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The Forest Inventory System in Russia

A Wealth of Data for Western Researchers

By Yuri A. Kukuev, Olga N. Krankina, and Mark E. Harmon

Scotch pine *(Pinus sylvestris)* is one of the most prevalent tree species in Russia. This mature stand is growing on a forest plantation in the northwestern part of the country, near St. Petersburg.

The forested area in Russia is the largest of any country in the world and therefore plays a crucial role in a wide range of global environmental and economic issues, from timber supply to biotic responses to climate change. Forty-five percent of Russia is covered by closed forest stands, which constitute more than 20 percent of the world's forested area and about 50 percent of all boreal forests (FAO 1995).

Most forests in Russia belong to the boreal conifer type, also known as taiga; the belt of taiga is more than 2,000 kilometers wide in eastern Siberia *(fig. 1, p. 16).* South of the taiga are a zone of mixed hardwood stands in the west and a belt of dry forest–steppe vegetation that runs across Europe-Urals and West Siberia. Temperate mountain hardwoods and conifers can be found in the northern Caucasus. From north to south the climate changes significantly, and from west to east the precipitation decreases and the climate becomes less maritime and more severely continental. Russian forests are dominated by a limited number of coniferous tree species *(table 1, p. 17).*

Because of their size and location, Russian forest resources are difficult to inventory. Initial attempts to measure timber stocks were made on state forestlands in the 18th century, when forests products first became an industrial commodity in Russia. Systematic forest inventory work started in the mid-19th century and has developed and expanded ever since (Zagreev et al. 1991). With information on Russian forests, English-speaking scientists and resource managers can consider potential applications of these data, from timber market projections to mitigation measures for climatic change.

The Nationalized Survey System

In its current form the Russian inventory system is handled by the state, which nationalized all forestlands in 1918. That year, the Decree on Forests proclaimed that forests were the property of the citizens. Eventually a uniform, countrywide forest inventory system was instituted to meet the information demands of the centrally planned forest industry (Krankina and Dixon 1994). Despite all the recent economic and political changes in Russia, forestlands are still owned by the state (94 percent are managed by the Federal Forest Service), and the state forest inventory system is being maintained.

The system for forest inventory in Russia was given statutory definition by the Fundamental Forestry Legislation of the Russian Federation, adopted in 1993. Its objective is to supply all levels of the state forest management—the Federal Forest Service, regional forest management departments in the 89 administrative regions, 1,800 forest management enterprises (FME), and about 10,000 ranger districts—with reliable data on forestlands.

Information is gathered using either detailed forest surveys developed for long-term forest management plans or simplified forest surveys. The data are then updated annually and every five years from reports on timber harvest and natural disturbances. Forest inventory data correspond to the management level: detailed information is required for site-specific planning, but at the regional and national levels, summary data suffice for general planning and assessments.

Detailed surveys. Detailed forest surveys cover all forests that are relatively accessible and those where development is planned *(fig. 2),* which amounts to 670.2 million hectares, or about 60 percent of all forests under state forest management. This type of inventory has been performed within the last 10 years on 72 percent of these lands; 19 percent were surveyed 11 to 15 years ago, 7 percent were surveyed 16 to 20 years ago, and 2 percent more than 20 years ago. The surveys are conducted by 13 regional forest inventory

Figure 1. **Russia's four geographic regions form longitudinal segments: Europe-Urals, West Siberia, East Siberia, and the Russian Far East. The forests of Europe-Urals, the most densely populated and economically developed part of Russia, constitute 26 percent of the total forest area and have been intensively harvested for many decades (Anuchin et al. 1985). East of the Ural Mountains, forests in Siberia and the Russian Far East occupy an area the size of the continental United States. These are largely natural forests at different stages of recovery after wildfires, with nearly half in mature and overmature stands (Anonymous 1990). Management activities are limited to lands around major population centers.**

