Forest Inventory in the USSR, 1982

A report on the visit of Canadian Forest Inventory Specialists to the Soviet Union

T.G. Honer, F. Hegyi and G.M. Bonnor

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Forestry Technical Report 34

Canada

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GOVERNMENT OF CANADA

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4. Development and certification of codes and standards for wood product performance.
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by

T.G. Honer,[1] F. Hegyi,[2] and G.M. Bonnor[3]

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Canadian Forestry Service
1985

[1] Head of Delegation, Senior Mensurationist, Pacific Forest Research Centre, Canadian Forestry Service, Victoria, B.C.
[2] Director, Inventory Branch, Ministry of Forests, Victoria, B.C.
[3] Manager, Research and Development Program, Forestry Statistics and Systems Branch, Canadian Forestry Service, Chalk River, Ontario.

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Pacific Forest Research Centre
Canadian Forestry Service
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Cette publication est aussi disponible en français sous le titre *L'inventaire forestier en URSS en 1982: Compte rendu de la visite en Union soviétique d'un groupe de spécialistes canadiens de l'inventaire forestier.*

Abstract

The forest resources of the USSR, the organization that conducts forest inventory, and the methods used in carrying out surveys of various intensities are documented. The remote sensing and computer methods are briefly described, and new developments currently in the testing stages are discussed. An evaluation of the forest inventory sector in the USSR is presented.

Résumé

Des renseignements sont donnés sur les ressources forestières de l'URSS, sur l'organisme chargé de l'exécution de l'inventaire forestier national et sur les méthodes d'exécution des inventaires régionaux. Sont aussi brièvement décrites les techniques de télédétection et d'informatique, tandis que sont présentés de nouveaux perfectionnements en cours d'essai. On évalue enfin le secteur de l'inventaire forestier de l'URSS.

Acknowledgment

The assistance of Mr. Jerry Holowacz, World Forestry Information Group, Canadian Forestry Service, in preparing briefing material and in reviewing this manuscript is greatly appreciated.

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Introduction

Canada and the Soviet Union have had a formal agreement for cooperation in forestry since 1971, through the Canada/USSR Working Group, under the auspices of the Canada/USSR Mixed Commission on Economic, Industrial, Scientific and Technical Cooperation. In 1978, the Mixed Commission approved the establishment of a separate Working Group on Forestry, which held its first meeting in Canada in 1979. The Protocol of cooperation ratified at that time and renewed in 1981 in Moscow, includes programs on cooperation in forest inventory, forest site classification, forest fire protection, regeneration, the control of forest pests, and the exchange of tree seed. It also provides for the exchange of specialists, publications, and scientific and technical information.

The current Chairman of the Canadian side of the Working Group is J.H. Cayford, Director, Great Lakes Forest Research Centre, Canadian Forestry Service. The Chairman for the Soviet side is Mr. P.I. Moroz, Chief of V/O Lesproekt,[1] Moscow.

During the period June 20 - July 3, 1982, a Canadian delegation of forest inventory specialists visited the Soviet Union to study the mandate, organization, and technical practice of forest inventory in the USSR. The delegation met with various directors, managers, survey personnel, academics, and research scientists to discuss current practices, problems, and new developments in the forest inventory sector. The delegation visited institutions concerned with forest survey, forest research, and teaching of forest inventory personnel in Moscow, Leningrad, and Kiev.

This report, the result of the very informative visit, briefly documents the forest resource, the organization that conducts forest inventory, and the methods used in carrying out surveys of various intensities. The remote sensing and computer methods are briefly described, and new developments currently in the testing stages are discussed.

During our visit to the Soviet Union, the Chief of V/O Lesproekt, Mr. Pavel Ivanovich Moroz, was our host. He was assisted by Mr. V.I. Agapov, Chief, Northwestern Forest Surveying Enterprise, Leningrad, and Mr. V.N. Poliakov, Deputy Chief, Ukrainian Forest Surveying Enterprise, Kiev. Mrs. Marina Nazarova, Chief of Information and Translation, V/O Lesproekt, acted as our interpreter.

The Forest Resource of the USSR

The USSR is generously endowed with forests. In this regard, it surpasses all other forest empires of the world such as Canada, Brazil, and the USA; it contains over 22% of the world's timber and well over 50% of the world's coniferous wood volume.

Over 33% of the territory of the the Soviet Union is under forest cover, but most of the exploitable forest reserves are located in the relatively remote areas of the country. The portion of the territory distributed roughly to the north and the east of the line extending from the city of Leningrad to the southernmost tip of Lake Baikal supports over 80% of the timber reserves, but only 20% of the population of the country.

By itself, the USSR can boast of the highest annual allowable cut (638.7 million m^3) and the greatest mean annual increment (890.7 million m^3). It competes with the USA for the first place in timber harvest and lumber production, and occupies second place in the volume of lumber exported. In the production of fibreboard, particleboard, and plywood, it is a strong competitor with the USA, Canada, the Federal Republic of Germany, and Japan.

Annual regeneration operations in the USSR cover an area of over 2.4 million ha (1980). However, the entire silvicultural effort in regeneration, tending, thinning, anti-erosion work, field shelterbelt establishment, and drainage occupies an area of about 3.0 million ha annually.

There are 15 specialized forest technical institutes and about 25 faculties of forestry at-

1 All-Union Aerial Photography, Forest Resources Inventory and Forest Regulation Association of the State Committee of Forestry of the USSR (V/O "Lesproekt"). (Vsesoiuznoe aerofotolesoustroitel'noe ob'edinenie Gosudarstvennogo komiteta SSSR po lesnomu khoziaistvu). The noun "association" is used by the Soviets in a corporate sense denoting a group of specifically regional Forest Resource Inventory organizations with the head office in Moscow.

Address: SSSR-URSS
MOSKVA - 117292
ul. Ivana Babushkina, 19/1
V/O Lesproekt

Table 1. Basic data on Canadian and USSR forestry

	Canada	USSR
Population (millions)	24	270
Territory (1 000 ha)	992 233	2 227 490
Forest land, all (1 000 ha)	436 400	1 257 300
Productive forest land (1 000 ha)	264 100	921 245
Productive forested land (1 000 ha)	244 013	791 645
Reforestation backlog area* (1 000 ha)	22 686	129 600
Total growing stock (1 000 000 m^3)	23 046	84 166
Average growing stock per hectare (m^3)	94.5	106.3
Proportion of coniferous volume (%)	79	82
Proportion of mature and overmature volume (%)	60	67
Total MAI (1 000 m^3)	425 482	890 700
MAI per hectare of forested area (m^3)	1.7	1.1 (1.38)**
Allowable cut (principal harvest), all forests† (1 000 m^3)	250 200	638 700
Actual cut (principal harvest) in 1980 (1 000 m^3)	156 167	325 200
Percentage utilization of MAI in 1980	37	36.5
Percentage utilization of allowable cut in 1980	62	51
Average annual volume of thinnings (1976-1980) (1 000 m^3)	2 000	52 300
Total area under closed plantations (1 000 ha)	–††	15 900*
Average annual areas regenerated (1976-1980) (1 000 ha)	2 127	2 391
Planting and seeding (1 000 ha)	166	1 291
Average annual forest regulation and inventory effort (1976-1980), hectares	–††	46 900
Employment in forestry and forest-based industries in 1980	302 000	3 248 000
Employment in forestry only (silviculture, etc.)	11 000*	459 000
Higher forestry and forest industrial teaching institutes	6	35
Graduation of forest industrial engineers/year	–††	4 400*
Graduation of foresters/year*	430	1 800
Middle forestry and forest industrial schools	13	Over 100
Industrial technicians/year*	800	14 000

*Estimation.

