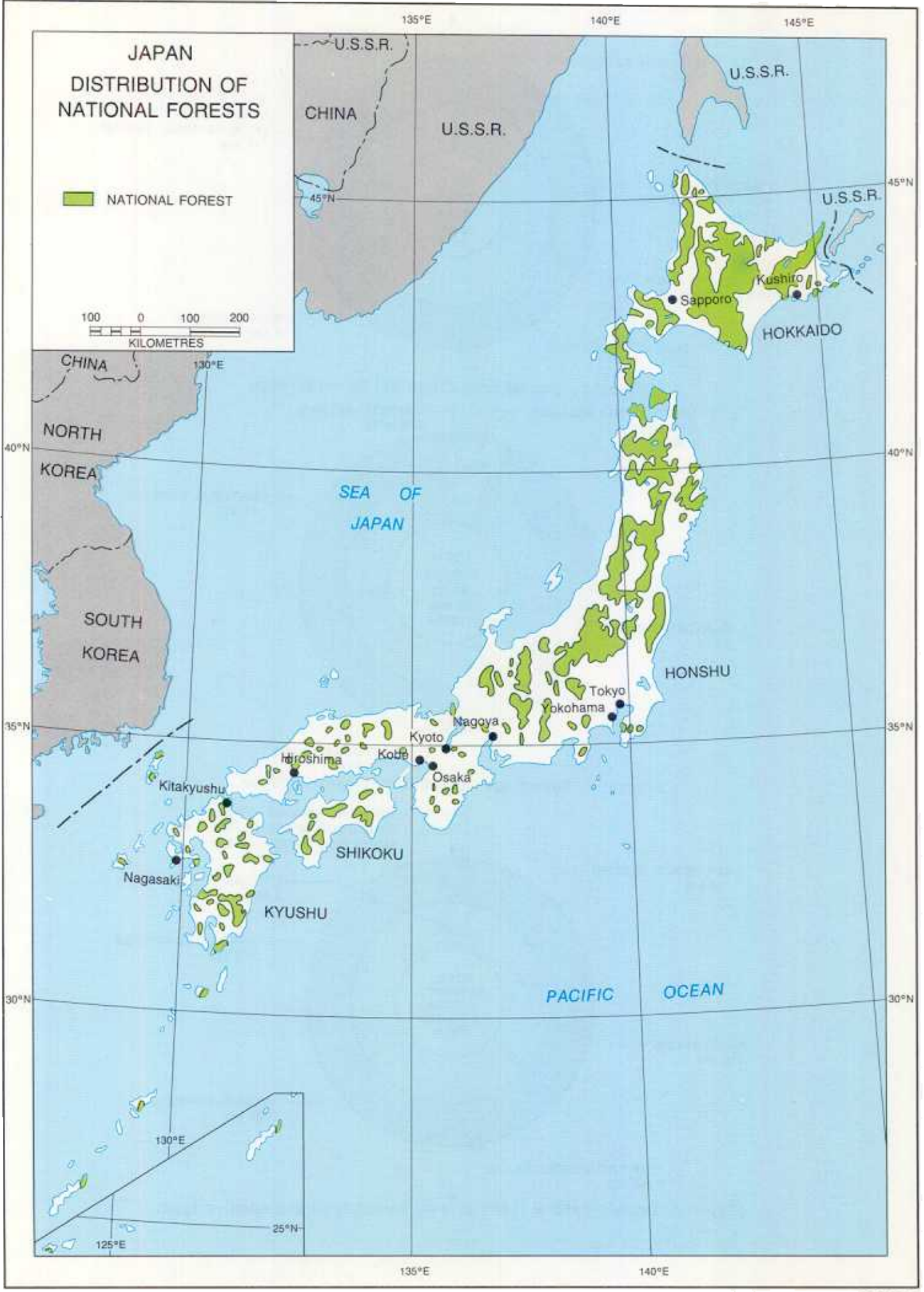
Forest zones and species

The forest composition and distribution vary considerably, and are influenced by various elevations and latitudes. There are three main forest zones (Map 4).

Table : Summary of forest resources

Ownership class and item	Total				Stocked land								Unstocked land and others				Bamboo grove	Left over
					Plantation				Natural forests									
	Area (1000 ha)	Growing stock (1000 m³)			Growing stock (000 m³)				Growing stock (000 m³)				Area (1000 ha)	Growing stock (1000 m³)			Area (1000 ha)	Area (1000 ha)
		Total	Softwood species	Hardwood species	Area (1000 ha)	Total	Softwood species	Hardwood species	Area (1000 ha)	Total	Softwood species	Hardwood species		Total	Softwood species	Hardwood species		
National forests:																		
Administered by Forestry Agency																		
- National forests	7 551	772 406	342 570	429 836	2 109	127 348	120 641	6 707	4 804	643 516	221 491	422 025	638	1 542	438	1 104	0	..*
- Government plantations on private land	172	10 566	10 023	543	146	10 325	9 969	356	5	236	53	183	21	5	1	4	-**	..
Sub-total	7 723	782 972	352 593	430 379	2 255	137 673	130 610	7 063	4 809	643 752	221 544	422 208	659	1 547	439	1 108	0	101
Administered by other ministries and agencies	214	22 173	10 161	12 012	34	2 795	2 713	82	158	19 378	7 448	11 930	22	0	0	0	0	-
Total	7 937	805 145	362 754	442 391	2 289	140 468	133 323	7 145	4 967	663 130	228 992	434 138	681	1 547	439	1 108	0	101
Non-national forests:																		
Public forests																		
- Prefectures	1 138	100 108	45 128	54 980	435	25 806	25 493	313	653	74 007	19 591	54 416	51	297	44	251	-	..
- Communities	1 399	96 925	54 277	42 648	601	42 152	41 872	280	735	54 772	12 405	42 367	59	1	-	1	4	..
Sub-total	2 537	197 033	99 405	97 628	1 035	67 958	67 365	593	1 388	128 779	31 996	96 783	110	296	44	252	4	8
Forests owned by individuals	14 789	1 183 738	752 574	431 164	6 053	589 933	587 223	2 710	8 082	593 803	165 351	428 452	510	2	-	2	144	-
Total	17 326	1 380 771	851 979	528 972	7 088	657 891	654 588	3 303	9 470	722 582	197 347	525 235	620	298	44	254	148	8
Grand total	**25 263**	**2 185 916**	**1 214 733**	**971 363**	**9 377**	**798 359**	**787 911**	**10 448**	**14 437**	**1 385 712**	**426 339**	**959 373**	**1 301**	**1 845**	**483**	**1 362**	**148**	**109**

*Figures not available.
*Nil or zero.


JAPAN
DISTRIBUTION OF
NATIONAL FORESTS
NATIONAL FOREST
100 0 100 200
KILOMETRES
U.S.S.R.
CHINA
U.S.S.R.
U.S.S.R.
U.S.S.R.
45°N
Kushiro
Sapporo
HOKKAIDO
CHINA
130°E
NORTH
KOREA
40°N
SEA OF
JAPAN
SOUTH
KOREA
HONSHU
Tokyo
Yokohama
Nagoya
35°N
Kyoto
Kobe
Osaka
Hiroshima
Kitakyushu
SHIKOKU
Nagasaki
KYUSHU
PACIFIC OCEAN
30°N
130°E
25°N
125°E
135°E
140°E
145°E

MAP 3

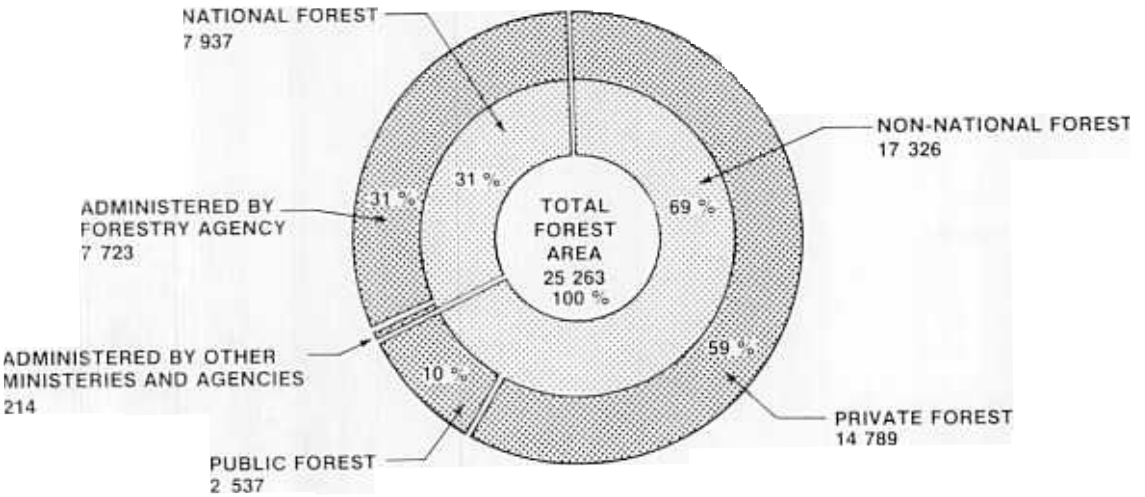


Figure 1. Forest area (1000 ha) by ownership.

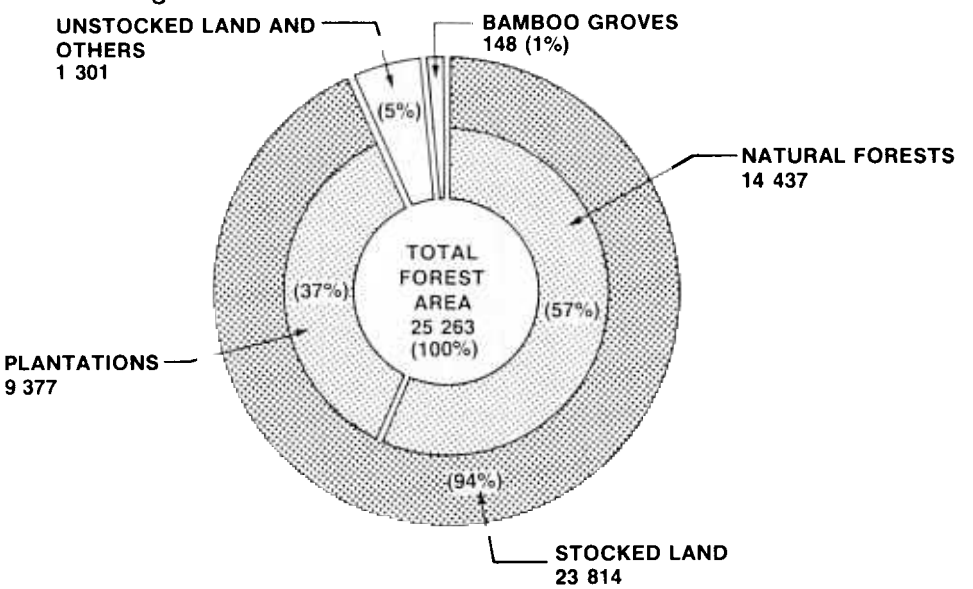


Figure 2. Forest area (1000 ha) by growing type.