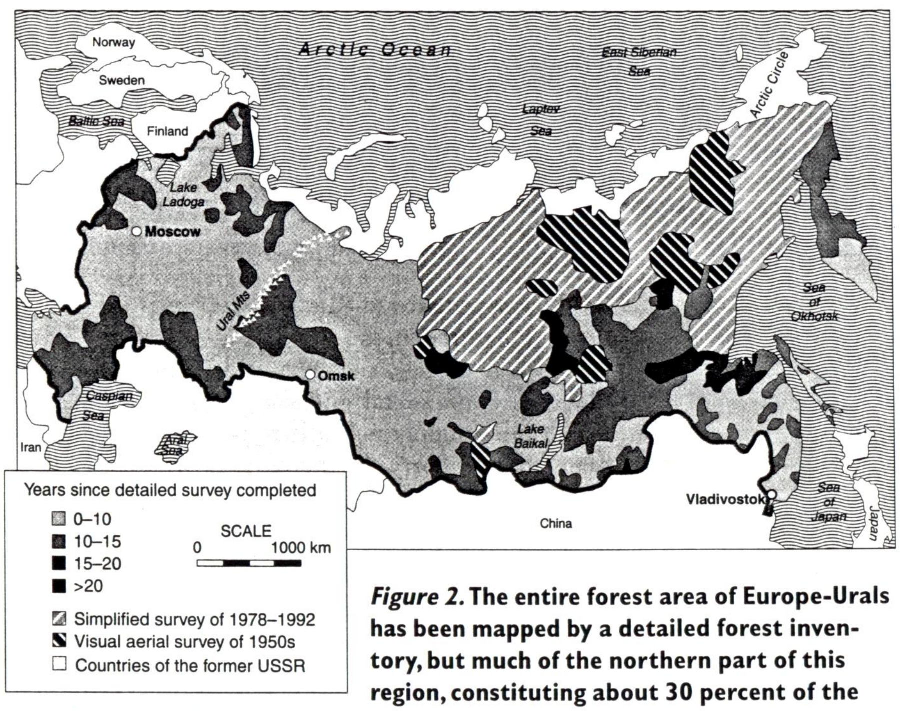

Figure 2. **The entire forest area of Europe-Urals has been mapped by a detailed forest inventory, but much of the northern part of this region, constituting about 30 percent of the total, is overdue for a new survey because it does not meet current accuracy requirements. Forest inventory data for the Asian part of Russia also do not meet the current needs of forest management and forest monitoring. Only 53 percent of this region's total forestland is covered by detailed forest inventories, many of them outdated. The remaining 47 percent was inventoried by simplified survey methods.**

Table 1. Dominant tree species in the regions of Russia, in millions of hectares and percent of total forest (Anonymous 1990). Data on dominant tree species are available only for the forestlands managed by the Russian Federal Forest Service (87.5% of the total forest area).

	Europe-Urals		West Siberia		East Siberia		Far East		Total	
Scotch pine *(Pinus sylvestris)*	40.7 ha	24%	28.7 ha	30%	32.1 ha	13%	12.0 ha	3%	113.6 ha	13%
Spruce (*Picea* sp.)	47.3	27	5.4	6	12.4	5	13.7	4	78.8	9
Fir (*Abies* sp.)	0.7	<1	3.8	4	9.4	4	1.8	1	15.7	2
Larch (*Larix* sp.)	0.4	<1	5.9	6	102.8	40	168.8	47	277.6	31
Cedar pine *(Pinus sibirica)*	0.7	<1	12.5	13	23.5	9	3.1	1	40.1	5
Birch (*Betula* sp.)	30.5	18	17.0	18	26.4	10	11.6	3	85.5	10
Aspen *(Populus tremulae)*	7.1	4	4.7	5	4.8	2	1.1	<1	17.7	2
Other species and lands without tree cover[1]	45.6	27	18.0	18	43.6	17	147.6	41	254.8	28

[1] *Includes burned and dead forest stands, unregenerated clearcuts, open-canopy woodlands, and wastelands.*

enterprises supervised by the Department of Forest Inventory of the Russian Federal Forest Service in Moscow.

The basic unit in Russian forestry is the forest management enterprise, which can range from about 20,000 to more than 1,000,000 hectares. Each FME is divided into several ranger districts, and these are divided into inventory grid cells. The cells are demarcated by cleared lanes that also provide access for fire control and other management activities. FME-level forest survey work includes field-verifying and marking borders and inventory grids, mapping stand polygons based on aerial photos, and collecting stand-level data.

Collecting accurate stand-level data and making appropriate management recommendations in the field are priorities. Depending on the intensity of forest management activity in a given FME, different levels of detail are needed, and therefore different inventory grades are used *(table 2)*. Field crews survey each stand polygon. A standard set of data gathered in the field includes site characteristics, tree species composition, mean height, diameter and age, canopy structure, wood volume, and characteristics of types of land without tree cover (e.g., clearcuts, bogs, meadows). More than 300 parameters that are measured or estimated in the field may be used to describe stands, depending on the land category and management requirements. For example, data on medicinal plants are collected only if commercial harvest is planned. A sample of data for closed forest stands demonstrates the level of detail contained in stand-level data *(table 3, p. 19)*. Field data also include evaluation of previous management practices.