**In forests of national significance, which account for 92.1 % of the total forested area of the country.

†Excluding intermediate cuttings, i.e. thinnings.

††Data not available.

Sources: Canada – Bonnor, G.M. 1982. *Canada's Forest Inventory 1981*. Canadian Forestry Service, Environment Canada, Chalk River (Ontario).
– Other official canadian sources.

USSR – [National economy USSR 1922-1982, Anniversary statistical handbook.] Finansy i statistika, Moscow, 1982. (In Russian.)
– Other official Soviet Sources.

tached to various universities and higher agricultural schools. Approximately 7 600 foresters, forest industrial, and pulp and paper engineers graduate every year. Forestry and forest industrial technicians of various profiles are trained at over 100 technical schools, which graduate some 17 000 technicians in forestry and forest industrial disciplines annually.

The USSR maintains 14 forest research institutes, supported by about 60 semiautonomous permanent research stations. Together, these institutions employ over 4 000 research workers and assistants. In addition, forest industrial research institutes, forest technical institutes, faculties of forestry, and related disciplines also conduct forestry-oriented research work.

The entire Soviet forestry enterprise, that is, forestry and forest-based industry, employs 3 248 000 workers; in forest management and forest protection alone, the Soviets employ 458 000 people.

In relation to Canada, the total forest land area of the USSR is 2.2 times as large; that of forested lands is nearly 4 times as great, while that of exploitable forest land is 2.8 times as large. The total wood volume of the Soviet Union is more than four times that of Canada, and the coniferous wood volume is equally greater. Both Canada and the USSR control nearly 70% of the world's subboreal and boreal resources and face similar management problems. Table 1 presents a comparison of basic Canadian and Soviet forestry data.

Forest Land Classification

The forest resource area of the Soviet Union comprises all land administered by forestry authorities and other government agencies. In Soviet literature, this category of land is frequently described as "general forest land" or "forest land fund" and includes two broad land categories: forest land and nonforestry land. Forest land is subdivided into forested (stocked) land and nonforested (unstocked) land.

Forested land is defined as land supporting both natural and man-made forest stands with a minimum stocking of 40% for juvenile stands and 30% for mature stands. Recent cutovers are not considered forested land.

Lands classified as "nonforested (unstocked)" represent areas capable of producing timber, but now do not support a forest cover of minimum stocking. To this forest land category are relegated recent and old cutovers, areas to be clear-cut within the next one or two years, burns, insect- or disease- killed stands or stands killed by flooding and other lands suitable for forestry purposes but which do not support a forest stand.

Nonforestry lands are incapable of producing a merchantable forest stand. Nonforestry land is generally surrounded by forest land but, for physical or economic reasons, is not suitable for forest production. This land category is comprised of agricultural lands, meadows, swamps, talus slopes, steep hillsides, rock outcrops, shifting sands, road allocations, building sites, homesteads, etc.

Figure 1 shows the forest land classification system currently used in the Soviet Union in conjunction with forest resource inventory and regulation.

Forest Land Tenure

The USSR State Forestry Committee administers about 95% of the forest resource area. The remaining 5% is divided between the collective farms and those lands that are under tenure to various ministries and agencies.

The exploitable forests comprise 73% of the total forest resource area. Figure 2 shows the distribution of resource according to tenure categories.

Forests in the USSR are also grouped according to management intensity classes as shown in Table 2.

Forest Inventory and Regulation

Background

Soviet forest resource inventory has always been considered an integral part of the entire forest regulation process. Most Soviet professionals use the terms 'forest inventory' and 'forest regulation' interchangeably, but in fact 'forest resources inventory' is only a part of the larger discipline of forest regulation.