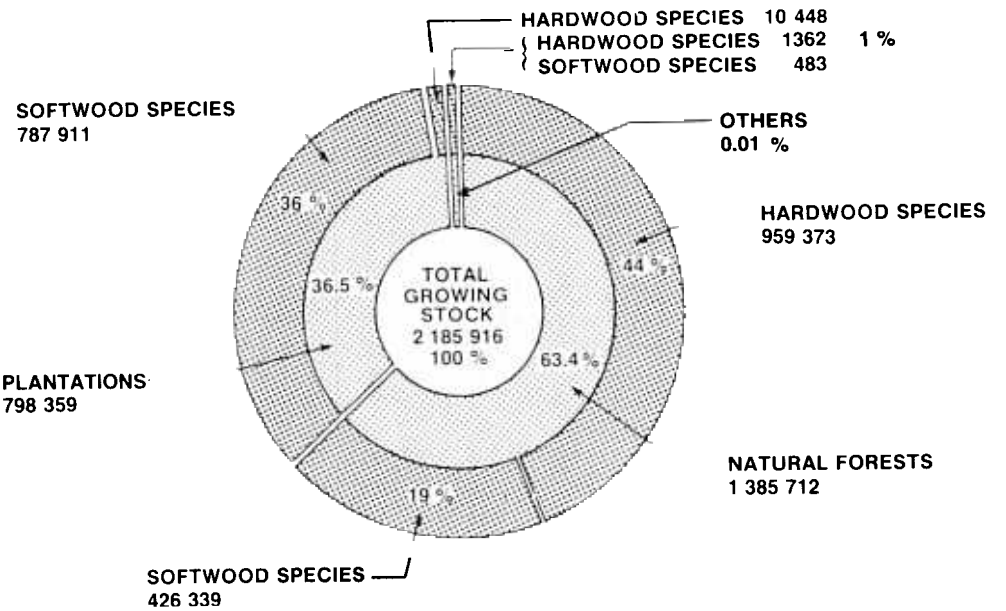
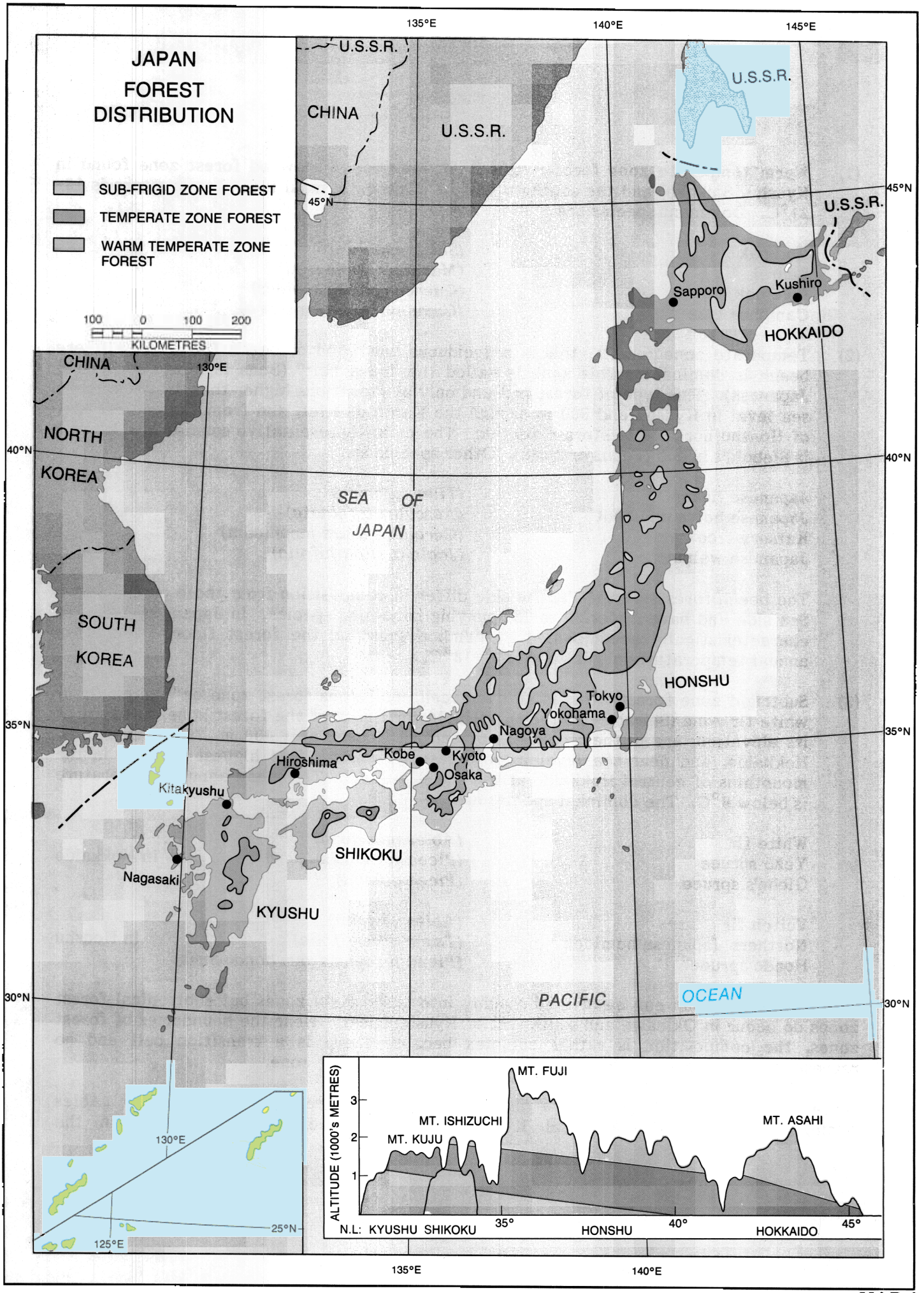


Figure 3. Growing stock (1000 m^3) by forest type and species type.


JAPAN
FOREST
DISTRIBUTION
SUB-FRIGID ZONE FOREST
TEMPERATE ZONE FOREST
WARM TEMPERATE ZONE FOREST
100 0 100 200
KILOMETRES
135°E
140°E
145°E
U.S.S.R.
CHINA
U.S.S.R.
U.S.S.R.
45°N
U.S.S.R.
Sapporo
Kushiro
HOKKAIDO
CHINA
130°E
NORTH
KOREA
40°N
SEA OF
JAPAN
SOUTH
KOREA
HONSHU
Tokyo
Yokohama
Nagoya
35°N
Hiroshima
Kobe
Kyoto
Osaka
Kitakyushu
SHIKOKU
Nagasaki
KYUSHU
30°N
PACIFIC
OCEAN
130°E
25°N
125°E
ALTITUDE (1000's METRES)
3
2
1
MT. FUJI
MT. ISHIZUCHI
MT. KUJU
MT. ASAHI
N.L: KYUSHU SHIKOKU
35°
HONSHU
40°
HOKKAIDO
45°
135°E
140°E

MAP 4

(1) Warm temperate zone forest: this is an evergreen hardwood forest zone found in Kyushu, Shikoku, and the southern half of Honshu. Annual mean temperature is 13-21°C. Dominant species are

Red oak	*(Shiia sieboldii)*
Laurel	*(Machilus thunbergii)*
Live oak	*(Quercus phylliraeoides)*
Camphor tree	*(Cinnamomum camphora)*

(2) Temperate zone forest: this is a deciduous hardwood or beech forest zone where beech is dominant. This zone is called the "buna belt" (Buna is beech species in Japanese). This type of forest is found only at elevations higher than 1 000 m above sea level in Kyushu and 600 m around the Kanto district, and from the central part of Honshu north to western Hokkaido. The main representative species in this zone is Siebold's beech *(Fagus crenata)*. Other species are

Japanese linden	*(Tilia japonica)*
Japanese horse chestnut	*(Aesculus turbinata)*
Katsura tree	*(Cercidiphyllum japonicum)*
Japanese walnut	*(Juglans ailanthifolia)*

The beech forests on the Pacific side differ in composition from those on the Japan Sea side and have different accompanying hardwood species. In Japan, all beech is characteristically accompanied by bamboo grass on the forest floor. The mean annual temperature in this zone is 6°-13°C.

(3) Subfrigid zone forest: this is an evergreen coniferous forest zone or "Veitch fir or white fir zone (Shirabe-todo belt)." The lower limits of the forest zone, in terms of its elevation, are in the mountains of central Honshu at 1 400 m, 700 m in central Hokkaido, and near sea level in northeast Hokkaido. The highest limit is in the mountains of central Hokkaido at the 1 400 m level. The mean annual temperature is below 6°C. The dominant species are

White fir	*(Abies mayriana)*	
Yezo spruce	*(Picea jezoensis)*	in Hokkaido
Glehn's spruce	*(Picea glehnii)*	
Veitch fir	*(Abies veitchii)*	
Northern Japanese hemlock	*(Tsuga diversifolia)*	in Honshu
Hondo spruce	*(Picea jezoensis* var. *hondoensis)*	

The forests of Japan can be divided roughly into three main zones but subtropical forest zones do occur in Okinawa and southwest of Kyushu Island. Near the boundaries of forest zones, the composition is rather complex because there is a transition belt and no representative species can be identified precisely with either zone.

Some other important species are distributed in various regions: Japanese fir *(Abies firma)* in Honshu, Shikoku, and Kyushu; Siebold's beech *(Fagus crenata)* in the

southern part of Hokkaido and throughout the whole of Honshu; and Sakhalin fir *(Abies sachalinensis)* in Hokkaido. There are three outstanding well-stocked forest areas:

Hiba arbor-vitae	*(Thujopsis dolabrata)* in Aomori area.
Japanese cedar	*(Cryptomeria japonica)* in Akita area.
Japanese cypress	*(Chamaecyparis obtusa)* in Kiso area.

Sugi *(Cryptomeria japonica)* and hinoki *(Chamaecyparis obtusa)* are the most important planting species in Japan. They are distributed from the warm temperate zone to the lower half of the temperate forest zone. Natural forests, which are close to pure stands, are found as sugi forest in Akita Prefecture and as hinoki forest in Kiso area.

Akamatsu *(Pinus densiflora)* and Karamatsu *(Larix leptolepis)* are the next most important planting species in Japan. Akamatsu is found all over the country except in Hokkaido. Karamatsu is one of the representative planting species, especially in the cool region, where sugi and hinoki species are not suitable.

FOREST TECHNOLOGY

Forest technology includes all forest practices such as silviculture, protection, and harvesting.

Silviculture

Because of the destruction caused by World War II, few forests were planted between 1945 and 1950. It was then recognized that wood supply and environmental reconstruction were vital to the country. In 1954, 432 700 ha were planted — the highest annual total since World War II. After that the planting rate declined, and by 1977, it dropped to less than half of its all-time record. This decrease was caused by changing socioeconomic conditions, modified management methods, and increasing imports of overseas timber.

Important planting species of softwood in Japan:

1) Japanese cedar (*Cryptomeria japonica*) is a representative and important planting species in Japan. It is distributed from a part of Hokkaido to Kyushu in the south. The wood is important for construction purposes.

2) Japanese cypress (*Chamaecyparis obtusa*) is distributed from the south of the northeastern district of Honshu to the south of Kyushu. It is an important species comparable with Japanese cedar and is the best Japanese wood for building materials.

3) Japanese larch (*Larix leptolepis*) is one of the most important planting species in Hokkaido and the temperate zone in Honshu. The wood is good for poles, sleepers, posts, construction, and pulp.

4) Japanese red pine (*Pinus densiflora*) is distributed throughout the country and is used, particularly along the seashore, for windbreaks and garden trees. The wood is useful for lumber, shipbuilding, and pulpwood.

5) Japanese black pine (*Pinus thunbergii*) is a popular species in central and southern Japan, especially along the seashore for windbreak and coastal sand protection. The wood has rich resin, is durable under moist conditions, and is often used for civil engineering and foundation material.

Important planting species of hardwood in Japan:

1) Keyaki (*Zelkova serrata*) is one of the largest and most important native species. It is found at the foot of the mountains in cool and warm temperature zones in Honshu, Shikoku, and Kyushu. The wood is used for building material, furniture, and shipbuilding.

2) Kunugi (*Quercus acutissima*) is an important species for fuelwood and is highly prized for making charcoal. The wood is hard and strong and is used in making utensils.

By 1977, 70% of the planted area was Japanese cedar and Japanese cypress (Fig. 4) followed by Japanese pines, Japanese larch, and broadleaved species.

Silvicultural techniques have been greatly improved, in particular for the native species of Japan cedar, "Sugi." This species exhibits rapid growth and a slender trunk, which is good for construction. It is widely distributed throughout the country.

In Japan, the typical silvicultural process is: site preparation, planting, weeding, vine-cutting-improvement, and cutting-pruning-thinning. Because of the complication of topography, silvicultural practices are often taken into consideration for subsequent operations and reduction of harvesting expenses.

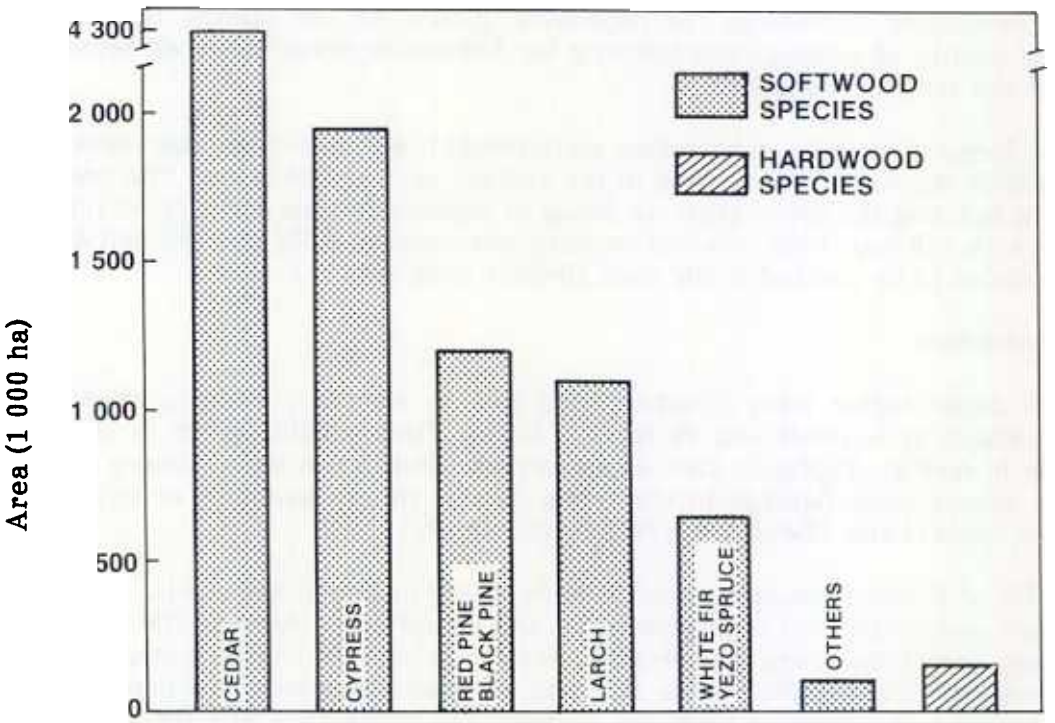


Fig. 4 Plantation area by species (1950-1977).

