Poland's once-considerable forest resource suffered destruction during World War II and is now a victim of the legacy of past forestry practices, the toxic effects of industrial pollution, and the urgent needs of its people today. Economically and culturally, however, the forests of this largely lowland country remain important to the Polish, and better forestry management promises higher productivity and conservation values.

**History Lessons**

Poland's forests vary greatly in quality and maturity because of the nature of the afforestation that followed World War II. Enormous damage had been inflicted by the Nazis, who cut nearly 200 million m³ to support the Axis powers' war effort—perhaps three times what could have judiciously been harvested. Then regeneration, afforestation, and maintenance were neglected; soil loss occurred; forestry infrastructure was destroyed; and forests fell victim to insect infestation and fire. The chaos created by the invasion and occupation caused other long-term problems as well, such as the destruction of the forestry educational system and the dispersion of competent technical staff. In the immediate postwar years, local administration of forests was commonly entrusted to people unqualified for their positions.

Substantial effort and resources were needed to restore the forest resource. The devastated country had few resources to invest, however, and essential rebuilding caused further exploitation of the forest. Political reorganization created some opportunities to redefine forest management. Nationalization of all private forestlands above 25 hectares (ha) brought about 85 percent of all forestlands under state control.

Soon after the war, the newly created Ministry of Forestry began the labor-intensive effort of afforestation, which included planting unproductive farmland and wastelands, allowing the natural succession of trees and shrubs, and settling land tenure and ownership issues. Although the area covered by forest today is somewhat less than the European average of 32 percent, the current figure of 28 percent represents an increase from the 1945 figure, 21 percent. Moreover, forestland is projected to reach 30 percent by 2020 and 33 percent by 2050, largely because of the afforestation of low-productivity agricultural lands.

Most of the afforestation was accomplished between 1957 and 1966, in both state and private forests. Scotch pine was planted throughout Poland, except in the mountains, and Norway spruce was planted in mountains and the northeast. Between 10,000 and 16,000 Scotch pine seedlings per hectare and 4,000 to 6,000 Norway spruce seedlings per hectare were planted. In total, 1.2 million ha was turned into forest. In many cases the seedlings were taken from other regions of Poland, and so there are huge pure stands of inappropriate species. Such decisions compromised the natural resistance of Polish forests.

**Toxic Threats**

The Polish forests are threatened by a variety of abiotic, biotic, and anthropogenic factors. Because Poland is on the border between continental and maritime climates, extreme temperatures, powerful winds, and severe frosts can damage its forests. Declining groundwater levels because of precipitation deficits are also a problem.

The homogenous species structure of Poland's forestlands predisposes the trees to outbreaks of insects and fungi, especially epiphytic diseases. The nun moth (*Lymatricia monacha*) is the most serious pest of Polish coniferous forests. In 1962, this moth occurred on an area of 160,000 ha; by 1994 it was necessary to fight this insect on 757,000 ha. Other insect pests of conifers include the pine moth (*Dendrolimus pini*), sawflies (*Diprion sp.*), and pine noctuid (*Panolis flammea*). The most significant insect in deciduous stands, especially oaks, was green tortrix (*Tortrix viridiana*). Other invaders that weaken stands are the eight-toothed bark-beetle (*Ips typographus*) and the large pine-shoot beetle (*Phaenops cyanea*).

The most serious threat to Poland's forests, however, is pollution. Contamination of air, water, and soil is widespread throughout Europe, and the proximity of countries with divergent national policies creates problems. Although most western European countries have reasonably compatible environmental laws, the eastern countries have historically demonstrated less sensitivity to pollution. The unification of Germany and the rapid shift of Poland and Hungary to market economies have brought those former East Bloc countries...
more in line with Western thinking. Other eastern European nations have not followed suit, however. The Czech Republic and Slovakia, for example, with only marginal control of industrial and automobile pollution, are primary contributors to environmental problems in a large area of Europe. Today, it is estimated that at least 40 percent of the contaminants in Poland’s air originates in neighboring countries.

Problems of forest health are particularly important because of the central role forests play in the economic, cultural, and social lives of Europeans. Gathering mushrooms and berries in the forest is still popular throughout Europe, and hunting wild boar, elk, deer, and reindeer is a thousand-year-old Polish tradition. Cultural issues aside, forests are important as habitat for wildlife, a source of fiber, and a reservoir for soil and water.

Much of the air pollution in Poland is attributable to mining and burning high-sulfur coal. Sulfur and nitrogen in particular affect all ecosystem components, initiating disease processes and causing forest decline. Excessive amounts of sulfur, nitrogen, and fluorine compounds in the soil have had a devastating effect in many sections of the country. The most affected species are silver fir and Norway spruce. Broadleaved species and Scotch pine are substantially less affected, and beech (Fagus silvatica) is the most resistant species. Stand damage in the country has worsened since 1993, and only Moldavia and the Czech Republic have higher damage levels than Poland.