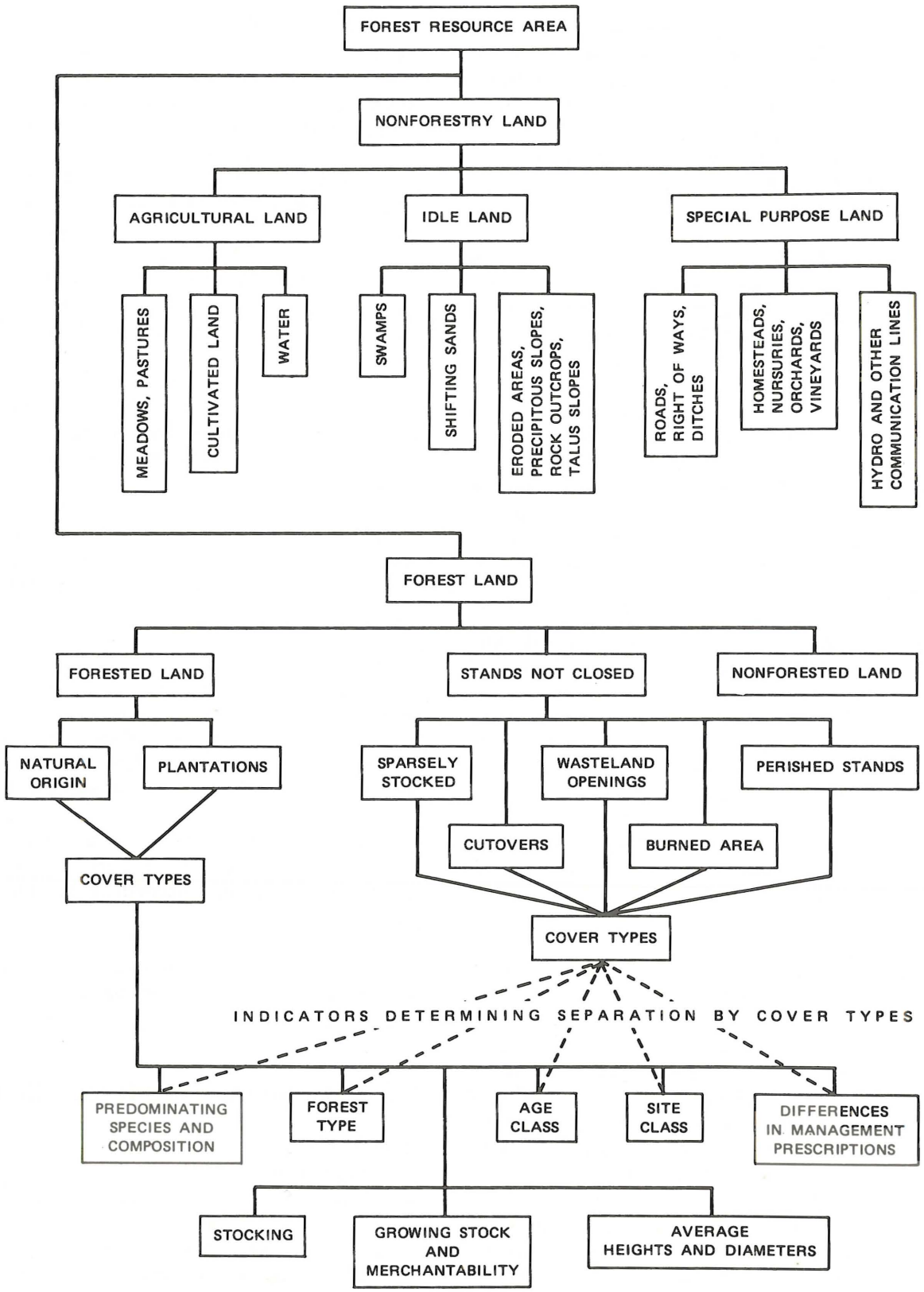

Figure 1. Land classification for forest regulation in the USSR

Table 2. Forest management intensity classes in the USSR

Group I Forests	Only sanitary cutting is permitted.
Group II Forests	The harvest is not to exceed the mean annual increment.
Group III Forests	Industrial forests where harvest may repeatedly exceed the annual allowable cut in a given area for a limited number of years.

Soviet forest regulation guidelines were formulated in 1924 and remain the principal policy document governing regulation, inventory, and cut determination for forests of local significance. The industrial forests of distant regions were intended to be incorporated into the overall national (central) plan but were not subject to regulation in the classical sense. Annual cut was determined in accordance with the needs of the national economy and, in those years following the 1917 Revolution, the delivery of timber to the market and construction sites was of paramount importance. Forest regulation often played a secondary role. It wasn't until after World War II that substantial resources were made available to expand the national effort in forest regulation and inventory.

V/O Lesproekt

In 1947 a single institution, the V/O Lesproekt, was established to carry out forest regulation in the USSR. The function of this new organization was to *carry out forest regulation in all the forests of the country on a uniform, technical, and methodological basis in conformity with the overall economic policy of the country, irrespective of tenure.*

V/O Lesproekt reports to the State Forestry Committee, which acts as the general master of forests. Since its inception in 1947, the work of V/O Lesproekt has expanded considerably and the individual functions carried out on a regular basis can be summarized as follows:

- Territorial organization of the resource in time and space and the carrying out of forest inventory on all forest lands including the maintenance of the data base.
- Determination of the growing stock and allocation of allowable cuts by area and species.
- Resource planning in terms of future use, including forest land, parks, nature reserves, hunting areas, and industrial harvesting.
- Determination of insect and disease damage in terms of location and extent.
- Production of forest inventory and planning maps, and associated statistics.
- Research and development in the area of forest inventory and regulation, including classification, sampling, remote sensing, mensuration, growth estimation, and allowable cut determination.
- Maintenance of administrative, planning, budgetary, technical, and methodological controls over the central apparatus of the organization as well as its regional and field offices.

The V/O Lesproekt organization is comprised of 19 Enterprises, an Enterprise being a regional office of the organization. Nine of the Enterprises are located within the boundaries of the Russian Soviet Federated Socialist Republic (SSSR) which contains 95% of the forested area of the country. The remaining 10 regional offices are located in the constituent union republics, which control forest resources considered to be of economic significance.

Each of the regional offices has a specific specialization. For instance, the Moscow office specializes in remote sensing, whereas the Enterprise in Leningrad specializes in air photo surveys and inventories of the northern reserved, remote forests. The Ukrainian Forest Surveying Enterprise puts its emphasis on intensive forest inventories in the protection and greenbelt forest; it also has responsibility for the data base management systems.

The Enterprises carry out operational functions as well as those of a research nature in support of the operational role. The research is also conducted in the research institutes located in the regions and the emphasis is on regional forests and problems.

The areas regulated annually by each Enterprise differ considerably as can be seen in Table 3.

The 19 Enterprises are further subdivided into 60 "Epeditionary Groups," and are domiciled in

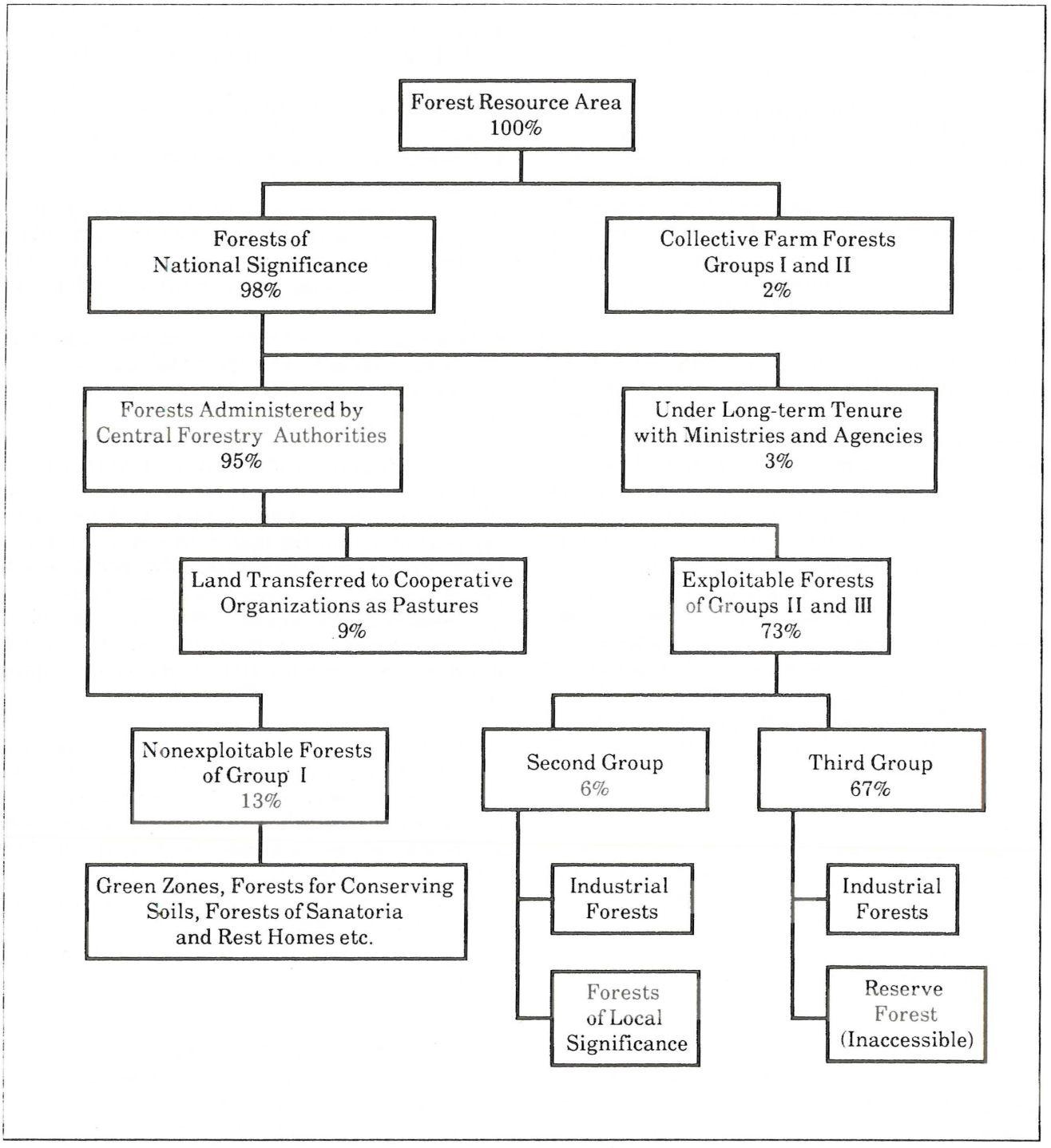

Figure 2. Forest land tenure in the USSR

40 different towns and cities of the USSR. Each Expeditionary Group may comprise 5-15 forest regulation parties composed of 2-5 graduate assessors (foresters), and 1-5 technicians.