For site preparation, the felling residues on the ground are usually collected and piled in strips along a contour line to prepare the area where planting is expected. Because of the shortage of farmland, the operation is often conducted so as to leave only stumps. Other crops such as potatoes and peas are then cultivated in the spaces. Such operations require 30 or more man-days per hectare. Application of a herbicide is encouraged.

Plantings are done in spring and fall, with spring planting from early February to mid-April in the west of the Kanto plain (Tokyo district), from early April to mid-May in the north of Kanto plain, and from early May to early June in Hokkaido. Fall plantings are done from mid-September to late October.

The density of planting varies with the region, species, and soil conditions but, in general, it is 2 000-6 000/ha for Japanese cedar, and 4 000-5 000/ha for Japanese cypress. When the two species are planted in combination, density averages 2 500-4 500/ha.

Planting is done by the hand-hoe, a method that requires great care and high labor intensity. Because of the steep terrain of most forest land (except Hokkaido) mechanical planting has not been used.

Surface vegetation quickly recovers under favorable physical conditions and competes with young seedlings. The weeding operation to eliminate the competition is usually done once or twice during the initial three to four years. Because of labor shortages since the 1960s, weeding machines and chemical spraying have been introduced, particularly spraying of herbicides by helicopter. Weeding operations are carried out on an estimated total of 2-2.5 million ha each year.

Later, vine-cutting operations for improving growth of the stands, branch-pruning for improving quality of lumber, and thinning for increasing space between trees are applied as part of the tending procedure.

One pilot forest that is an outstanding achievement is a man-made Japanese larch forest established on the vast treeless land in the eastern part of Hokkaido. The project is under a plan "for building the green treasure house of agriculture and forestry on the wilderness" and covers 14 170 ha. Four hundred ha have been successfully planted and 8 700 ha have been scheduled to be planted in the next 10-year program.

Forest protection

Forests in Japan suffer from disasters such as fire, weather, disease, insect infestation, damage caused by animals and so forth. Forest fires usually occur in the dry season, especially in spring. Typhoons visit Japan several times each year. Heavy snow and frost in winter causes much damage to the trees. Under the influence of complicated climate conditions, insects and disease pose serious problems.

Nearly 40% of forest fires occur during early spring in March and April. The main causes of fires are unextinguished cigarette butts and campfires. Because the topography is so steep, many forest lands are inaccessible, even with modern fire equipment and facilities. Two methods of fire prevention, the fire line and protection belt, are important. The fire line is an open belt where no trees are planted; the protection belt forms a broad-leaved belt 20 m wide in a man-made forest to prevent the spread of fire. Helicopters are used for fire fighting and forest patrols are carried out constantly.

Weather damage from wind, snow, drought, and freezing are frequently encountered. The unforgettable Toya Maru Typhoon in 1954 and the Isewan Typhoon in 1959 caused tremendous windfall in old and overmature stands, equal to the mean annual cut on Hokkaido. Most snow damage is caused in slightly warmer regions by heavy wet snow. Young stands, especially in sugi plantations, cannot withstand a sudden wet snowfall. Proper management, including tending practices such as thinning, pruning, and cutting, may reduce timber loss. In young plantations, damage from frost and drought often occurs through water loss caused by freezing and drying winds in winter and excessive dryness of the soil in summer.

Many insects and diseases are found in man-made forests. The most serious enemy to forests is the pine bark beetle. Some 70 species cause diverse outbreaks and infestations. Susceptible species are todomatsu (*Abies sachalinensis*) and ezomatsu (*Picea jezoensis*) in Hokkaido, and akamatsu (*Pinus densiflora*) and kuromatsu (*Pinus thunbergii*) in Honshu, Shikoku, and Kyushu. When an infestation occurs, damaged trees are cut down and either burned or treated with chemicals. If the infestation covers a large area, clear-cuttings are made and pesticides are applied, in some cases by helicopter spraying. The pine bark beetle has caused the most serious damage, affecting 820 000 m^3 of forest in 1977.

The other common diseases and insects in Japan are

Pine caterpillar	*(Dendrolimus spectabilis)*
Pine needle gall midge	*(Thecodiplosis japonensis)*
Cedar needle gall midge	*(Contarinia inouyei)*
Gypsy moth	*(Lymantria dispar)*
Cedar spider mite	*(Oligonychus hondoensis)*
Chestnut gall wasp	*(Dryocosmus kuriphilus)*
Larch shoot blight	*(Guignardia laricina)*

The most effective control at present is aerial spraying of chemicals on insects flying around infested trees. The forest pests and diseases control law has been enforced to prevent serious outbreaks. Damage can be suppressed to a minimum level that will be beneficial to the public as well as to the nation.

Because two-thirds of Japan is covered by mountainous terrain with many short rivers, the rainy season often creates rapid flows, soil erosion, landslides, and flooding. To prevent such disasters, soil and water conservation measures are particularly emphasized in Japan.

Planting responsibilities are imposed, as well as restrictions on felling of standing trees, and changing the topography. Protection of watersheds in their headwaters and construction of dams and retaining walls are promoted to minimize disasters and form a part of the forest protection strategy in Japan.

Harvesting

Logging operations, rather primitive before the 1920s, were carried out using the hand saw, hand hatchet, and intensive manual labor. The chainsaw was introduced in 1946. Now, in the national forest the logging practices of felling, limbing, and bucking are 100% mechanized using chainsaws or hydraulic felling machines.

Along with the introduction of the one-man chainsaw, "Renaud's disease" (white-finger disease) became common among Japanese operators. As a result, operating hours became regulated, and rotary engines and remote control chainsaws were developed and introduced. Other machines including portable logging machines, noiseless chainsaws, shears, remote control winches, and portable automatic pruning machines are under study at the Numata Forestry Mechanization Centre of the National Forestry Agency.

Yarding operations using various cable skyline systems are very common in Japan because of the steep terrain. Three of the most popular yarding operations (Tyler, Endless Tyler, and Falling Block) have been employed. Generally, operations equipped with yarders of 2-4 drums, skyline spans 1200-1300 m in length, and lateral yarding distances of 50-100 m

are conducted. In Hokkaido, truck-hauling and tractor-hauling systems are more common because of the gentler terrain. As a result of the labor shortage, full-tree operations have been considered the most efficient and productive.

Significant development of forest roads has resulted from the necessity to transport logs from the forest to mills or markets. High mobility of trucks produces the most economical and efficient results for log transportation as well as for forest management. Each year, the forest roads in national and private forests are extended 3 000 km. In 1980, the total length of forest roads in Japan was 131 000 km. The expansion of the forest road system has been a goal of the National Forestry Agency for the last two decades. The total target distance is set at 183 000 km by 1990.

Mechanization

Forest mechanization has been an important issue for the last two decades because of labor flow from forests to industrial cities. Also, the improvement and innovation of mechanical technology in recent years has made the mechanization task feasible. The Forest Mechanization Council in the Forestry Agency and the Forestry Mechanization Centre in Numata District Forest Office were established to perform experiments on forestry machines, equipment, and mechanical operations as well as to train engineers in private and national forests. The Mechanization Department of the Forest Experiment Station in Tsukuba of Ibaraki and each prefectural forest experiment station are responsible for research in forest mechanization.

The introduction of the one-man chainsaw and later, in 1955, the yarder promoted the practical application of logging mechanization. The tractor was developed in 1955 adding to the more efficient equipment. As a result, the full-tree tractor system, developed in 1958, and full-tree yarder system, developed in 1961, have changed the pattern of operation and influenced production.

Mechanization of planting machines, brush cutters, and ploughing machines was developed basically through imports or transferred from agricultural machines in 1955. All these machines were tested in the pilot forest of the Obihiro Branch Regional Office. Consequently, full-scale operations of wheel-type tractors and mechanization of planting operations were carried out. Large civil engineering machines (bulldozers, dump cars, tractor shovels, graders, and so forth) were being used in the 1960s, for forest road construction.

FOREST MANAGEMENT

National forests

There are 7.9 million ha of national forests of which 7.7 million ha are under the jurisdiction of the Japanese Forestry Agency. The growing stock totals 138 million m^3 in plantations and 644 million m^3 in natural forests (Table 1). There are 353 million m^3 of softwood species and 430 million m^3 of hardwood species.

The forest management plan of the national forests consists of the basic and long-range plans. Both plans are established every 5 years for a term of 15 years by the Director General of the Forestry Agency.

All management plans take into consideration basic resource planning and operational planning, such as forest inventory, land classification, management group, cutting age, cutting volume, forest roads, conservation and so forth. All these strategies aim to achieve a long-term goal:

to ensure a stable timber supply
to conserve soil and water resources
to protect the land from landslides and soil erosion
to preserve green environment, plants, and animals
to furnish recreational areas
to develop local industries
to create employment
to enrich family life and other public benefits.

Furthermore, the Forestry Agency is consistently promoting plantations and natural regeneration with proper tending and protection.

Within the Forestry Agency there is a total staff of 34 000 permanent employees and 28 700 temporary workers distributed across the country in 10 regional offices, 350 district forest offices, and 2 333 ranger offices. They provide services to the national forests to achieve maximum benefit for the public.

Non-national forests

The non-national forests are classed into private individual and publicly owned forests of which the latter are company organizations, temples, and shrines. Non-national forests account for 69% (17.3 million ha) of the total forest area (Fig. 1). Within non-national forests, 85% (14.8 million ha) of the area belongs to individuals and 15% to the public. Approximately 90% of individual owners are farmers who each own less than 5 ha. This forest management is closely related to agriculture. Because ownership is on such a small scale, both minor forest products and agro-forest products have been produced.

Because of the length of time required to grow forest products, the government provides special financial assistance to individual forest owners. Loans with low interest or without interest are granted through the Agriculture, Forestry, and Fisheries Finance Corporation.

Various funds such as the Forestry Improvement Fund, the Domestic Timber Industry Enhancement Fund, and the Forest Credit Fund are available for assistance. In addition, the incentives of different taxation systems are granted to reduce the tax burden on forest owners. The government sponsors a forestry structure improvement project to increase forest production and forestry workers' income, to improve the management base, and to promote owners' cooperation.

The forest owners organize cooperatives called forest owners' associations to improve their economic and social position. There are approximately 2 100 forest owners' associations in Japan with 1.8 million members who own about 80% of the total private forest. The majority of associations play an important role in planting, cutting, forest road construction, and providing guidance on forest management.

Public forests consist of prefectural forests of 1.1 million ha with 100 million m^3 of growing stock, and town or community forests of 1.4 million ha with approximately 100 million m^3 of growing stock. These forests constitute 10% of the country's forest area and 9% of its growing stock. More than half of these forests are classified as restricted and dedicated to providing public benefits.

Man-made forests

There was little effort made to create man-made forests during the period of World War II in Japan. Consequently, the destruction caused by the war and the urgent demand for wood material created a great shortage of lumber. After World War II planting was expanded on a nationwide scale from rather limited areas to all classes of ownership. Today, man-made forests cover 9.38 million ha accounting for 38% of the total forest area. The registered growing stock of 798 million m^3 accounts for 37% of the total growing stock in Japan.

Sugi (*Cryptomeria japonica*) is the most important plantation species because of its rapid growth, superior quality of wood, and wide adaptability to sites from the southern part of Hokkaido to Yaku island of Kyushu. Hinoki (*Chamaecyparis obtusa*) is the second most important plantation species in Japan. It can tolerate poorer sites than sugi and is distributed widely in the northern part of Honshu and Kokkaido. The wood is fine and straight-grained with a good lustrous surface, highly valued for interior work. Both species are rather resistant to disease and insects, and are highly recommended for planting.

Sugi and hinoki plantations cover 66% (45% for sugi, 21% for hinoki) of the total man-made forest area (Table 2).

Table 2. Distribution of species in man-made forests

Species	Area in % of total
Cryptomeria japonica	45
Chamaecyparis obtusa	21
Pinus densiflora and *Pinus thunbergii*	13
Larix leptolepis	12
Abies sachalinensis and *Picea jezoensis*	7
Other species	5
Total	100 % (9 380 000 ha)

As a result of intensive cultivation, 85% of the man-made forests bears trees under 20 years of age.