Damage to forests from pollution is measured by comparing morphological changes in the leaves and needles of trees in both polluted and relatively contamination-free regions. Forests in the south and west (nearest eastern Germany and the Czech Republic, respectively) show the most severe damage. Some stands have lost approximately 75 percent of their foliage. Grasses and other plants provide additional evidence of contamination.

Of particular concern to researchers and government administrators is the spread of such damage. Mountain areas in the south are particularly vulnerable. Despite progress in small areas, many of the already contaminated regions are expected to suffer more damage, and by 2000 about half of Poland’s forest resources could be affected.

In the past several years Polish citizens have applied political pressure to policymakers and forced several major industrial facilities in the region near Jelenia Góra to close; local economic hardship has been the unintended consequence. Research by state organizations and external organizations, including the United Nations International Development Organization, has resulted in copious documentation of pollution but little action.

**State Control**

Of the approximately 8,720,000 ha of forestland in Poland, about 7,229,000 ha is under state management, primarily the Ministry of Environmental Protection, Natural Resources, and Forestry (successor to the postwar Ministry of Forestry). Approximately 6,833,000 ha is used for numerous state forest enterprises, 144,000 ha constitutes national parks, and 175,000 ha is devoted to other enterprises. Of the forests not managed by the state, 1,380,000 ha is in private ownership, 71,800 ha is owned by local municipalities, 44,000 ha is in commons, 26,800 ha is controlled by cooperative farms, and 2,800 ha belongs to farming organizations.

Virtually all the privately owned forests are of marginal quality and have low silvicultural value. Woodlots in Poland are very small—an average of only one hectare. Provinces with the highest rate of private ownership also have the lowest forest cover rate and thus the least protection of watersheds.

Relaxation of regulations has encouraged such practices as uncontrolled fellings and a decrease in afforestation, regeneration, and silvicultural thinnings. Investment in forests has become less attractive to landowners, and with the poor economy, owners engage in behavior contrary to judicious forest stewardship.

Because of many environmental factors, softwood forest maturation in Poland requires approximately 100 to 130 years. Most of Poland’s forests, however, are very young. The mean stand age is 53 years in Poland’s state forests and 36 in the private forests. Forty-year-old stands prevail, occupying 41 percent of the forest area. The proportion of stands older than 80 years—currently 16 percent—is increasing, however.

Growing stock was 1,513,000,000 m$^3$ in early 1995—an increase over previous years attributable to changes in the age structure of stands and the practice of sustainable harvesting on state land. Nevertheless, the stand volume is lower than that possible from natural conditions of the forest sites because of air pollution, inefficiencies in land use, and excessive harvesting in past years.

The 1991 Act on Forests set new priorities in Polish forestry:

1. Maintaining forests and their positive effects on the environment.
2. Protecting forests, particularly natural parks, with valuable genetic, scientific, and landscape values.
3. Protecting soil, particularly endangered terrains.
4. Producing timber and other forest products.

Although timber production is the lowest priority, according to the act, Poland’s forests must nevertheless meet numerous and diverse societal demands. The country’s Plan of Forest Management is reevaluated every 10 years or when ecological disasters, windstorms, or threats from insects and diseases warrant. Each plan describes the forests and lands slated for afforestation and defines future management goals, such as the level of timber harvesting, estimated annual cutting capability, afforestations and regenerations, game management, and infrastructure. Management of state

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**Table 1. Comparison of state and private forests in Poland.**

<table>
<thead>
<tr>
<th>State forests</th>
<th>Mean growing stock</th>
<th>Mean annual increment</th>
<th>Mean stand age</th>
</tr>
</thead>
<tbody>
<tr>
<td>194 m$^3$/ha</td>
<td>3.6 m$^3$/ha</td>
<td>53 years</td>
<td></td>
</tr>
<tr>
<td>Private forests</td>
<td>107</td>
<td>2.9</td>
<td>36</td>
</tr>
</tbody>
</table>

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30 February 1997
forests is executed by a department of State Forests Husbandry.

The Act on Forests applies regardless of landownership, so forest management is prescribed for private owners, communes, and rural communities, too. Given the very poor economic situation of private owners, however, the regulations are often ignored. Overharvesting and the removal of the most valuable trees take place, often illegally. The quality of private stands is therefore generally poor. Various inadequacies—lack of well-educated forest staff, insufficient money in provincial offices, inability to fine private owners—hinder sustainable forest management in private forests.

State-controlled forestlands are divided into three categories:

- Reserve forests contain national parks, wildlife reserves, and other lands devoted to maintaining biodiversity and other ecological considerations.
- First-group forests are managed for socially important functions, such as soil and water conservation, recreation, and aesthetics. Occasional harvesting is permitted only to advance the main land-use aim.
- Second-group forests are managed for sustained yield of raw materials. These forests produce the fiber that is needed to sustain the national economy.