Table 3. Area regulated annually by the Enterprises

Number of Enterprises	Area regulated Annually (millions ha)
5	6
5	3 to 6
6	About 3
3	Less than 1
Total 19	16

About 11 000 people are employed by the V/O Lesproekt organization. Nine thousand of these are engineers and technical personnel of whom 40% are women. The remainder are casual or auxiliary positions. The personnel within each Enterprise are composed of engineers, including soils personnel, mathematicians, computer scientists, foresters, and others associated with the resource sector.

The periodic goals assigned to V/O Lesproekt are received from the State Forestry Committee and are then delegated to the various Enterprises. The regions then are responsible for achieving these goals and organizing their research and operational functions accordingly.

The Northwestern Enterprise in Leningrad is one of the oldest enterprises of V/O Lesproekt and, despite its name, the mandate is very broad. It employs approximately 1100 people of which 700 are engineers and the remainder are technicians and support personnel, who are engaged in computing, financial and cartographic services. Within the Enterprise there are six branches: four are concerned with management of the forest, one branch is concerned with aerospace methodology, and another branch deals with parks and greenbelt. Each branch is divided into various divisions or subgroups and these deal with protection, inventory, and other general operational functions. Each group has 10 to 12 subgroups or forest management parties with the chief of a subgroup being responsible for projects.

The Enterprise is totally decentralized from the V/O Lesproekt organization in Moscow. They do all of their own cartographic work, publication of results, and determination of volume and harvest figures. In fact, all of the operations of the region are done by the Northwestern Enterprise office group. They also have an airphoto section which contracts out photography to Aeroflot, the national air line. They photograph approximately 10 million hectares annually in different parts of the country. The Northwestern Enterprise is responsible for taking photos for several of the Enterprises, and they have film storage archives for this purpose.

The Enterprise annually surveys about 8 to 9 million hectares at a level III inventory, in their own region and also in other regions across the USSR. They also inventory the 160 000 hectares of the Leningrad greenbelt area.

The Ukrainian Forest Surveying Enterprise in Kiev reports to V/O Lesproekt in Moscow but has agreements with the Ministry of Forestry of Ukraine and the Ministry of Forest Industry regarding the carrying out of forest survey and regulation work. These agencies provide funding for the Ukrainian Forest Surveying Enterprise to carry out survey projects on an annual basis.

The annual work of the Ukrainian Forest Surveying Enterprise can be summarized as follows:

- Forest management planning for 2.5 million hectares comprised of 2 million hectares state forest, 200 000 hectares collective farm forest, and 300 000 hectares belonging to various other ministries and organizations.
- Forest soil classification is done on 150 000 hectares annually.
- Planning for hunting and management on 600 000-700 000 hectares.
- Delineation of areas of forest byproducts, such as mushrooms, approximately 1.6 million hectares annually.
- Preparation of general forest management plans for approximately 1 million hectares annually.
- The control of inspections for five to nine forest management units annually.

This volume of work costs approximately 4 million rubles annually (Cdn $6.4 million).

In the planning sector, approximately 50 plans are prepared each year for the forest management units. Similar projects are developed for collective farms and total approximately 700 annually. Other projects comprise about 20 per year. Maps are prepared for hunting units at about 25 per year, soil survey projects at the rate of about 10 or 15 per year, and 2-3 general projects are prepared for regions and republics. The work is carried out by approximately 50 crews made up of 450 people.

Within the Ukrainian Enterprise there are a total of 900 full-time employees; approximately 50- 100 casuals are retained for the field season. The Enterprise is composed of a Chief and three Deputy Chiefs in charge of Engineering, Supplies & Services, and Operations. The Chief is also responsible for finance, personnel, and daycare centres for 150 children.

Forest Inventory

Emphasis in the forest survey operation is on timber and the quantification of forest lands for timber exploitation. The forests are now inventoried on a 10-year cycle. However, V/O Lesproekt wants to implement an annual update through the use of computers and various yield models. Should this take place, they wish to concentrate their inventory on disturbed areas, or areas that will soon be harvested, and update their undisturbed forests using the various models available. In this way, they expect to adopt a routine of re-inventorying their land on about a 20-year cycle.

Pest problems are identified on a routine basis during every forest survey. If, however, the infestation is of a serious nature, the Pest Survey Institute of Moscow takes over the survey function. This Institute is a special branch of V/O Lesproekt that measures the losses incurred from various forest pests.

The results of the inventory are tabulated by computer and placed in hardcover binders for each block and management region. Colored maps indicating the composition and status of the forest for specified blocks are also available. Our impression was that their systems were very well organized and that they had good documentation at all levels of the survey process.

The forest inventory operation concentrates on providing accurate estimates of merchantable volume, but in the Soviet Union, the utilization of all tree components (crown, bole and roots) and all tree size classes is increasing at a rapid rate.

About 60% of the total wood production for the Ukraine comes from plantation thinnings of immature species and represents about 6 million cubic metres annually out of the total annual cut of 10 million cubic metres.

Thinnings are divided into four product classes. Trees less than 20 cm dbh, associated with stand clearing operations, are used for the manufacture of particleboard. Small branches and needles are manufactured into foliage flour, or muka, which is used as a cattle feed supplement. Trees larger than 20 cm are used for lumber production, as well as poles and posts. Chemical products such as turpentine are derived from the stump and root mass.

Forest management in these populated areas is very intensive and utilization approximates 100% of the tree material. A display seen in the Forestry Pavilion at the Exhibition of Economic Achievements in Moscow, showed that the utilization of stump and root material as well as thinnings was increasing at a rapid rate. In particular, it appeared that the production of particleboard had more than doubled in the last five years. Other charts showed how the land base for forestry purposes was affected.

The need for a biomass data base was discussed with various survey personnel. There seems to be some concern for estimates of forest biomass within the State Forestry Committee. However, V/O Lesproekt has not seriously addressed this problem and no forest biomass estimates are available on a routine basis.

V/O Lesproekt is also responsible for initiating studies and research aimed at solving forest inventory problems. The Chief of V/O Lesproekt is Chairman of the Scientific Board and Chairman of the Technical Board that governs all professional and scientific studies within the organization. The Scientific Board has approved about 300 individual research projects underway in the various Enterprises. On an annual basis, probably 20 are assessed by a technical evaluation team. When the projects are completed and ready for a pilot introduction into the regular survey operation, they are reviewed by the Technical

Board and, if found to be of importance, are approved and implemented. Since the Chief of V/O Lesproekt is Chairman of both Boards, he exercises final authority over approval of all projects.