Because of the decrease in manpower and increase in costs, there is a trend toward smaller annual plantation areas. Table 3 shows that in 1979 the area planted was 178 000 ha, a decrease of 7% from the previous year.

Table 3. Annual area planted

Fiscal year	National forest	Non-national forest	Total
	(1 000 ha)		
1977	46	156	202
1978	45	146	191
1979	46	132	178

The government has formulated and implemented a fundamental policy through which forest owners and cooperative organizations obtain financial assistance for promotion of planting in nongovernment forests.

Natural forests

Natural forests cover 57% of the total forest area. Approximately 35% of the total forest area is managed by the natural forest management method that aids natural regeneration by removing competing trees or raking the ground to promote growing of young trees. The coppice system (stump sprouts) is being promoted to cope with the increased demand for small logs for mushroom (shiitake) cultivation. Also in the natural hardwood forests, the elimination of defective trees is encouraged to promote superior stands. Thus, a

favorable environment for natural seedings is created, especially in the places where regeneration was unsuccessful with conifer species.

The coniferous species of natural regeneration are Japanese red pines (*Pinus densiflora*), Japanese black pine (*Pinus thunbergii*), Yezo spruce (*Picea jezoensis*), and white fir (*Abies mayriana*). The hardwood species of natural regeneration are white oak (*Quercus* spp.), beech (*Fagus crenata*) and birch (*Betula* spp.).

FOREST INDUSTRY

During 1971-1980, total wood consumption in Japan exceeded 100 million m^3 annually, except in 1975. More than 50% of the consumption consisted of imports from tropical countries (Malaysia, Indonesia, and the Philippines) and the rest from Canada, the USA, the USSR, and other countries. Domestic supply accounts for less than 40% of total consumption.

Japan's timber demand will likely remain high despite the recent recession in the world economy, steadily changing styles in the construction sector, and the substitution of other materials in the production of railroad sleepers, posts, and poles. The traditional Japanese house is based on wooden structures because the Japanese admire the beauty of wood so much. In addition, the apparent growth of the economy and the rising standard of living will cause demand for wood to remain high.

Sawmills

There were about 22 000 sawmills, employing 202 000 workers, in Japan in 1980. But their numbers have been decreasing at the rates of 300 mills and 5 000 workers per year. Based on a classification of power consumption, there has been a decrease in numbers of small mills (less than 37.5 kW in size), but an increase in numbers of larger mills (Table 4).

Table 4. Number of sawmills by size (electrical power consumption)

Year	Consumption (kW)							Reduction in no. of sawmills from previous yr.
	Under 7.5	7.5 - 22.5	22.6 - 37.5	37.6 - 75.0	75.1 - 150.0	Over 150.0	Total	
1967	2 172	10 233	6 859	5 530	1 699	542	27 035	
1968	1 861	9 690	6 980	5 826	1 978	656	26 991	44
1969	1 623	8 995	6 913	6 062	2 164	788	26 545	446
1970	1 395	8 125	6 704	6 349	2 387	981	25 941	604
1971	1 224	7 888	6 476	6 299	2 437	1 099	25 423	518
1972	1 077	7 485	6 191	6 469	2 506	1 279	25 007	416
1973	948	6 868	6 023	6 814	2 790	1 523	24 966	41
1974	816	6 590	5 844	7 917	2 028	1 637	24 832	134
1975	699	6 201	5 579	7 035	3 099	1 716	24 329	503
1976	599	5 878	5 463	7 159	3 195	1 787	24 081	248
1977	511	5 442	5 396	7 172	3 255	1 871	23 647	434
1978	444	5 077	5 302	7 215	3 255	1 945	23 238	409
1979	..*	..	..	..	..	..	22 541	697
1980	..	..	..	..	..	..	22 231	310
1981	..	..	..	..	..	..	21 535	696

*Figures not available.

Table 5. Number of sawmill employees by mill size

Year	Consumption (kW)						Change in no. of employees from previous year
	7.5 - 22.5	22.6 - 37.5	37.6 - 75.0	75.1 - 150.0	Over 150.0	Total	
1967	45 918	61 987	38 794	47 314	25 596	269 564	
1968	42 574	59 946	87 402	52 319	30 180	272 421	+ 2 857
1969	37 823	54 719	88 624	53 332	34 080	263 578	- 8 843
1970	32 231	49 663	81 180	52 923	38 356	254 343	- 9 235
1971	31 190	45 613	76 434	50 955	40 368	244 560	- 9 783
1972	29 958	43 293	75 244	50 399	47 062	245 956	+ 1 396
1973	26 099	39 178	73 982	51 394	52 528	243 181	- 2 785
1974	24 184	35 766	69 222	51 177	52 383	232 732	- 10 449
1975	22 563	32 566	66 455	48 887	50 885	221 356	- 11 376
1976	20 743	30 689	64 567	48 482	51 490	215 921	- 5 435
1977	18 861	28 747	61 829	47 296	51 269	207 492	- 8 429
1978	16 566	27 494	60 508	46 084	51 729	202 381	- 5 111
1979	..*	..	..	..	..	202 000	- 381
1980	..	..	..	..	..	202 000	- 0

*Figures not available.

This decrease in number of employees as related to sawmill size is a sign of managerial efforts to obtain higher productivity by automation. However, as shown in Table 5, the average size of all sawmills was 67.8 kW and the average number of employees was 9 per mill. The total production was 37 million m^3 of sawnwood per year with an average capability of 1 664 m^3 per mill. This low level of production per mill places Japanese sawmills in a cottage industry class. The mills are scattered throughout the country at various forestry centers (for domestic logs) and timber ports (for imported logs). The ratio of domestic to imported logs was 2:3. In 1980 the demand for lumber was stagnant, reflecting a reduction in the number of houses built and the suspension of some public works.

The rationalization of the sawmill industry is very difficult because of the variety of demands for lumber size and quality. Builders, the largest users of lumber, require many dimensions and shapes because of the unique structural characteristics of Japanese houses. In an extreme case, to satisfy builders' requirements, sawmills must use complicated ways of cutting posts, boards, and strips, all from the same log. Close attention is paid to the appearance of lumber, the presence or absence of knots, and type of grain to satisfy the builders' appreciation for the beauty of the wood.

Total 1981 world exports of sawnwood were 71 759 000 m^3, of which Canada exported 27 571 000 m^3 (38%) and Japan exported 50 000 m^3 (less than 1%). On the other hand,

total world imports of sawnwood in 1981 were 69 487 000 m^3 of which Canada imported 2 096 000 m^3 (3% of total) and Japan imported 3 824 000 m^3 (6% of the total world imports). Canada exported 2 053 000 m^3 to Japan in 1981 accounting for 55% of the total sawnwood imported by Japan. The main species exported from Canada to Japan are Sitka spruce, hemlock, and Douglas-fir.

The peak of annual lumber production reached approximately 45 million m^3 in 1973 and gradually decreased to 37 million m^3 in 1981 (Fig. 5).

Fig. 5 Annual Japanese lumber production (1955-1981).

In 1979, 76% of lumber was used for housing materials, 8% for containers (packing), 7% for furniture, and the rest for vessels, vehicles, and craft industries.

Statistics in Table 6 are based on reports from importing countries. The statistics in Table 7 are based on reports from exporting countries. Therefore the figures are slightly different.

Canada exported 2 053 000 m^3 of sawnwood to Japan in 1981, which accounted for 55% of total sawnwood imported by Japan and almost all of it consisted of coniferous species. The USA exported 1 231 0000 m^3 of sawnwood to Japan in 1981 accounting for 33% of Japan's imports of sawnwood (Table 7). On the other hand, Canada and the USA do not import any sawnwood from Japan.

Japan ranked fourth in the world in total coniferous sawnwood production and fourth for imported coniferous sawnwood (Table 8).

Table 6. Sawnwood and sleeper production imports and exports, world, Japan, and Canada (1981)

	World	Japan	Canada
Production quantity (1 000 m^3)	419 163	36 962	38 956
Imports quantity (1 000 m^3)	70 408	3 898	2 181
Imports value (US $ 1,000,000)	11 368	782	255
Exports quantity (1 000 m^3)	72 757	51	27 631
Exports value (US $ 1,000,000)	10 203	27	2 553
Coniferous sawnwood			
Production quantity (1 000 m^3)	307 520	29 905	38 000
Imports quantity (1 000 m^3)	57 893	1 208*	3 410*
Imports value (US $ 1,000,000)	8 273	624	108
Exports quantity (1 000 m^3)	60 789	10	27 293
Exports value (US $ 1,000,000)	7 647	3	2 471
Nonconiferous sawnwood			
Production quantity (1 000 m^3)	107 729	7 015	956
Imports quantity (1 000 m^3)	11 594	414	888
Imports value (US $ 1,000,000)	2 938	143	135
Exports quantity (1 000 m^3)	10 970	40	278
Exports value (USA $ 1,000,000)	2 404	24	76

Source: *1981 FAO Yearbook of Forest Products.*
*Figures reported by importing countries.

Table 7. Japanese imports of sawnwood by exporting country in 1981 (1 000 m^3)

Type of sawnwood	Total volume	Exporting Country							
		Canada	USSR	USA	Malaysia	Singapore	Indonesia	Philippines	Brazil
Coniferous	3 364*	2 047	122	1 195					
Nonconiferous	392*	6		36	89	22	99	136	4
Total	3 756	2 053	122	1 231	89	22	99	136	4
(%)	100%	55%	3%	33%	2%	1%	3%	4%	-

Source: *1981 FAO Yearbook of Forest Products.*
*Figures reported by exporting countries.
-Nil or zero

Table 8. Top 10 countries in production, imports, and exports of coniferous sawnwood in the world (1981)

Rank	Country	Sawnwood production (1 000 m^3)	Import rank	Country	Sawnwood imports (1 000 m^3)	Export rank	Country	Sawnwood exports (1 000 m^3)
1	USSR	86 000	1	UK	5 149	1	Canada	27 293
2	USA	53 596	2	Italy	3 928	2	USSR	6 925
3	Canada	38 000	3	F.R.G.	3 663	3	Sweden	5 624
4	Japan	29 905	4	Japan	3 410	4	Finland	5 377
5	China	10 365	5	France	2 056	5	USA	4 477
6	Sweden	10 266	6	Netherlands	1 696	6	Austria	3 787
7	Finland	8 185	7	Egypt	1 455	7	Czechoslovakia	1 090
8	F.R.G.	7 630	8	G.D.R.	1 271	8	Chile	847
9	Brazil	7 143	9	Canada	1 208	9	Portugal	780
10	Austria	6 024	10	Saudi Arabia	908	10	Romania	710
	World	307 520		World	57 893		World	60 789

The sawmill industry in Japan is now facing some problems for which solutions must be found.

(1) A system must be established to react properly to changes as demand for sawmill products and the timber supply situation change.

(2) Since the demand for lumber by residential builders has decreased, the problem is how to make more attractive products of better quality and at lower cost.

(3) Better methods of utilization must be developed for the expected increase in domestic supply of small-diameter timber from thinnings.

(4) Establishment of a reliable supply of lumber is urgent because it is becoming more difficult to rely on imports.

(5) It is necessary to renovate equipment, achieve high efficiency, decrease costs, and optimize operations.

Plywood

The plywood industry is entirely dependent on imported tropical hardwood from southeastern Asia. Most plywood mills are small scale. Those mills employing more than 300 workers number as few as 44.

The production of plywood in 1981 amounted to 7 096 000 m^3, equivalent to 19% of world production and second in world rank next to the USA.

The use of plywood in Japan was directed to interior panels for nonstructural purposes. Recently its use has been expanded to a new sector of waterproof and climate-resistant, durable, exterior materials.

Plywood is one of the main exported forest products in Japan and accounted for 60 % of all lumber exports by volume in 1978. Japan exported 26 260 m^3 of plywood with 22 767 m^3 (87%) going to the USA. The plywood industry is greatly affected by the US economy and its housing construction trends.

The plywood industry started in Japan about 1907. In the beginning, domestic hardwood species like white oak, birch and ash were used. Two main types of adhesives, urea-resin and carbolic acid-resin, have been used in Japan.

There are two types of plywood, ordinary and special. Ordinary plywood has three or five plies without special finishing. Special plywood is a general name for plywood that has special layers of material with decorating on the outer plies.

The number of plywood plants was 611 in 1978 employing 46 180 workers. Number of workers per plant varied from 10 to 3000 with an average of 76. From 1969-78 there was a tendency toward decreasing numbers of workers in all sizes of plants, perhaps because of the slow rate of economic growth.

There are two problems facing the plywood industry in Japan. One is how to stabilize the demand/supply situation because it has become more difficult to obtain raw material from

southeast Asian countries (Japan's main suppliers). Moreover, the demand from the USA for Japanese plywood has stagnated. The other problem is price fluctuations caused by the low inventory carrying capacity in the distribution system.