Field data are checked, archived in electronic form, and aggregated at the grid cell, management category, ranger district, and FME level. The resulting report identifies lands eligible for final harvest, thinning, reforestation, and forest protection measures; allocates forestlands into management and functional groups and categories; calculates the allowable cut for thinnings and final harvests; prescribes afforestation and reforestation, fire and pest control, and other management practices; and determines the scope of nontimber forest uses, including harvesting nontimber forest products, hunting, and recreation.

The report provides background information on the natural, economic, and social environment of the FME and detailed data on the status of forest resources, including maps at 1:10,000, 1:25,000, 1:50,000, and 1:100,000 scales and stand-level data and summary tables describing the dominant tree species, productivity and age classes, and stocking density levels. The report next analyzes and evaluates changes in the forest resource and past forest management, thus generating a form of state audit for each FME. A forest management plan is also drafted for the upcoming 10 to 15 years. The report is reviewed and approved by the Federal Forest Service.

Simplified surveys. A high level of detail is unnecessary for the vast and remote forests in Siberia and the Russian Far East, where there is no infrastructure or planned management activity. Instead, field data are collected from a combination of satellite imagery analysis and aerial photo interpretation with limited ground verification. The accu-

Table 2. Parameters of forest inventory grades.

Grade	Grid cell area	Minimum length of survey routes per 1,000 ha of forest	Average stand polygon area	Minimum stand polygon area for closed forest	Minimum stand polygon area for plantations and nonforested lands
1	25–50 ha	60 km	3–6 ha	1.0 ha	0.5 ha
2	100–200	35	7–15	3.0	0.5
3	400–800	14	16–35	5.0	2.0

racy of these data is relatively low, and no management planning or grid demarcation is done, although many of the same stand parameters of the detailed inventories are determined. This simplified survey work was performed on 268.2 million hectares, or 24 percent of all Russian forestlands, between 1978 and 1992 *(fig. 2)* and replaced visual observations from aircraft, a practice widely used in the 1950s but proven to be of minimal accuracy. Nevertheless, data from those aerial observations are the only information available for 172.1 million hectares, or 16 percent of Russian forests.


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Boreal coniferous stands, also known as taiga, are the most common type of forest in Russia. This section, located in East Siberia, is part of a generally mature forested belt that is more than 2,000 kilometers wide.

Federal Forest Census

The federal forest census, which has been conducted every five years since 1949, provides forest inventory summaries updated to January 1 of a given year. Each FME provides information on changes associated with management practices (timber harvest, forest plantations), natural disturbances (fires, windstorms, dieback from pests and pathogens), and natural forest regeneration. Collecting and reporting these data are the responsibility of each FME. The information is then aggregated by administrative regions, by economic regions, and by the entire Russian Federation to determine the current status of forest resources. The census data are also used to calculate allowable cut and other parameters used to make decisions at different levels of state forest management. Forest census reports are currently prepared every one to five years, and summary tables are published every five years (Anonymous 1990, 1995).

Current Outlook

The forest inventory system is evolving in response to changes in the economic environment and the role of the Russian Federal Forest Service. In drafting plans for FMEs, the market for timber and nontimber forest products and fee collection for forest use will be considered. Recommendations on timber harvest and on the development of nontimber resources will be based on an analysis of a region's economy, supply, and prices. Data collection for the federal forest census will also be updated for accuracy and efficiency. As the lease of forestlands by private Russian and foreign companies becomes more common and the role of the Russian Federal Forest Service as the custodian of forest resources expands, the monitoring and auditing functions of the forest inventory are likely to become more significant. Moreover, the demand for contractors to develop acceptable management plans will increase.

Maintaining the existing forest inventory system despite economic decline and government cutbacks is a major challenge for the Russian Federal Forest Service. Between 1983 and 1991 about 50 million hectares of forestlands were inventoried annually; in 1993 only 36.8 million hectares were inventoried; and by 1995 the area declined to 30.5 million hectares (Kukuev 1996). Even less inventory work was completed on forestlands managed by state agencies other than the Federal Forest Service.