Forest Regulation and Inventory

Forest regulation as practiced in the Soviet Union includes inventory; the allocation of allowable cuts; resource planning for harvest, parks, nature reserves, and hunting areas; and damage appraisal and research in support of the operational role. Forest inventory, although only one segment of this process, provides the essential information upon which all other decisions depend.

Forest regulation is practiced in accordance with five forest regulation intensity classes (Table 4). The level of forest inventory applied to a particular area is determined by the intensity of forest management to be practiced in the region. The most detailed surveys are conducted under Classes I and II, because lands inventoried under these regulations will receive intensive treatment. These surveys would be carried out on the greenbelt forests surrounding the cities and on those forests associated with collective farms, and other institutions. Reserve forests and those lands where exploitation will not take place for many years are inventoried under Class IV, which is comparable to a reconnaissance inventory where detail on individual stands is limited. Intensity Class III inventory accounts for the largest area usually surveyed and applies to the industrial forests of the Soviet European north, the Urals, and substantial portions of Siberia and the Soviet Far East.

The implementation of forest regulation in an area to be brought under management entails the delineation of management units and the preparation of appropriate base maps. Within populated areas, the boundaries of management units are usually surveyed, but in remote regions it is sufficient to delineate them utilizing prominent geographical features such as lakes, rivers, and roads.

Each management unit is subdivided into blocks and, for each block, a map is prepared with a scale determined by the forest regulation intensity classification system. For intensity classes I-II, the area of the block is about 2 000 hectares; for Class III it is 12 500 hectares; and for Class IV it is 50 000 hectares.

Each block is further subdivided into compartments. A regular block generally comprises 16 compartments and the area represented by each compartment is again determined by the forest regulation intensity classification system, e.g.,

Table 4. Inventory specifications for forest regulation intensity classes

Forest regulation intensity class	Normal compartment size (km)	Area (ha)	Distance between cruise lines* (m)	Approximate area of an average size cover type (ha)	Distance of cruise lines per 1 000 ha** (km)	Photo Scales	Prescribed map scales
Ia	0.5 x 0.5	25	500	1 – 2	78	1:5000	1:500 - 1:10 000
I	1.0 x 0.5	50	500	3 – 5	60	1:10 000	1:10 000
	1.0 x 1.0	100	500	3 – 5	60	1:15 000	1:10 000
II	1.0 x 1.0	100	500	6 – 15	45	1:10 000	1:10 000
	2.0 x 1.0	200	500	6 – 15	35	1:20 000	1:10 000
III	2.0 x 2.0	400	1 000	16 – 35	17	1:15 000	1:25 000
	4.0 x 2.0	800	1 000	16 – 35	14	1:20 000	1:25 000
IV	4.0 x 4.0	1 600	2 000	36 – 80	8	1:20 000	1:50 000
	8.0 x 2.0	1 600	2 000	36 – 80	7		1:50 000

* A brushed line separating two compartments may serve as a cruise line. In the event that aerial photos are not available, the distance between the cruise lines is *reduced for each* intensity class to: Ia = 125 m, II = 125 m, III = 500 m, IV = 1 000 m.

** The distance of cruise lines per 1 000 ha correspondingly increases for each intensity class when cruising is carried out without the aid of aerial photography: Ia = 100 km, I = 90 km; II = 45-50 km, III = 23-25 km, IV = 11-13 km.

Class Ia, 25 hectares; Class I, 50 hectares, etc. Figure 3 shows a fragment of a management unit indicating blocks and compartments.

Compartments are the most basic forest managment unit and cover types are the smallest silvicultural units.

Forest Inventories Class I and II

The Ukrainian Forest Surveying Enterprise specializes in forest management at forest regulation intensity levels I and II. This includes aerial photography, direction of field work, compilation of data and development of management plans. The time involved in conducting and completing the survey from air photo interpretation through to management plan, is usually about two years. The area is visited by a group of of forest managers one year before the project commences. This would include an evaluation for proposed boundaries for the forest management unit, and its subdivision into groups (greenbelt or exploitation forests), compartments, numbering systems, stand delineation for measurement purposes, and location of compartment corners in the field. All existing information on the management area is located and many working maps are completed in pencil. Sample plots are established in the area and used for training purposes; all information is used to establish the priorities and logistics for the next year's field measurement.

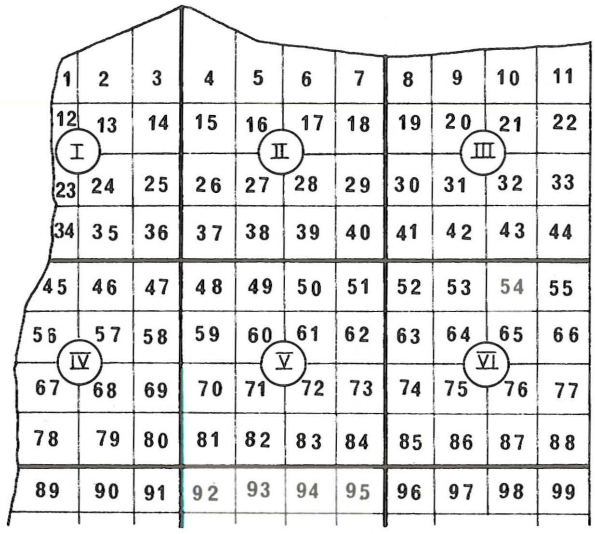

Figure 3. A fragment of a management unit showing blocks and compartments. Roman numerals indicate blocks. Arabic numerals denote compartments. Heavy lines indicate block boundaries. Cruise lines may coincide with block and compartment boundaries.

During this preliminary work, blocks and compartments are located. Preliminary maps are established at a scale of 1:10 000 and compartment boundaries are delineated on the photos and maps. No pretyping takes place at this time. A list of the work to be done is prepared and submitted to the contractor which would be either the Ministry of Forestry or Ministry of Forest Industry of the Ukraine.

The field operations are conducted from May to October. This involves a training period, using the sample plots established earlier. The crews practice measurement and estimation techniques on these training plots. Block and compartment boundaries are located and brushed out by the technicians. Forest engineers walk these lines and establish the measurement for volume determination. They also make preliminary recommendations and establish sample plots required for determining thinning, natural regeneration, and the assessment of planted trees. The status of the unit in terms of management intensity is established. Compartment sizes vary from 25 to 200 hectares depending on the intensity of the survey.

Execution of the work is accomplished through a combination of visual estimation and field sampling. Measurements are taken in mature forests and, in every fourth stand or compartment, 9-21 relascope samples are taken and the appropriate tally cards are completed. In the boreal forests, a combination of visual inspection and interpretation is used. Plot tallies are completed and in nonwood production areas the estimates are visual and supplemented by estimates of the quantities of berries, herbs, etc., within each compartment. Coverage is in 10% classes, and quantities of shrubs are estimated in numbers of 20, 40, and 60 individuals. Volumes are determined for these nonforest products and the biological yield is twice the amount that can be harvested. These volumes are determined on an area basis and eventually expressed in volume per hectare.