Laminated wood

Laminated wood can be classified into two groups: structural use and auxiliary use. The advantage of laminated wood is that it has superior characteristics unobtainable in ordinary lumber, for example, stabilized strength and performance and the ability to be formed into the required shapes.

Production of laminated wood in 1979 was 290 000 m^3 of which 120 000 m^3 (41%) were for structural use and 170 000 m^3 (59%) were for auxiliary use. There were 193 producing plants at the end of 1979, and the number was increasing, reflecting the increase in demand.

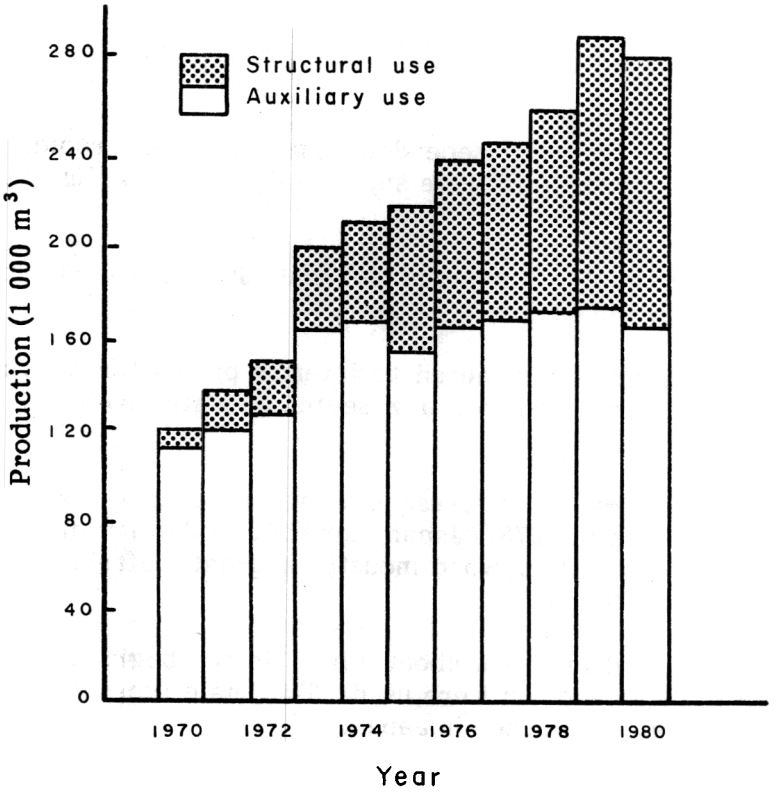


Fig. 6 Japanese laminated wood production.

In 1980 there were about 200 factories in Japan producing laminated wood. Interpolated from Figure 6 the total production was estimated to be 280 000 m^3, of which 170 000 m^3 were for auxiliary use and 110 000 m^3 were for structural use.

Flooring

The Japanese wood flooring industry has a long history. It was only after 1910 that flooring was made with machine processing. Growth has been steady since the number of

western-style houses increased. Also the industry has been supported by the large demands of the textile industry.

There are two groups of flooring: single-layer and multi-layer. Single-layer flooring is of two kinds: floorboard often used in nonresidential buildings, such as schools or gymnasiums, and flooring blocks, used in residential areas. Multi-layer flooring uses mostly plywood as the base with an overlay laminated onto it. One type of multi-layer flooring is a veneer showing the beauty of the natural wood grain, the other has a resin finish with printing.

The number of single-layer flooring mills was 124 in 1973. This number declined to 67 by the end of 1981. There were 26 multi-layer flooring producers in 1981.

In 1981, the total wood flooring production (both single-layer and multi-layer) was estimated at 37 432 000 m^{2*}, approximately 20% less than the previous year's production of 47 116 000 m^2. As wood prices, construction costs, and western influences increase, carpet can be used to substitute for wood flooring. The future of the industry must be considered closely in relation to the change in housing demand and people's views of housing interiors.

Fiberboard

The fiberboard industry began in 1920 with a low production using bagasse and ground-pulp waste. In the 1950s, advanced technology and production methods were introduced from abroad.

Fiberboard is a board made of dissolved wood fibers. According to the Japanese Industrial Standards (JIS) classification, there are three categories: hardboard, semihardboard and insulation board. There were 14 factories producing fiberboard in Japan in 1980. Total production, including all three types, was 97 673 000 m^{2*}.

In 1981 the total fiberboard production in the world in terms of volume was 15 440 000 m^3, of which Japan produced 545 000 m^3 accounting for 3.5% of world production.

It has become more and more difficult for the Japanese fiberboard industry to obtain imported wood material to supply its industry in recent years.

*m^2 is the unit used for flooring and fiberboard in Japanese statistics.

Table 9. Fiberboard production by types (1 000 m^2) average thickness of 15 mm

Year	1975	1976	1977	1978	1979	1980	1981
Hardboards	47 417	51 798	53 220	55 182	58 224		
	(50.9)	(50.5)	(51.1)	(53.4)	(51.8)	82 052	70 673
Semi-hardboards	23 211	23 836	21 290	20 566	20 234	(70.3)	(72.4)
	(24.9)	(23.2)	(20.5)	(19.9)	(18.0)		
Insulation boards	22 614	26 984	29 567	27 576	33 957	34 731	27 000
	(24.2)	(26.3)	(28.4)	(26.7)	(30.2)	(29.7)	(27.6)
Total production	93 242	102 618	104 077	103 324	112 415	116 783	97 673
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Note: "Semi-hardboards" are included in "hardboards" in 1980 and 1981.

Particleboard

The particleboard industry is relatively new to the forest product industries. Since the 1950s it has increased to a substantial scale through the introduction of techniques from abroad. Particleboard is a product made by cutting wood into fine particles and reassembling them by applying thermal pressure with adhesives. There are two types of particleboard based on the cross-sectional structure: single-layer and multi-layer board. The products can be used for soundproofing, heating insulation, furniture, construction, and radio or TV cabinets.

There were 19 factories producing particleboard in Japan in 1981. The peak production was approximately 85 million m^2 in 1980, but then decreased to 74 million m^2 in 1981. The particleboard industry has a competitive relationship with the woodpulp and fiberboard industries.

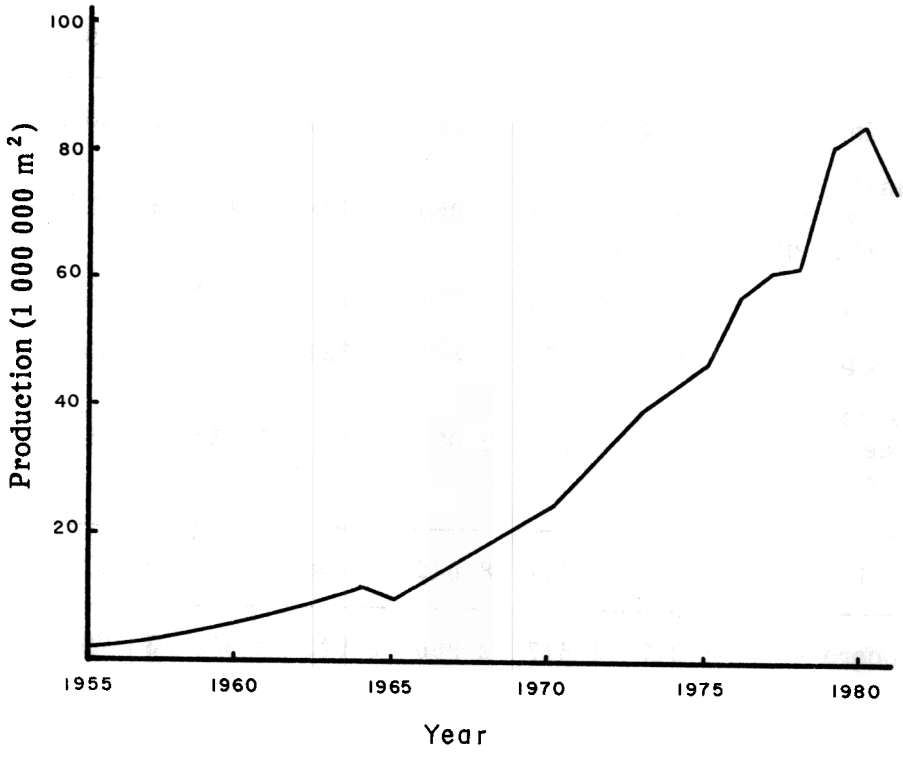


Fig. 7 Japanese particleboard production (1955-81).

By 1981, the average annual production per factory had doubled since 1971. One of the most productive factories has the capacity to reach 12 000 m^2 annually. Imported material accounted for 72% of the total used for particleboard; 90% was lauan residues, produced by plywood mills in Japan.

Total particleboard production was 39 670 000 m^3 in the world in 1981. Japan produced 1 141 000 m^3, which accounted for only 3% of world production. Japan imported 120 000 m^3 of particleboard and exported 2 000 m^3.

Pulp and paper

The pulp and paper industry is the most industrialized of the wood-related industries in Japan. This industry has come to be second in terms of wood consumption after the sawmilling industry. The technology in pulp and paper manufacturing is in an advanced stage. Almost the entire quantity of paper and paperboard needed in Japan is produced in Japan, but most of the raw material is imported in increasing amounts every year.

In 1981, total paper and paperboard production was about 9 943 000 t and 7 037 000 t respectively (Table 10).

Table 10. Paper and paperboard production (1 000 t) by type

Type		Year							
		1974	1975	1976	1977	1978	1979	1980	1981
Paper	Newsprint	2 233	2 160	2 341	2 370	2 482	2 566	2 566	*
	Printing, writing, and drawing paper	2 937	2 772	3 050	3 103	3 416	3 771	3 771	
	Kraft paper	903	710	797	787	799	761		
	Packing paper	393	327	365	384	412	438		
	Tissue paper, miscellaneous paper	1 978	1 742	2 079	2 114	2 253	2 445		
	Subtotal	8 444	7 711	8 632	8 758	9 362	9 981	10 536	9 943
Paper-board	Linerboard	3 217	2 617	2 900	2 923	2 955	3 379		
	Corrugating medium	1 838	1 419	1 719	1 771	1 857	1 971		
	White paperboard	1 087	952	1 088	1 149	1 198	1 275		
	Yellow paperboard	17	15	19	20	20	29		
	Solid fiberboard	186	161	192	208	204	233		
	Colored paperboard	148	127	149	155	157	158		
	Architectural paperboard	225	189	203	201	229	257		
	Others	485	409	492	517	516	579		
	Subtotal	7 203	5 889	6 762	6 944	7 136	7 881	7 552	7 037
	Total	15 647	13 600	15 394	15 702	16 498	17 862	18 088	16 980

*Figures not available.

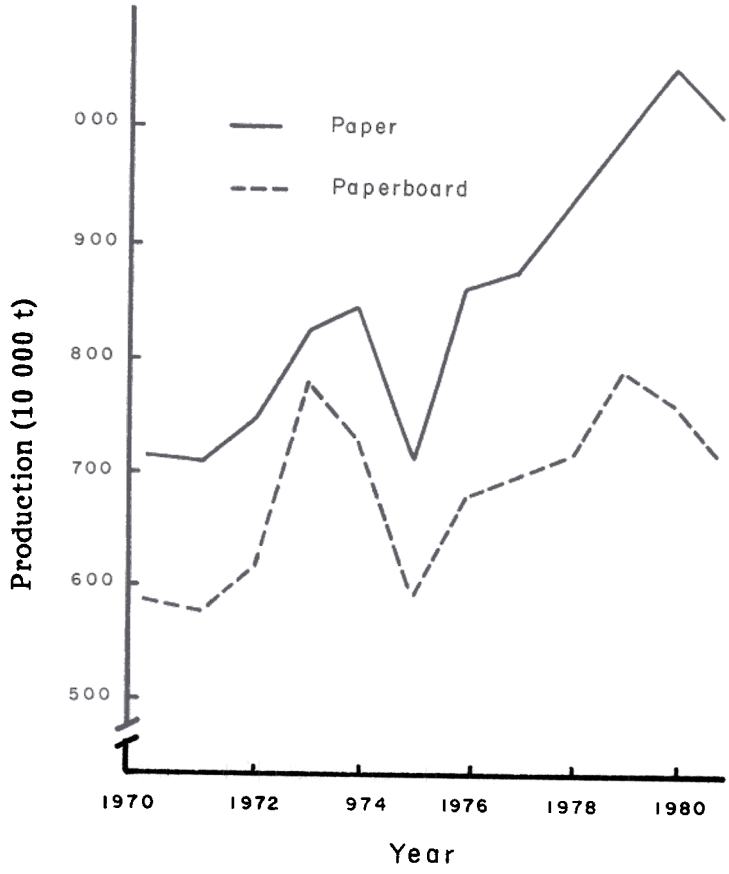


Fig. 8 Japanese paper and paperboard production.