The harvesting system is determined in a site-specific fashion. Clearcutting is often used because it promotes favorable conditions for artificial regeneration of coniferous forests. On richer forest sites shelterwood cutting is often employed. Strip-and-group cuttings are employed when appropriate. Improving the quality and quantity of wood is a primary goal. Periodic thinnings, sanitation cuts, and planting of undergrowth on marginal soils are commonly used techniques.

In recent years management practices have changed to address environmental pollution. Severely diseased trees will be harvested and replaced with species that are more tolerant of acidic conditions and able to alter soil chemistry. Managers expect that the hardwoods being planted will lead to higher retention of calcium, potassium, and magnesium in

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the soil and thus raise pH.

Because timber is the main economic product from Polish forests, harvest plans must be prepared years in advance and executed carefully. Forest measurements are made, and the Bureau of Forest Management and Geodesy, on the basis of stand measurements, works out the harvest plans for each forest division. The head forester determines the size for cuttings, and foresters evaluate the quantity and quality of available timber. All timber harvested in the Enterprise State Forests is sold in the following ways:

Contract sales proceed on the basis of a written contract between seller and buyer. Depending on how much is being purchased, the contract is signed by the head forester, regional director, or if the sale is large enough, general director. This kind of sale constitutes 85 percent of all sales in the state forests.

Auction sales put up for bid the best-quality timber on the state forests—perhaps 10 percent of all sales. Oak for top-quality veneer and plywood is sold this way.

Stumpage sales are fairly uncommon in Poland. Only about 5 percent of all harvested trees are sold this way, particularly in terrains with difficult accessibility.

**Forest Products**

Poland is not a major factor in international forest-products trade. Among the country's forest products are resins from pine and other species, bark, stump-wood, needles, leaves, wicker, fruits, medicinal and industrial herbs, mushrooms, animal products, and—most important—wood.

Demand for wood products is growing despite the increasing use of new, nonwood products. The markets for pulp, paper, and construction materials are dominant. In addition, the coal mines in Poland have created a large market in mining timbers: approximately 10 to 12 cubic meters of timber is needed to provide structural support for each thousand tons of coal extracted from Polish mines. Large volumes of wood are also used in the furniture and shipbuilding industries.

The state sawmill industry now owns about 95 percent of all processing facilities, but there are still family sawmills that process small quantities of timber. Big customers buy the timber from regional directorates of the state forests, accounting for approximately 4 million m^3^ of the annual timber production. Total demand is about 9 million m^3^ per year. The growth in demand for raw wood in Poland has spurred interest in importing timber, but transportation costs preclude imports from countries that are not adjacent to Poland.

Before 1990, the pulp and paper mills purchased about 80 percent of the conifer pulpwood and 60 percent of the hardwood pulpwood produced domestically. Pulpwood has been imported into Poland for many years, and today some pulpwood is imported from Germany and the former Soviet Union. Although many plants have folded, the surviving pulp industry has increased production, and recently, the industry has processed 3.5 million m^3^ of pulpwood per year. Demand in 1995 rose to approximately 4.8 million m^3^.

Another 2 million m^3^ of pulpwood is processed into composite board and other wood-based products. The composite board industry has experienced rapid growth as a result of increased investments. Demand in 1995 was about 2.5 million m^3^ and is expected to increase to 3.5 million m^3^ per year in the near future.

The plywood industry has experienced stable levels of product demand and raw material supply. Demand for plywood and veneer is assessed at about 300,000 m^3^ per year.

Lumber for construction comes in random lengths with only two visual grades. Though stress-grading machines can be found in some Polish sawmills, these machines see infrequent use: the small demand for machine-graded lumber combined with the high license fees for grading equipment makes machine-graded lumber unattractive. The design of wood structures is thus limited, but the lack of such lumber also precludes the production of glue-laminated (glulam) wood. The single glue-laminating facility in Poland can produce 10,000 m^3^ of structural glulam per year—enough to satisfy the entire domestic market for glulam. Both straight and curved sections are produced, and the products have performed well in service.

The average consumption of all kinds of board in Poland equals 55 m^3^ per 1,000 inhabitants. In Europe it amounts to 88 m^3^ per 1,000. Paper consumption in Poland is only 35 kg per inhabitant per year—one of the lowest per capita consumption rates in Europe and a mere tenth of US consumption.

The main trend in Poland will be production growth to the full capacity of plants—requiring a 21 percent production increase per year until 2000. To achieve that goal, the many sawmills using obsolete equipment will need to renovate their machining and seasoning infrastructure. Only about half of all state plants can be considered modern.

State forests supply approximately 20 million m^3^ of sawlogs per year. Despite the growing forest economy and the increase in forestland, however, it will be difficult to maintain this yield as environmental pollution spreads to previously unaffected regions and forestlands are reallocated to other uses higher on the nation's social agenda. Moreover, imports of round wood (mostly coniferous species) are relatively small because of strict phytosanitary controls, customs regulations, and the state tax system. The large number of young stands represents opportunity, however, as do residual wood and diseased trees.

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