Office work involves the preparation of maps (1:10 000) for forests, animals, soil surveys, geological materials, and the processing of plot tallies through the computer and the compilation of

tables on forest harvest and regeneration. Discussions with regard to the level of management and liaison are conducted with cooperating agencies. This liaison involves public participation with regard to natural habitat; objections to the proposed plans can be made to the State Forestry Committee.

Following approval of the plan it becomes the main document for forest management in the block and compartment for the next 10 years. There is an inspection after a 5-year period, and some modifications to the plan may be made if they are required.

Forest Inventories Class III and IV

For level III and IV inventories, systematic sampling procedures are used and data are collected along compartment lines as well as designated cruise lines. Only cover types supporting mature and overmature timber are visited. Juvenile stands are described only when they are crossed by a cruise line. Other information on stands located between the cruise lines is derived from the aerial photographs, or from an overflight in a helicopter or small plane.

An inventory generally takes place over a 2-year period. During the first summer, information on forest types is collected and compartment lines may be established and/or brushed out. During the winter months, the color photos (1:15 000) are interpreted in great detail and preliminary maps are prepared. For the second summer, the compartment lines, roads, and cruise lines are walked and the information obtained from photo interpretation is upgraded. The remaining stand characteristics are determined by correlating known factors with those stand characteristics observed on the aerial photographs. A tally card describing all forest stand parameters is completed for each stand.

While the intensity of forest management governs the level at which forest inventory is conducted, inventory methodology has not remained static. Procedures used at each forest regulation intensity class have been periodically modified in response to new developments in science and technology. The introduction of aerial photography, the Bitterlich relascope, and space photography are the most prominent examples of these new developments.

Statistically Designed Surveys for Reserve Forests

V/O Lesproekt has always been keenly interested in the application of statistical methods to forest inventory problems and has had special methods developed for application in the northern reserve forests which are remote and difficult to access.

The Northwestern Forest Surveying Enterprise, located in Leningrad, is responsible for surveying much of the reserved land (forested and nonforested) of the Soviet Union, which comprises approximately 600 million hectares across the northern part of the country. These lands are inventoried using aerial photographic techniques in conjunction with statistically controlled sampling design. Since 1978, 30 million hectares have been surveyed. Now about 8-9 million hectares are inventoried annually.

The inventories are conducted according to forest management units; the size of each unit ranges from 10-16 million hectares. The important features of this process are as follows:

- The forest management unit is covered at 1:60 000 - 1:100 000 air photos depending on forest complexity.
- For very homogeneous forests multispectral space photos are used instead of the air photos.
- Nonforest and water areas are determined. The photos are interpreted: stands are delineated, classified, and described. The forests are stratified by species composition, height, crown closure, and other parameters such as age class.
- The total number of strata in a management unit ranges from 6 - 15.
- Using equal probability formulae, calculations are made to determine the number of photo plots to be established in each stratum.
- The photo plots are distributed systematically across the strata in such a fashion that subsequent photography will be optimized; there will be approximately six or seven photo plots per flight line. Air photos are now taken at a scale of 1:5 000 in level areas and 1:10 000 in mountainous areas. The photos are 30 x 30 cm. Photo centers are transferred to the medium scale photos. The distance between photo plots is about 700-1200 metres. The film type is color infrared and red combined to cover the red-to-infrared spectrum from 600 to 840 nanometres. Images are brought forth on three-layered photo paper, which is of much greater

sensitivity than two-layered filament. Each forest management unit of about 10 million hectares has about 5 000 to 6 000 photo plots distributed in this systematic manner.

- Photo plots are now interpreted. Each photo plot of about one hectare has a number of stand parameters determined, such as crown closure to estimate density and height to estimate volume for a normal stand (a normal stand is considered to be of 80-85 % crown closure). Volume calculations are based on measures of height and crown diameter. Volumes of the normal forest are determined from the cruiser correlation tables; crown closure is used to adjust the normal estimates to those of the actual forest. A photo interpreter will measure between 12 and 15 photo plots per day.
- Ten percent of the large scale photo plots are ground sampled using the same size of ground plot as established on the photo, namely one hectare.
- The accuracy specified for mature, or overmature forests is plus or minus 2% at the 95% probability level for total volume in a forest management unit.
- Helicopters are often used to visit the field plots. In the field plots, measurements are made of individual trees for dbh and their species are recorded. In addition, 15-20 trees are measured for height, 8-10 trees are felled, and the age at stump is determined.
- Using the basic field measurements the plot volume is calculated by 2 cm dbh classes if the stand average dbh is less than 16 cm. If it is more, 4 cm classes are used. For each class the number of trees is determined on a per hectare basis and, from this, the volume per hectare is derived. Trees are also classified by quality, that is fuelwood, partly merchantable, fully merchantable and dead. The fully merchantable must be at least 6 m tall. The whole tree is put in one of these tree classes depending on the merchantable portion of the tree.
- If the ground volume is within 10% of the photo volume, no corrections to the photo estimates are required. If not, reinterpretation of the photo plots is done. Double sampling for regression is not used. Instead, only photo plot data are used to calculate volumes, etc.

The information given to V/O Lesproekt in Moscow for each forest management unit within these reserved forests is as follows:

- A map of the forest at a scale of 1:100 000 based on the medium and small scale photos.
- For each compartment, ledgers with summaries of volume by dominant species, age classes, forest types, and site classes. A 35% standard error of estimate for volume is recognized.

Table 5 summarizes the work performed by the V/O Lesproekt since 1940. By 1960, they had inventoried, with ground and aerial methods, the entire forest territory of the country. However, a detailed inventory and regulation effort, as well as re-inventory and revision of management plans formulated earlier, covered about 56% as of 1980. The forest area subjected to detailed inventory and regulation, as opposed to general reconnaissance, amounts to approximately 47 million ha annually. During the current five-year plan, about 75% of the forest area of the country will be regulated.

Aerial Photography

In 1922 Soviet foresters began using aerial photography on an experimental basis. An expanded application of black and white panchromatic prints developed after World War II and color spectrozonal photography came into use in 1954. In this type of photography, conifers are shown in a blue-green to green color and broadleaved trees in orange and purple colors of varying intensities. It seems equivalent to the technique known to Canadian foresters as false color photography.

Aerial photographs now used in most forest regulation work are 18 x 18 cm and range in scale from 1:500 - 1:20 000. The scale of photography is governed by the forest regulation intensity classification system (Table 4).

Space Imagery

The expanded application of space imagery to forestry dates back to the late 1960's when space images began to be widely used in monitoring the outbreaks and progress of forest fires in the remote regions of Siberia. However, the application of space photography in forest inventory had its beginnings in 1973. In that year, V/O Lesproekt, jointly with the Institute of Space Research of the Academy of Sciences of the USSR, initiated a series of experiments aimed at interpreting multiband high elevation photographs made with six synchronized cameras within the visible and near infrared ranges of the electromagnetic spectrum.