Paper is said to be the barometer of culture. Paper products such as newspapers, magazines, books, journals, and advertisements are strongly related to culture as well as to the progress of the community.

The total wood pulp production of Japan in 1981 was 7 897 000 t and accounted for 6% of the world production (125 270 000 t). Japan ranked fourth in its production next to the USA, Canada, and Sweden (Table 11). Japan also imported 1 687 000 t (ranked fifth importing country in the world) of wood pulp but only exported 105 000 t.

Table 11. Wood pulp production of the top 10 countries (1981)

Rank	Country	Total wood pulp production	Import rank	Country	Total wood pulp imports	Export rank	Country	Total wood pulp exports
		(1 000 t)			(1 000 t)			(1 000 t)
1	USA	46 187 (37%)	1	USA	3 686	1	Canada	6 752
2	Canada	19 945 (16%)	2	F.R.G.	2 415	2	USA	3 322
3	Sweden	9 530 (7%)	3	UK	1 857	3	Sweden	2 886
4	Japan	7 897 (6%)	4	France	1 708	4	Finland	1 685
5	Finland	7 331	5	Japan	1 687	5	Brazil	951
6	Brazil	3 338	6	Italy	1 541	6	USSR	844
7	China	2 346	7	Netherlands	585	7	S. Africa	653
8	F.R.G.	2 021	8	Korea Rep.	517	8	Norway	560
9	France	1 815	9	Belgium-Lux.	423	9	New Zealand	514
10	Norway	1 614	10	China	315	10	Portugal	455
	World	125 270 (100%)		World	19 487		World	20 583

Wood chips

Chips are the main form of raw material used in the transportation and production systems of the pulp and paper industry. About 90% of chip production is generated by sawmills, most of which have a small capacity. Therefore, the chip plants are small scale, having an average of four or fewer employees.

Domestic producers of chips have had difficulty competing with imports in terms of cost and quantity. Domestic producers must collect chips from all over the country as compared to bulk delivery of imported chips by sea. Because of export restrictions by suppliers, there is great concern about the development of the chip industry in Japan.

In 1981, Japan imported 13 561 000 m^3 of chips from various countries (Table 12). Eighty percent of total imports of chips by Japan are from the USA and Australia. The remainder of the imports are from the USSR, Canada, New Zealand, Malaysia, South Africa, Papua New Guinea, and other countries.

Table 12. Japanese imports of wood chips by country

Country	1973	1974	1975	1976	1977	1978	1979*	1980*	1981**
					(1 000 m^3)				
USA	8 619	9 290	7 631	8 658	8 467	7 330	8 408	8 246	5 832
Malaysia	636	796	725	463	399	365	261	293	284
Australia	2 368	2 772	2 002	2 495	3 040	2 963	3 717	4 188	5 851
New Zealand	329	368	382	342	523	516	493	570	487
USSR	95	267	428	607	660	709	715	546	-
South Africa	-	-	28	269	277	347	409	552	-
Canada	-	-	-	-	-	-	732	1 190	468
Papua New Guinea	-	-	-	-	-	-	117	180	87
Others	47	87	144	191	454	886	559	169	0
Total	12 094	13 580	11 340	13 025	13 820	13 116	15 412	15 934	13 561
					(Percentage)				
USA	71.3	68.4	67.3	66.4	61.3	55.9	54.6	51.8	43.0
Malaysia	5.3	5.9	6.4	3.5	2.9	2.8	1.7	1.8	2.1
Australia	19.6	20.4	17.7	19.2	22.0	22.6	24.1	26.3	43.1
New Zealand	2.7	2.7	3.4	2.6	3.8	3.9	3.2	3.6	3.6
USSR	0.8	2.0	3.8	4.7	4.8	5.4	4.6	3.4	4.1
South Africa	-	-	0	2.1	2.0	2.6	2.6	3.4	-
Canada	-	-	-	-	-	-	4.8	7.5	3.5
Papua New Guinea	-	-	-	-	-	-	0.8	1.1	0.6
Others	0.4	0.6	0.1	1.5	3.2	6.8	3.6	1.1	0
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Ministry of Finance *Monthly report on Japanese trade.*

*Fenton, R. 1982. International wood chip trade.
**FAO yearbook of forest products, 1981.
-Nil or zero.

More than 90% of all chips from the USA are softwood, of which 70% are Douglas-fir. Most chips from Australia are hardwood, mainly eucalyptus.

Of the chip import volumes in 1980, softwood species accounted for 9 595 000 m^3, and hardwood species accounted for 6 339 000 m^3, which are 60% and 40% respectively of total imports (Table 13).

Table 13. Japanese imports of chips by softwood and hardwood species in 1980

Exporting country	Softwood (1 000 m^3)	Hardwood (1 000 m^3)	Total (1 000 m^3)	%
USA	7 374	872	8 246	51.8
Australia	51	4 137	4 188	26.3
Canada	1 190	-	1 190	7.5
New Zealand	462	108	570	3.6
South Africa	-	552	552	3.5
USSR	492	54	546	3.4
Malaysia	5	288	293	1.8
Papua New Guinea	-	180	180	1.1
Indonesia	-	102	102	0.6
Taiwan	21	26	47	0.3
Singapore	-	20	20	0.1
TOTAL	9 595	6 339	15 934	
%	60.2	39.8	100	100.0

-Nil or zero.

Wood chips imported in Japan have been increasing each year but problems are anticipated with future chip supply. Producing countries tend to process raw material at home or even to impose an export tax, resulting in lack of confidence in both buyers and suppliers.

FORESTRY ORGANIZATIONS

Forestry Agency

The central forestry organization in Japan is the Forestry Agency, which is a branch of the Ministry of Agriculture, Forestry, and Fisheries. The Forestry Agency engages in both national forest management and administration of private forests.

The Forestry Agency engages in private forestry guidance, supervision, and assistance through the forestry department of prefectural governments. Both the Administration Department and Private Forest Department are in charge of private forest administration (Fig. 9). The Forestry Agency also controls and manages all national forests through the regional forest offices and district offices. The National Forest Department and Personnel Department look after national forest management (Fig. 10).

There are ten regional forest offices and 342 district forest offices and many more ranger offices and logging stations within the Japanese Forestry Agency. These offices are responsible for managing and controlling the national forests. Three National Forestry Research Institutes: Forestry, Forest Products, and Forest Tree Breeding conduct research and experiments concerning forests, forestry, forest products, and tree breeding and seedling problems.

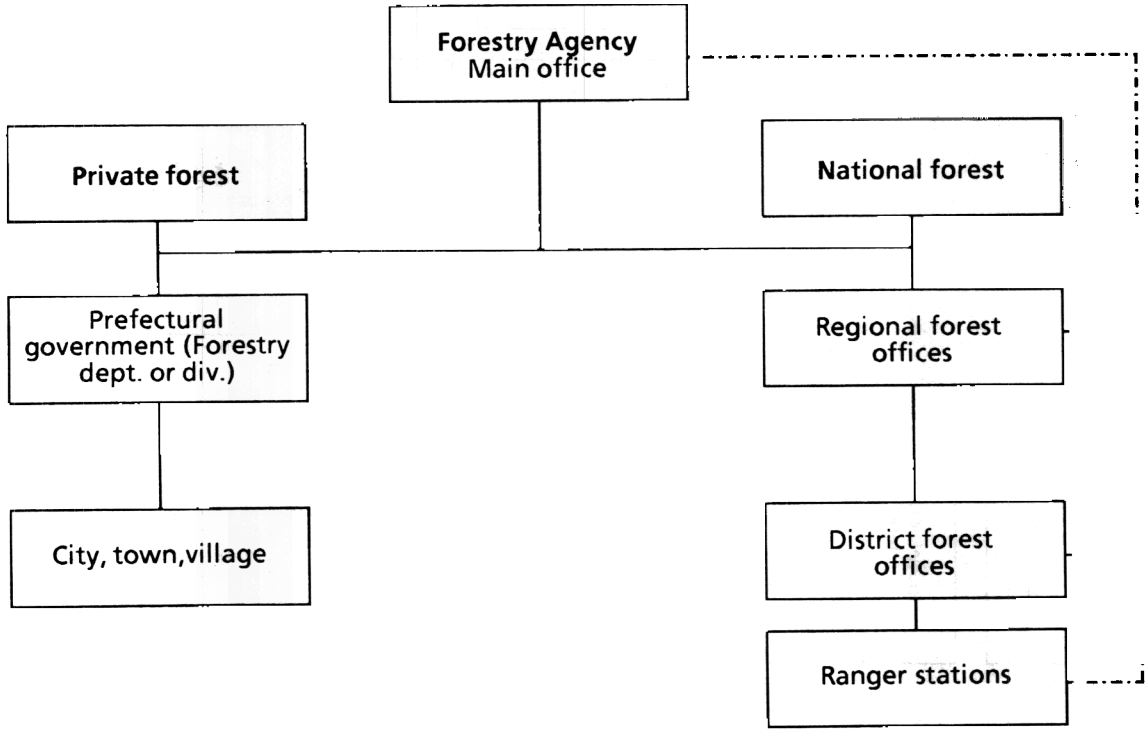


Figure 9. Forestry administration organization.

THE MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES

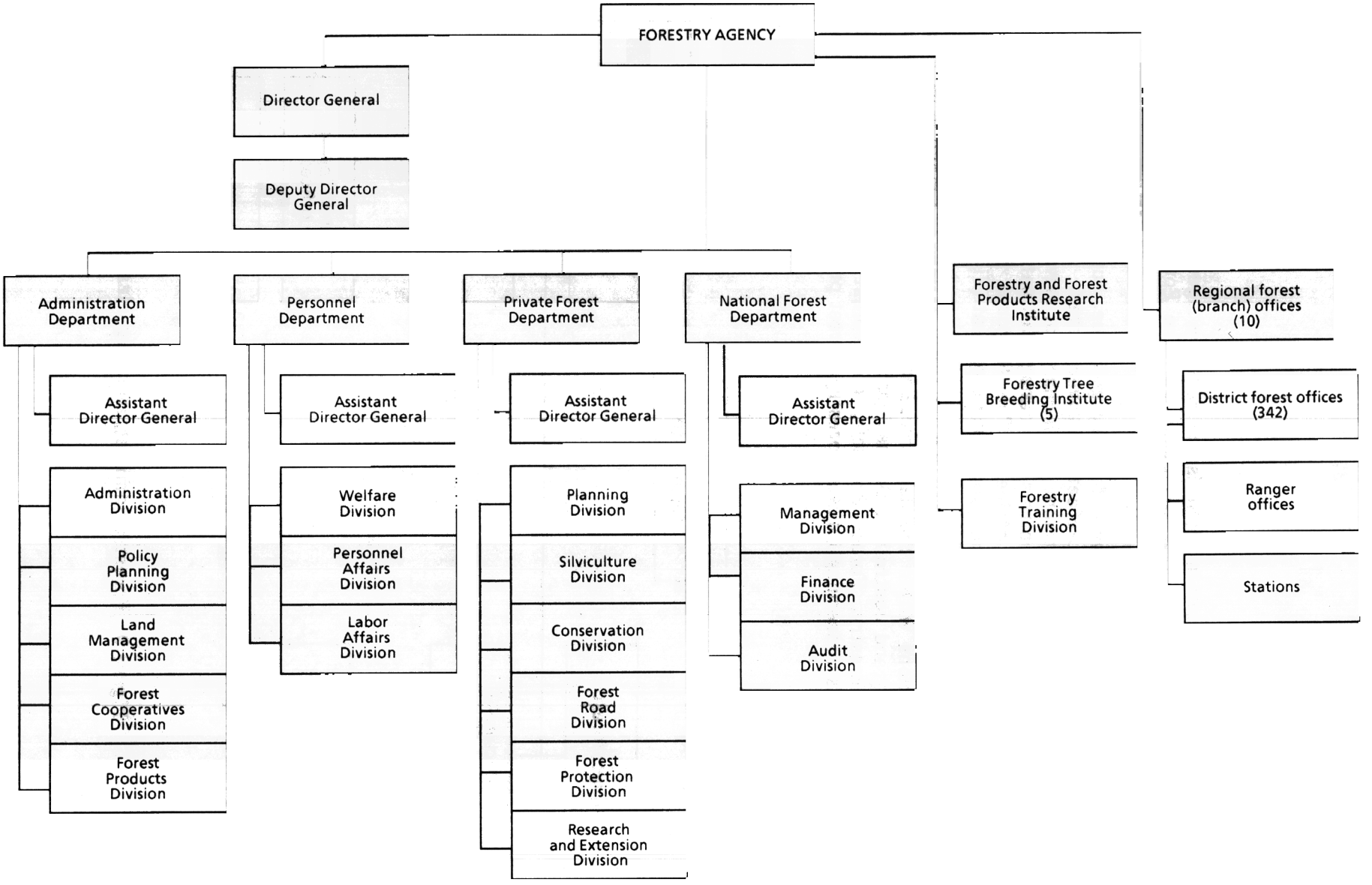


Figure 10. Organization of the Japanese Forestry Agency.