Ironically, as the scope of inventory work and quality of data begin to decline, an evolving market economy and growing environmental concerns in Russia demand more accurate information on forest resources. Among the priorities for the year 2000 are a new, detailed survey of 245 million hectares of forestlands that were inventoried more than 10 years ago and an inventory of 137.8 million hectares covered only by aerial surveys of the 1950s.

Meeting demand for updated information on forest resources will require inventorying an estimated 50 million to 52 million hectares annually (Kukuev 1996), as well as new technologies for collecting and processing data. The Russian Federal Forest Service has been exploring the use of geographic information systems and remote sensing technology. Both remote sensing and ground survey results have been improved by use of global positioning systems. Use of lidar to estimate tree stature and volume is also a possibility in the near future (Weishampel et al. 1996).

Evaluation and Potential Uses

Russia's forest inventory system provides consistent information on forests across the entire country and detailed data for 87.5 percent of the forests under state management (Anonymous 1990). This is probably the world's largest collection of field forest data,

Table 3. Sample of stand-level inventory database from Porozhskoye Lesnichestvo, Volkhov Leskhoz (forest) of the St. Petersburg region in northwestern Russia.

	Polygon 47 33.0 ha	Polygon 59 6.3 ha	Polygon 61 30.0 ha	Polygon 95 4.4 ha
Species 1	Birch	Spruce	Birch	Pine
% growing stock	50	40	60	50
Age (years)	60	60	15	130
Mean height (m)	22	19	6	21
Timber quality (class[a])	2	1	0	1
Species 2	Alder	Aspen	Alder	Spruce
% growing stock	40	40	20	10
Age (years)	50	50	15	100
Mean height (m)	18	20	6	20
Timber quality (class)	3	2	0	1
Species 3	Aspen	Birch	Aspen	Birch
% growing stock	10	20	10	20
Age (years)	60	50	15	80
Mean height (m)	22	19	7	20
Timber quality (class)	3	2	0	2
Species 4	—	—	Spruce	Aspen
% growing stock			10	20
Age (years)			30	80
Mean height (m)			8	21
Timber quality (class)			0	3
Stand density[b]	0.8	0.7	0.7	0.7
Growing stock[c], m^3 per ha	220	200	4	250
Productivity class[d]	3	3	4	5
Site type[e]	*Oxalis*	*Oxalis*	*Vaccinium myrtillus*	Long moss
Understory regeneration				
Species	Spruce	—	—	Spruce
Density per ha	1,000			5,000
Height (m)	1			3
Age (years)	20			20
Shrub layer				
Density (1,000 per ha)	2–5	<2	>5	2–5
Species	*Rhamnus* sp., *Sorbus aucuparia*	*Sorbus aucuparia*, *Rhamnus* sp.	*Rhamnus* sp., *Padus*, *Sorbus aucuparia*	*Sorbus aucuparia* *Salix* sp.
Pests				
Damaged tree species	Aspen	Aspen	—	Aspen
Pest type	Conk fungus	Conk fungus		Conk fungus
% damage	30	40		40

[a] *Timber quality classes represent timber output from growing stock. For softwoods, class 1 = >80%, class 2 = 61–80%, class 3 = <60%. For hardwoods, class 1 = >70%, class 2 = 51–70%, class 3 = 31–50%, class 4 = <30%.*
[b] *Stand density is the proportion of basal area in a given stand to basal area in a stand of maximum potential density for given species and mean height found in standard tables (Zagreev et al. 1991).*
[c] *Volume of stem wood for all trees > 6 cm dbh.*
[d] *Level of stand productivity as measured by mean tree height at the given age: 1 = highest, 5 = lowest.*
[e] *Site type is identified with understory plants that are local edification species for common drainage and soil productivity levels: e.g.,* Oxalis *sp. occur on productive sites with medium drainage, Long moss type represents poor drainage and low soil fertility, and* Vaccinium myrtillus *type is intermediate.*

but it has its limitations.

Although stand-level data address a large proportion of Russian forests, some of the older data are available only in hard copy. In other cases, electronic files stored by the regional forest inventory enterprises use incompatible formats. Moreover, the sheer size of the stand-level database makes it unwieldy. Since timber inventory is the main purpose of the system, few data on biomass components other than stem wood are included (Krankina and Harmon 1995). Although each stand polygon is mapped, the maps until recently were produced only in hard copy, making spatial aggregation and interpretation difficult. Because data are collected for different FMEs in different years, they are temporally inconsistent. Besides, the resolution, timeliness, and accuracy of data vary by region, and some remote areas were last surveyed more than 40 years ago. Finally, the entire system is based on the Russian forestry and forest management tradition and is thus not easily understood by outsiders.