Table 5. Forest regulation effort in the USSR

Year	Area investigated and partly regulated by ground and aerial methods* (000 000 ha)	Percent of total	Area considered regulated for the first or second time** (000 000 ha)	Percent regulated
1940	480.0	48	130.0	13
1950	567.8	53	191.8	18
1956	1104.5	98	237.4	21
1961	1237.5	100	393.0	32
1966	1233.4	100	441.9	36
1973	1229.6	100	544.6	44
1978	1257.3†	100	611.0	49
1979	1257.3†	100	658.1	52
1980	1257.3†	100	704.9	56
1981–1985 Plan	1257.3†	100	940.2	75

* Mainly data derived from typed aerial photos supplemented with information obtained from aero-visual cruising or reconnaissance with fixed wing or rotary wing aircraft.

** As of 1980, the area regulated (and inventoried) for the second time by ground methods with the aid of aerial or space photography amounted to 232.5 million ha, or 18.5% or the total forest land resource area.

† 1 275 million ha according to other sources. This figure includes forested land, nonforested but suitable for forestry land and nonforestry land.

At the present time, Soviet forestry organizations can draw material on space imagery from three sources:

- Earth satellites of the "Meteor" or "Kosmos" series are equipped with TV scanning devices and produce images within the visible and near infrared bands of the spectrum. These images find practical application in meteorology, in monitoring the progress of forest fires and assessing cloud cover for possible inducement of precipitation. Satellites of these series orbit about 900 km above the earth's surface. The average angle of the orbit relative to the Equator is about 81°, the period of revolution is 102 minutes, and the scale of imagery obtained may range from 1:1 700 000 to 1:12 000 000 with a resolution of about 1.25 km.
- Piloted space ships of the "Soyuz" type are manned vehicles set in space on a periodic basis to do a specific job such as observing various geographical phenomena. Of the space expeditions in this series, the "Soyuz 22" was perhaps the most remarkable from a forestry point of view.
- The Karl Zeiss Plant of Jena, East Germany, built a special six band camera, MKF-6, capable of photographing images from space. The entire camera mechanism consisted of 6 synchronized cameras wih focal length of 125 mm producing images of the earth's surface concurrently within six bands of the electromagnetic spectrum. The result was multiband photography with a resolution of 20 m.
- The "Soyuz 22" with the MKF-6 camera aboard began photographing on September 17, 1977 at an apogee of 280 km, perigee 250 km, declination of orbit at 65°, and time per revolution of 89.6 minutes. Extensive areas were photographed around Lake Baikal, and in the northern and northeastern parts of Siberia. Images obtained from "Soyuz 22" have found application in forest resource inventory work for remote areas and are generally used in combination with standard aerial photographs as well as ground surveys.

  Piloted orbital stations of the "Salyut" series have been used in photographing the earth's surface using cameras similar to those employed on "Soyuz 22."

Computers

Computers and automated data processing methods have been used extensively in the forest inventory operation. Perforated data sheets for sorting field tallies were introduced in 1940, and desk calculators were in common use by the 1960's.

The Moscow office of V/O Lesproekt in 1964 acquired its first computer, apparently a "Ural-2," for use in the development of volume and product tables. At about the same time, the Ukrainian

Forest Surveying Enterprise acquired a computer of the "NAIRI" series. Software for these operations was provided by the All Union Research Institute of Silviculture and Mechanization of Forestry at Pushkino, the Faculty of Forestry, Ukrainian Agricultural Academy in Kiev, and by the Leningrad Forest Research Institute. These organizations are still actively involved in software development for forest regulation.

The period of the ninth five-year plan (1971-1975) marked an expanded application of second generation computers of the "MINSK" series. In recent years, a third generation of computers of the "ES" series has been introduced to forestry work. At the present time, at least 10 computers are operating within 7 regional offices of the V/O Lesproekt organization. Table 6 shows their type, location, and the year of installation.

The 1978 inventory was processed on the "ES-1022" computer, from a data bank of stand, compartment, block, management unit information. Some 70 different tabulations are produced on the various land categories, cover types, growing stock, etc. These reports are essential for planning effective forest management.

The system of records is being revised in conjunction with the development of a new data bank. The Ukrainian Forest Surveying Enterprise is responsible for this new data bank initiative.

We visited the computer center in Kiev. The ES-1022 computer has the following characteristics: 522 kilobytes of memory, 7.8 megabytes of disc storage, (29 megabytes of disc storage at Leningrad), 8 tape drives, 6 disc drives, 2 line-printers at 600 lines per minute, 2 card readers, and 2 paper tape drives. Programs are written in PLI and assembly languages. The information is stored on magnetic discs in sequential rather than direct access files. The basic record is the stand and the geographical data and control information are also coded.

At the Research Department of V/O Lesproekt in Moscow, the computer and mapping equipment is from the United States, France, and other European countries. A partial list is as follows:

- Computers: General Data Corp. (U.S.A.) and IBM CM-4
- Digitizer, Benson 6201 (France)
- Plotters, Benson 400, 1202 and 5342
- Automated mapping system, GRAFIXI (255k)
- TV scanner, Scandic No. 3
- Drum scanner
- Color additive viewer
- Stereoscope G-2 (or Stereocord)
- CRT display unit
- Pericolour 2, IGDS
- Diablo 1641.

Forest Inventory Research

Research Department, V/O Lesproekt, Moscow

Research on inventory methodology is generally contracted out to various research institutes or to universities. However, V/O Lesproekt also maintains a research department in Moscow that concentrates on remote sensing and systems applications for inventory operations. Emphasis is on

Table 6. Computer centers within the V/O Lesproekt organization

Regional V/O Lesproekt offices	Computer make	Year of installation
Belorussian Branch, Minsk	ES-1022	1976
Southeastern Branch, Voronezh	ES-1020	1975
Central Region Branch, Moscow	ES-1020	1976
	ES-1033	1978
Upper Volga (Povolzhe) Branch, Gor'kii	Minsk-32	1972
Northwestern Branch, Leningrad	Minsk-22	1970
Ukrainian Branch, Kiev	ES-1022	1978
	NAIRI-M	1968
	ES-1033	1979
West Siberian Branch, Novosibirsk	ES-1022	1979

the automation of interpretation and measurement techniques applied to aerial and space photographs.

The study of space techniques started in 1975. Space photographs are taken by the MKF-6 camera, which is on board each of the Soyuz manned satellites. The film is brought to earth when the cosmonauts return and is first developed at a scale of 1:2 000 000 and then enlarged to a scale of 1:500 000. These larger scale photographs are used to separate forest and nonforest areas and to map the major land characteristics, roads, and other geographical features. All images are in color and the quality of the photographs shown to us was excellent.

In processing their space imagery as well as the traditional air photos, four basic steps are followed:

1. The images are photographed simultaneously on four bands similar to those used in the LANDSAT satellite series. They are then developed and the transparencies are viewed through a color additive viewer used to bring out or enhance particular cover types or features of interest, for example, conifer stands, fire stands, or cutover areas.
2. The enhanced image is then scanned and digitized by a television scanner and the pixel values are stored in the computer. The digital image is then projected to a monitor (256 x 256 pixels) where classification takes place. Supervised classification involving training areas and various ratioing algorithms are used to establish the tree or forest stand classes.
3. The computer program identifies the trees or class of interest, contours the boundaries (stands or individual tree crowns), and cleans up the supervised classification on the image.
4. The areas are subsequently determined from the pixel values and stored in the computer files for summation and output, either in map or tabular format, at a later date.