Forestry associations

There are now more than 2 000 private associations in Japan of which the Forest Owners' Association is the central body. The associations provide education in forest management, give aid for forest road construction, improve forestry operation systems, enhance the industry's socioeconomic status, and promote trade of lumber and other forest products.

Name of organization	Address	Postal Code
Forestry Agency	1-2-1 Kasumigaseki, Chiyoda-ku, Tokyo	100
Forest Experiment Station	Tsukuba Norinkenkyu-danchi, Ibaraki	305
Ministry of International Trade & Industry	1-3-1 Kasumigaseki, Chiyoda-ku, Tokyo	100
Agriculture, Forestry, and Fisheries Research Council	1-2-1 Kasumigaseki, Chiyoda-Ku, Tokyo	100
Water Resources Development Corporation	5-3-6 Akasaka, Minato-ku, Tokyo	107
Forest Development Corporation	Fukuda Bldg. 3-29 Kioi-cho, Chiyoda-ku Tokyo	102
Japan Soil Conservation & Flood Control Association	Nagatacho Bldg. 2-4-3 Nagata-cho, Chiyoda-ku, Tokyo	100
Japan Forestry Association	Nagatacho Bldg. 2-4-3 Hirakawa-cho, Chiyoda-ku, Tokyo	100
Japan Forest Road Association	Nagatacho Bldg. 2-4-3 Nagata-cho Chiyoda-ku, Tokyo	100
Water Utilization Research	1-7-22 Koraku, Bunkyo-ku, Tokyo	112
Forest Enterprisers' Association	Sankaido Bldg. 1-9-13 Akasaka, Minato-ku, Tokyo	107
National Forestry Extension Association	Sankaido Bldg. 1-9-13 Akasaka, Minato-ku, Tokyo	107
The National Parks Association of Japan	Denki Bldg. 15 Shiba Nishikubo, Akefune-cho, Minato-ku, Tokyo	105

Name of organization (Cont'd)	Address	Postal Code
All Japan Federation of Lumber Cooperatives	Nagatacho Bldg. 2-4-3 Nagata-cho, Chiyoda-ku, Tokyo	
Pulp and Paper Association	3-9-2 Ginza Higashi, Chuo-ku, Tokyo	103
Japanese Forestry Society	Nihon-Ringyo Gijitsu Kyokai Bldg. 7 Rokuban-cho, Chiyoda-ku, Tokyo	102
Japan Forest Technical Association	7 Rokuban-cho, Chiyoda-ku, Tokyo	
Japan Federation of Forest Owners' Association	Zenkoku-choson Kaikan, 1-11-35 Nagata-cho, Chiyoda-ku, Tokyo	
Japan Plywood Exporters' Association	Meisan Bldg. 1-18-17 Nishishinbashi, Minato-ku, Tokyo	105
Japan Timber Exporters' Association	Meisan Bldg. 1-18-17 Nishishinbashi, Minato-ku, Tokyo	
Japan Lumber Importers' Association	Yushi-kogyo kaikan, 3-13-11 Nihonbashi, Chuo-ku, Tokyo	103
The Japanese Association for Preservation of Birds	49 Nanpei-dai, Shibuya-ku, Tokyo	
Hokuyozai (Siberian wood) Importers' Association	Hokkai Bldg. 1-6 Nihonbashi-dori, Chuo-ku, Tokyo	103
Japan Plywood Inspection Corporation	Meisan Bldg. 1-18-17 Nishishinbashi, Minato-ku, Tokyo	

FORESTRY EDUCATION AND RESEARCH

Education and training

Forestry education in Japan is provided at universities and high schools, both of which are under control of the Ministry of Education. Of the 430 universities in Japan, 28 of them have forestry departments and, within these, 7 of them also have forest products departments for professional education (Table 14). Among them, 22 universities have a postgraduate master's course and 5 universities have a doctorate course. There are approximately 1 200 forestry students registered annually at universities.

High schools conduct ordinary and vocational courses. There are about 5 000 high schools in Japan of which 92 have forestry courses. The number of graduates from forestry-related high schools is 3 200 annually.

In addition, some local governments and private associations offer short courses providing technical assistance and information on practical forestry programs to forest owners, potential owners, and other groups interested in forestry.

The central government also provides training opportunities to people engaged in forest road construction and maintenance, erosion control, forest protection, tree breeding, afforestation, planning harvesting, and forest land development. These courses are offered once a year at the government training institute.

Tables 15-19 provide data on the number of students in university and high school as well as the number who received forestry training courses (Source: "Forestry and Forest Administration in Japan - National Progress Report on Forestry (1976-1980)" by Forestry Agency of Japan).

Table 14. Universities

Name of University	Address
Hokkaido University	Nishi 9 chome, Kita Kujo, Sapporo City
Iwate University	2-18-8 Ueda, Morioka City
Yamagata University	1-23 Wakaba-cho, Tsuruoka City
Niigata University	106 Kogane-cho, Niigata City
Utsunomiya University	350 Mine-cho, Utsunomiya City
Tsukuba University	1-1-1 Tennodai, Niihara-Gun, Sakura-Mura 3001-31, Ibaraki
Tokyo University	1-1-1 Yayoi, Bunkyo-ku, Tokyo
Tokyo Agriculture and Technical University	3-5-8 Saiwai-cho, Fuchu City
Tokyo Agriculture University	1-1-1 Sakuragaoka, Setagaya-ku, Tokyo
Tamagawa University	6-1-1 Tamagawa-Gakuen Machida 194, Tokyo
Nihon University	3-49 Shimo-uma-cho, Setagaya-ku, Tokyo
Shinshu University	Suburb of Ina City, Nagano Pref.
Shizuoka University	4300 Mitsuke, Iwata City
Nagoya University	Furo-cho, Chikusa-ku, Nagoya City
Gifu University	Naka-monzen-cho, Kagamihara City
Mie University	Uehama-cho, Tsu City
Kyoto University	Oiwake, Kita-shirakawa, Sagyo-ku, Kyoto City
Kyoto Prefectural University	1 Shimogamo Hangi-cho, Sagyo-ku, Kyoto City
Tottori University	1-1 Kozan-cho, Tottori City
Shimane University	1060 Nishi-Kawazu-cho, Matsue City
Okayama University of Horticulture and Gardening	Tsushima, Okayama City
Ehime University	118 Tarumi-cho, Matsuyama City
Kochi University	200 Monobeotsu, Nangoku City
Kyushu University	Hakozaki, Fukuoka City
Miyazaki University	100 Funatsuka-cho, Miyazaki City
Kagoshima University	1946 Kamiarata-cho, Kagoshima City
Ryukus University	Naha-City 903, Okinawa.

Table 15. Number of students in forestry-related universities (1980)

Department	National	Public	Private	Total	Remarks
Forestry	590	40	260	890	Source: Ministry of Education, 1980
Forest products	240			240	
Forest engineering	40			40	
Total	870	40	260	1 170	

Nil or zero.

Table 16. Number of students in forestry-related high schools (1979)

Department	National	Public	Private	Total	Remarks
Forestry		9 427		10 441	Source: Ministry of Education, 1979

.. Figures not available.

Table 17. Training of Forestry Agency staff related to national forests (1979)

Type of institute	Number of employees
Central forestry training institute	1 088
Regional forestry training institute	5 358
Total	6 446

Table 18. Training of prefectural government staff (1980)

Trainees	Number of employees
Forestry specialists	356
County agents	2 533
Others	673
Total	3 562

Table 19 shows the number of people who received training in their discipline in 1980. Through this training, forestry workers will keep their knowledge up-to-date and be able to cope with changing technology and evolving forestry strategy.

Table 19. Number of people who received various training (1980)

Operators of lumber processors	5 298	Senior operators of lumber processors	4 961
Yard operators	1 777	Yarder operators, safety controllers	1 513
Senior timber stackers	1 204	Chainsaw operators	7 624
Retraining for senior forestry cable-yarding engineers	1 589	Pre-test training for senior forestry cable-yarding engineers	1 070
Safety instructors and promoters	360		

Source: Imamura, K. 1981. *Human resources in Japanese forestry.*

Research

Research and experiments in forestry and forest products are conducted by the Forestry and Forest Products Research Institute, and prefectural and university forest experiment stations. Basic and applied research prevails at the national and university forest experiment stations. Indigenous and practical research are conducted by local forest experiment stations across the country.

The Forestry and Forest Products Research Institute was established in 1905. The headquarters is located at Tsukuba, the academic town in Ibaraki Prefecture near Tokyo. Several branch stations are located in the Hokkaido (Sapporo city), Tohoku (Morioka city), Kansai (Kyoto city), Shikoku (Kochi city), and Kyushu (Kumamoto city) regions of Japan.

Research is divided into six forest research divisions and three forest products research divisions. In the former, the programs relate to silviculture, forest productivity, management, mechanization, protection, forest influences, and forest soils. In the latter, forest product research work is conducted in wood utilization, wood technology, and forest product chemicals.

The Forestry and Forest Products Research Institute is the main organization responsible to the National Forestry Agency for its research and experiments. The Institute's budget for its research programs has been considered adequate with many significant leading projects in forestry and forest products that have been carried out satisfactorily. In addition, there has been frequent exchange of staff and cooperation with projects between the Institute and the universities.

The Japanese Government provided almost all the new facilities when the Institute was relocated to the Tsukuba Science City (60 km east of Tokyo) in 1978. All of the laboratories are well equipped with some of the most elaborate facilities for forestry and forest products research in the world.

The Institute has a total staff of approximately 750. Five hundred are listed as research officers (70% of these are university graduates, and half of them have doctorates). Four hundred are now at the Institute Headquarters and 350 in branch stations and the experimental forest.

FORESTRY PUBLICATIONS

The national research institutes, universities and governmental agencies publish their research or experimental reports several times a year. In the private forest industries, there are two types of forestry related publications, journals and newspapers published quarterly, monthly, or daily. Through these publications, knowledge can be updated and information can be exchanged. The following is a list of the principal forestry related publications and their publishers' addresses.

Forestry

1. ZENSHINRENJIHO (National Forestry Union Report), by ZENKOKU SHINRIN KUMIAI RENGOKAI (National Forestry Union Committee), 1-1-12 Uchikanda, Chiyoda-ku, Tokyo 101. Tel: 294-9711. Published every ten days.

2. GENDAIRINGYO (Modern Forestry), by ZENKOKU RINGYO KAIRYO FUKYU KYOKAI (National Forestry Improvement and Promotion Association), 1-9-13 Akasaka, Minato-ku, Tokyo 107. Tel: 582-3451, monthly.

3. RINGYO SHINCHISHIKI (New Knowledge of Forestry), by ZENKOKU RINGYO KAIRYO FUKYU KYOKAI (National Forestry Improvement and Promotion Association), address same as 2 above. Tel: 582-7451, monthly.

4. RINYA JIHO (Information on Forestry Agency), by RINYA KOSAIKAI, 1-7-12 Koraku, Bunkyo-ku, Tokyo 112. Tel: 816-2471-8, monthly.

5. KOKUDO RYOKKA (Greening of Nation), by KOKUDO RYOKKA SUISHIN IINKAI (Land Greening Promotion Committee), 2-7 Kirakawa-cho, Chiyoda-ku, Tokyo 102. Tel: 262-8451, quarterly.

6. RYOKKA TO NAIGI (Greening and Seedling), by ZENKOKU SANRIN SHUMYO KYODO KUMIAI RENGOKAI (Japan Forestry Seed and Seedling Union Committee), 4-9-9 Iidabashi, Chiyoda-ku, Tokyo. Tel: 262-3071, quarterly.

7. SHINRIN BOEKI (Forestry Prevention of Insects and Diseases), by ZENKOKU SHINRIN BYOGAICHU BOJYO KYOKAI, 1-1-12 Uchikanda, Chiyoda-ku, Tokyo 101. Tel: 294-9711, monthly.

8. NIHON RINGYO KAIHO (Japanese Forestry Journal), by NIHON RINGYO KYOKAI (Japanese Forestry Association), 2-4-3 Nagata-cho, Chiyoda-ku, Tokyo 100. Tel: 581-1338, monthly.

9. JIZAN RINDO KOOHO (Erosion Control and Forest Road Journal), by NIHON JIZAN KYOKAI (Japan Soil Conservation and Flood Control Association), 2-4-3 Nagata-cho, Chiyoda-ku, Toyko 100. Tel: 581-1902, monthly.