Despite those shortcomings, this database has environmental, economic, resource management, and scientific applications. Projecting the timber supply is the most straightforward use, especially now that Russian timber exports are expected to play a major role in the world market.

The data are also used for research on carbon budgeting and potential climatic change associated with carbon dioxide accumulation in the atmosphere (Kolchugina et al. 1992; Isaev et al. 1993; Alexeev and Birdsey 1994; Krankina and Dixon 1994; Krankina et al. 1996). Unfortunately, because of difficulties in accessing stand-level data, researchers have so far used only published summary data, and because of differences in methods, the range of resulting estimates of live biomass is fairly wide: from 29.5 petagrams (Pg) of carbon (Alexeev and Birdsey 1994) to 50.4 Pg of carbon (Kolchugina et al. 1992). Taking full advantage of forest inventory data can help resolve the uncertainties in carbon budgeting and evaluate the potential of Russian forests to sequester and store carbon (Krankina et al. 1996).

Other potential applications include a variety of environmental assessments (e.g., forest health, disturbance regime, wildlife habitat), analysis of alternative strategies for regional and local economic development, feasibility studies for a wide range of ventures involving forestlands, and ground data for interpreting remote sensing images. JOF

Literature Cited

ALEXEEV, V.A., and R.A. BIRDSEY. 1994. *Carbon in ecosystems of forests and peatlands of Russia.* Krasnoyarsk, Russia: Ecos (in Russian).

ANONYMOUS. 1990. *Forest fund of the USSR.* Moscow: State Committee for Forestry (in Russian).

———. 1995. *Guidelines for inventory of the state forest lands of Russia.* Moscow: Russian Federal Forest Service (in Russian).

ANUCHIN, N.P., et al. 1985. *Forest encyclopedia, vols. 1 and 2.* Moscow: Soviet Encyclopedia Publication (in Russian).

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO). 1995. *Forest resources assessment 1990: Global synthesis.* FAO Forestry Paper 124. Rome.

ISAEV, A.S., G.N. KOROVIN, A.I. UTKIN, A.A. PRYAZHNIKOV, and D.G. ZAMOLODCHIKOV. 1993. *Estimation of carbon pool and its annual deposition in phytomass of forest ecosystems in Russia.* Moscow: Lesovedenie (in Russian).

KOLCHUGINA, T.P., T.S. VINSON, A.Z. SHWIDENKO, R.K. DIXON, K.I. KOBAK, and M.S. BOTCH. 1992. Carbon balance of forest biomes (undisturbed ecosystems) in the former Soviet Union. In *Proceedings of the IPCC Workshop*, 52–62. Joensuu, Finland: University of Joensuu.

KRANKINA, O.N., and R.K. DIXON. 1994. Forest management options to conserve and sequester terrestrial carbon in the Russian Federation. *World Resource Review* 6(1):88–101.

KRANKINA, O.N., and M.E. HARMON. 1995. Dynamics of the dead wood carbon pool in Northwestern Russian boreal forests. *Air, Water, and Soil Pollution* 82:227–38.

KRANKINA, O.N., M.E. HARMON, and J.W. WINJUM. 1996. Carbon storage and sequestration in the Russian forest sector. *Ambio* 25(4):284–88.

KUKUEV, Y.A. 1996. Forest inventory at the threshold of change. *Lesnaya Gazeta,* January 13, 1996 (in Russian).

WEISHAMPEL, J.F., K.J. RANSON, and D.J. HARDING. 1996. Remote sensing of forest canopies. *Selbyana* 17:6–14.

ZAGREEV, V.V., N.N. GUSEV, A.G. MOSHKALEV, and S.A. SELIMOV. 1991. *Forest mensuration and forest inventory.* Moscow: Ekologia Publishers (in Russian).

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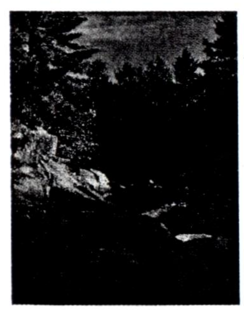

Rocks and rapids on the Jump River, Big Falls Park, Price County, Wisconsin. © 1997 Jeff Martin.

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