10. RINMOKU NO IKUSHU (Tree Breeding), RINMOKU IKUSHU KYOKAI (Tree Breeding Association), 6-7 Chiyoda-ku, Tokyo 102. Tel: 261-3433, bimonthly.

Forest products

1. MOKUZAI JYOHO (Lumber Intelligence), by NIHON MOKUZAI BICHIKU KIKO (Japan Timber Products Storage Organization), 1-7-12, Koraku, Bunkyo-ku, Tokyo 112. Tel: 816-5595, monthly.

2. MOKUZAI KOGYO (Lumber Industry), by NIHON MOKUZAI KAKO GIJUTSU KYOKAI (Japan Lumber Processing and Technical Association), 5-12-10, Shibakoen, Minato-ku, Tokyo 105. Tel: 432-3053, monthly.

3. MOKUZAI HOZON (Lumber Preservation), by NIHON MOKUZAI HOZON KYOKAI (Japan Lumber Preservation Association), 584-1-9-13, Akasaka, Minato-ku, Tokyo 107. Tel: 584-0913 or 584-6810, quarterly.

4. KAMIPA GIKYOSHI (Pulp and Paper Journal), by KAMI PARUPU GIJUTSU KYOKAI (Pulp and Paper Technical Association), 3-4, Ginzahigashi, Chuo-ku, Tokyo 104. tel: 541-8204, monthly.

5. MOKUZAI SHINBUN (Lumber Newspaper), 3-10-9 Irifune, Chuo-ku, Tokyo 104. Tel: 553-5411, daily.

6. HOKKAIDO MOKUZAI SHINBUN (Hokkaido Lumber Newspaper), Nishi 6 Chome, Kita 22 jo, chuo-ku, Sapporo, Japan 060. Tel: 011-721-0423, daily.

ECONOMIC DATA

Japan is not well endowed with natural resources in comparison to Canada, expecially in relation to density of population. Because forest resources are no exception, the forest industry is heavily dependent on imported raw material. Based on the promotion of manufacturing industries for export products, Japan has achieved and maintained a high rate of economic growth for the last decade.

Gross national product (GNP) grew at an average annual rate of 10.3% betwen 1962 and 1972. In 1971, Japan's GNP was the second largest in the western world, ranking next to the USA. In 1981 the GNP was Can $ 1,351 billion (1982-12-10, *Globe and Mail*). The 1979-85 economic plan predicted an average annual growth rate of 5%.

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APPENDIX 1

Forest products data

1. Production of forest products by commodity aggregate and quantity (1981).

Commodity aggregate[a]	Quantity[b]
Roundwood, fuelwood, and charcoal (1 000 m^3)	609
Industrial roundwood (1 000 m^3)	
Sawlogs, veneer logs	19 979
Pit props	329
Pulpwood, chip particles, and wood residues	11 283
Other industrial roundwood	972
Total industrial roundwood	32 563
Coniferous	20 427
Nonconiferous	12 136
Sawnwood and sleepers (1 000 m^3)	36 962
Wood-based panels (1 000 m^3)	9 082
Wood pulp (1 000 t)	7 897
Paper and paperboard (1 000 t)	17 913

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a Roundwood, chipped material, and products of mechanical wood conversionare expressed in terms of solid volume. All pulp and paper products are expressed in terms of air-dried tonnes.

b FAO figure.

APPENDIX 1 (Cont'd)

2. Imports and exports of forest products by commodity aggregate and quantity (1981)

Commodity aggregate[a]	Imports	Exports
Roundwood		
Fuelwood and charcoal (1 000 m^3)	310	0
Industrial roundwood (1 000 m^3)		
Sawlogs, veneer logs	28 381	22
Pit props	2	0
Pulpwood, chips, particles and wood residues	13 604	0
Other industrial roundwood	28	10
Total industrial roundwood	42 015	32
Total roundwood (1 000 m^3)	42 325	32
Sawnwood and sleepers (1 000 m^3)	3 898	51
Wood-based panels (1 000 m^3)	166	170
Wood pulp (1 000 t)	1 687	105
Paper, paperboard, others (1 000 t)	602	786

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a Roundwood, chipped material, and products of mechanical wood conversion are expressed in terms of solid volume. All pulp and paper products are expressed in terms of air-dried tonnes.

APPENDIX 1 (Cont'd)

3. Imports and exports of forest products by commodity aggregate and value (1981).

Commodity aggregate	Imports	Exports
Roundwood	(US$ 1,000)	
Fuelwood and charcoal	11,498	0
Industrial roundwood		
Sawlogs, veneer logs, and logs for sleepers	3,628,587	4,881
Pit props	120	0
Pulpwood, chips, particles, wood residues	782,693	0
Other industrial roundwood	3,945	1,909
Total industrial roundwood	4,415,345	6,790
Total roundwood	4,426,843	6,790
Sawnwood and sleepers	782,085	27,324
Woodbased panels	36,787	80,808
Wood pulp	846,295	44,618
Paper, paperboard, others	406,267	708,705
Total forest products	6,498,277	868,245

APPENDIX 1 (Cond't)

4 Imports of forest products by commodity aggregate and quantity (1981)

Exporters	Quantity (1 000 m^3)
Sawlogs and veneer logs (coniferous)	
USA	8 012
USSR	4 815
New Zealand	497
Canada	595
Chile	40
Indonesia	242
Total	14 201
Sawlogs and veneer logs (nonconiferous)	
Malaysia	8 613
Indonesia	3 767
Philippines	1 437
Papua New Guinea	495
USA	25
Ivory Coast	3
Cameroon	29
Gabon	1
Total	14 370
Pulpwood	
USSR	766
Indonesia	36
Total	802

APPENDIX 1 (Cont'd)

4. Imports of forest products by commodity aggregate and quantity (1981).

Exporters	Quantity (1 000 m^3)
Chips and particles	
Australia	5 851
USA	5 832
Canada	468
New Zealand	487
USSR	552
Malaysia	284
Papua New Guinea	87
Total	13 561
Sawnwood (coniferous)	
Canada	2 047
USA	1 195
USSR	122
Total	3 364
Sawnwood (nonconiferous)	
Philippines	136
Malaysia	89
Indonesia	99
USA	36
Singapore	22
Canada	6
Brazil	4
Total	392

APPENDIX 1 (Cont'd)

4. Imports of forest products by commodity aggregate and quantity (1981).

Exporters	Quantity (1 000 m^3)
Wood pulp	
Canada	727
USA	559
New Zealand	232
Brazil	165
Sweden	28
Finland	22
Chile	4
Others	8
Total	1 745
Veneer sheets	
Philippines	3
Malaysia	1
USA	1
F.R.G.	2
Total	7
Paper and paperboard (excluding newsprint)	
USA	250
Canada	52
Sweden	16
F.R.G.	7
UK	3
Norway	2
France	1
Total	331

APPENDIX 1 (Cont'd)

5. Exports of forest products by commodity aggregate and quantity (1981).

Paper and paperboard (excluding newsprint)

Destination	Quantity (1 000 t)
China	183
Malaysia	28
Hong Kong	146
Iran	4
Australia	39
F.R.G.	16
Belgium-Luxembourg	6
France	10
USA	7
Switzerland	4
UK	2
Netherlands	2
Italy	2
Canada	1
Others	200
Total	650

APPENDIX 2

Abbreviations, symbols, and conversion factors

Abbreviations

a.s.l.	above sea level
c.i.f.	cost, insurance, and freight
DBH	Diameter at breast height
EDF	estimated derived fellings
FAO	Food and Agriculture Organization of the United Nations
f.o.b.	free-on-board
F.R.G.	Federal Republic of Germany (West Germany)
GAI	Gross Annual Increment
GATT	General Agreement on Tariffs and Trade
G.D.R.	German Democratic Republic (East Germany)
GDP	gross domestic product
GNP	gross national product
GS	growing stock
IDA	International Development Agency
IFC	International Finance Corporation
IMF	International Monetary Fund
MAI	Mean annual increment
NAI	Net annual increment
o.b.	over bark
OECD	Organization for Economic Cooperation and Development
SI	The International System of Units (le système international d'unités)
u.b.	under bark (solid wood)
U.K.	United Kingdom of Great Britain and Northern Ireland
UN	United Nations
UNESCO	United Nations Educational Scientific and Cultural Organization
USA	United States of America
USSR	Union of Soviet Socialist Republics

APPENDIX 2 (Cont'd)

Symbols

a	annum
ha	hectare(s)
km	kilometre(s)
km^2	square kilometre(s)
m	metre
m^2	square metre(s)
m^3	cubic metre(s)
t	tonne(s) or metric ton(s)
°C	degree(s) Celsius
/	per

Conversion factors (SI to English units)

1 ha	= 2.471 05 acres
1 km	= 0.621 371 mile
1 km^2	= 0.386 102 square mile
1 m	= 3.280 84 feet
1 m^2	= 10.763 9 square feet
1 m^3	= 35.314 7 cubic feet
	= 0.353 147 cunit (of 100 cubic feet of solid wood)
1 m^3/ha	= 14.291 3 cubic feet/acre
1 mm	= 0.039 370 inch
1 t	= 1.102 31 tons (of 2 000 pounds)

Conversion factors (over-bark volume to under-bark or solid-wood volume):

Coniferous	0.85
Nonconiferous	0.88

APPENDIX 3

Definitions of terms

These definitions are, for the most part, similar to those used in Reidar Persson's World Forest Resources: Review of the World's Forest Resources in the Early 1970's, published in 1974 as Research Note No. 17, Department of Forest Survey, Royal College of Forestry, Stockholm, Sweden. Several others included here are those used by the FAO and ECE.

Closed forest:

Land with a "forest cover," i.e. with trees whose crowns cover more than 20 % of the area, and which is used primarily for forestry purposes.

Also includes:

(a) Forests in which trees have been temporarily removed by cutting or burning so that not more than 20% of the area is covered by tree crowns. Also included are young natural stands and all plantations, including one-rotation plantations, established for forestry purposes which have not yet reached a crown density of more than 20%.

(b) Areas of windbreak and shelterbelt trees sufficiently large to be managed as forest.

(c) Land under shifting cultivation which is expected to return to forest in the foreseeable future. Exceptions are those areas being prepared or used for agricultural crops.

(d) Areas satisfying the conditions of the definition, even if not under forest administration, e.g., all forests on private land.

(e) Areas satisfying the conditions of the definition but which are to be converted into other land utilization categories.

Excludes:

(a) Isolated tree groups smaller than 0.5 ha

(b) Land under shifting cultivation which is being prepared or used for agricultural crops or which is unlikely to return to forest in the foreseeable future.

NOTE: In running text, "forest" may be used instead of "closed forest."

Commercial (merchantable): that which can be economically removed under given conditions.

APPENDIX 3 (Cont'd)

Exploitable forest: forest in which industrial cuttings have occurred or could occur periodically. This implies at least one industrial cutting during a rotation period.

Forest and other wooded land: land covered with trees and/or shrubs and not used primarily for agriculture or other nonforestry purposes.

Includes:

(a) Public and private forest and other wooded land

(b) All plantations, including one-rotation plantations (primarily used for forestry purposes) and wattle plantations

(c) Forest roads, streams, other small open areas, and forest nurseries, which cannot readily be excluded by the survey system used

(d) National parks.

Excludes:

City parks and gardens

Areas occupied by fruit or nut orchards, and plantations of nonforestry crops, e.g., rubber and cinchona

(c) Wooded pastures and range lands

(d) Areas not meeting the conditions of forest and other wooded land as described above, even if administered by forestry authorities.

Gross annual increment: average volume of annual increment of all trees.

Growing stock: volume of standing trees (all species, all diameters, and measurable at breast height) including bark. Species which do not attain upright trunk forms (brush, etc.) are not considered trees.

APPENDIX 3 (Cont'd)

Man-made forests:

(a) Afforestation: forests artificially established on land which had not been forested within the previous 50 years (when records exist) or within living memory (when no records exist).

(b) Reforestation: forests established artificially on land which had been forested within the previous 50 years or within living memory.

Mean annual increment: the total increment up to a given age divided by that age.

Net annual increment: average annual net increment equals gross increment minus natural losses.

Nonstocked forest: forest in which temporarily less than 20% of the land area is actually covered by tree crowns.

Open woodland: land, other than forests, with tree crowns covering 5-20% of the area. The land is not used primarily for agricultural or other nonforestry purposes (such as grazing of domestic animals). In Europe and other temperate regions, scrub, brushland, forest nurseries, seed orchards, areas occupied by trees in lines, and shelterbelts are included in this category.

Protection reserves: Land reserved principally for the protection of natural resources, fauna and flora, or for other purposes not related to the production of wood (e.g., parks, watersheds, soil conservation, etc.).

Removals: fellings (or cuttings) less harvesting losses.

Scrub and brushland: residual category because these areas may have some forestry characteristics in their vegetation or administrative status.

Stocked forests: forest in which 20% or more of the land area is actually covered by tree crowns.