All imagery, whether small scale photography, large scale photography, or satellite photography from the MKF-6 camera, is treated in this way. In a production operation, approximately 1.5 million hectares are completed on one 8-hour shift over a 12-week period.

The Research Department of V/O Lesproekt is also responsible for developing computer applications to handle depletion records, particularly those associated with harvesting, windfall, and fire. The process involves steps 1 to 4 above. In addition, the boundaries of the harvested or fire-damaged areas are automatically plotted on standard topographic base maps. The supporting quantitative information on areas and volumes harvested, or burned, is also automatically tabulated during the plotting operation.

Inventories of remote regions of sparse vegetation are carried out using only remote sensing methods. The Moscow-based V/O Lesproekt organization, including the Research Department, cooperates to develop methodology and apply it to inventory the remote desert regions. The procedure is as follows:

- Space photographs at a scale of 1:2 000 000 are enlarged to approximately 1:300 000 and stratification takes place. Areas of desert and vegetation are delineated.
- The strata are then placed on a map at a scale of 1:300 000.
- The map is used to lay out a systematic sample to be taken over the area. Plots are established along parallel lines and the large scale photographs are taken at specified intervals across the strata.
- The photographs are taken at a scale of 1:1 500 and each photo plot measures 15 cm x 15 cm. (equivalent to a ground plot of 225 m x 225 m). On each of the plots, crown diameters are measured and the number of bushes are counted.
- Stratum estimates are computed from the estimates of vegetation density. No ground plots are taken.
- Computer outputs are prepared. The resulting volume estimates are derived from the interrelationships of volume per hectare and the areas of the various strata.

V/O Lesproekt is currently working on the development of inventory data bases, i.e., the placement of inventory data in computers, ready for rapid summary and extraction. This will assist in the planning of future work, which involves forest regulation on 45 million hectares annually. The data base now contains information about each cover type within a compartment, but the stand boundaries have not been digitized and no mapping can be done from the data base. V/O Lesproekt expects to have these problems over-

come and a mapping capability in operation by 1985.

Our discussions on data base construction were seriously hampered by translation difficulties and our understanding of their approaches to this complex problem was seriously limited.

Research Institutes and Universities

There are 15 research institutes administered by the State Committee for Forestry. They are decentralized and managed locally within the various regions.

The All-Union Research Institute of Silviculture and Mechanization of Forestry at Pushkino plans and coordinates basic forest research. It has branches in other parts of the country, and is also responsible for three research stations. It has the following three divisions:

- Silviculture and Biology is concerned with harvesting, reforestation, growth, yield, forest protection, and hunting.
- Mechanization includes planting and the development of machinery.
- Economic and Timber Management deals with inventory, computer science, and mathematical modeling.

There is also associated with the Institute a mechanical demonstration area of 100 000 hectares where prototype models are built and tested. The Institute employs about 3000 people and participates in international programs in which specialists from many countries come to the Institute to work. In inventory, they are particularly interested in developing statistical methodology, and in the use and application of forest and tree growth models.

The development of multi-stage sampling systems based on a statistical design was carried out at this Institute. V/O Lesproekt contracts out many of its research problems to this group, but it also has staff members on retainer at various universities.

We visited Professor A.Z. Shvidenko at the Faculty of Forestry, Ukrainian Agricultural Academy, Kiev, to discuss growth modeling and its application in forest regulation.

The Academy is 84 years old and is one of the largest educational institutions in the country. There are 12 faculties and 14 000 full-time students plus many thousands of correspondence or extension students. It suffered a great deal of damage during the Second World War.

In addition to their teaching responsibilities, the staff also conducts a variety of research projects. For example, they have undertaken herbicide research in cooperation with the Hoars Company in the United States. They have also done considerable research on the production of equipment which will produce muka at the rate of 1.5 tonnes per hour. They have also designed and built a tree planter intended for planting large seedlings or trees in greenbelts and cities.

The Faculty of Forestry at Kiev has about 750 full-time students and 600 correspondence students. There are 10 professors and scientific workers. Students and faculty have access to the Boiarka forest of 18 000 hectares for training and research purposes.

In the forest mensuration sector, the main task is teaching, but they also undertake contract work for V/O Lesproekt. These contracts have involved forest inventory and sampling, the development of reference materials such as standards and site index tables, and the assessment of problems in harvesting from a mensurational viewpoint. The Faculty also cooperates with V/O Lesproekt in remote sensing, particularly the computer aspects and the development of software. Another aspect of their work involves growth modeling, particularly the examination of optimal growth models for various forest stands. Optimum stands are defined in terms of maximum productivity or largest yield at maturity. They also define minimum waste and include recreation and other similar values. From this background information, they develop a function and maximize it. The maximum is at a later age than is normally considered usable; from that they decide on the optimum age. For these purposes, they develop stand models and use them for testing various alternatives. Growth functions used are the modified Richard Chapman's or Gompertz equations and are solved in an iterative manner.

Summary and Conclusions

V/O Lesproekt, the All Union Forest Air Survey Association, has the mandate for inventorying the forests, preparing management plans, determining the annual harvest, and monitoring the forest for change from natural (pest, fire, wind) and man-made causes (harvest, roads, reservoirs). It is the only forest survey organization in the USSR.

The priorities for the inventory program are established by the State Forestry Committee and responsibility is delegated to V/O Lesproekt, which in turn assigns the operating tasks to the appropriate regional Enterprises. Program development and coordination are centralized in Moscow, but the operations are carried out in the highly decentralized Enterprises.

Remote sensing, the use of aerial and space photographs in the survey operation, is highly developed. Photography is used at all levels of inventory, but the most sophisticated applications occur on surveys of northern and desert lands where the photo plot estimates of volume and nonwoody materials are used to develop the stratum values. On the more intensive surveys, photography is only used for classification purposes and the delineation of forest stands.

In the absence of digital data from Soviet space vehicles, V/O Lesproekt uses space photographs taken by the MKF-6 camera. The film is returned to earth by the cosmonauts working on the Soyuz space stations. The quality of this photography is excellent and the resolution appears to be very good. It is used extensively in delineating forest and nonforest land and in classifying the forest for sampling purposes.

A major innovation is the methodology in the digitizing of aerial and space photos in order to automate the classification and assessment processes. This technique is applied to photographs ranging in scale from 1:2 000 000 to 1:1 000. The method is operational and used annually to process data on 10 million hectares of forest land. However, this application appears to be unique to the Research Department of V/O Lesproekt. No similar approaches were seen in Leningrad or Kiev.

Soviet space information is now being received in digital mode, much like the LANDSAT computer compatible tapes. Their use of this information is in the development stages.

A visit to the Exposition of Economic Achievements indicated that utilization of stump, roots, branches, and tops, in addition to the mainstem, was increasing rapidly in the more populated areas of the USSR. The various displays at the Exposition showed that the production of chemicals, particleboard, and other products such as foliage flour had more than doubled over the past few years as a result of the increased utilization of wood materials previously considered waste. Repeated questioning of our hosts indicated that they were aware of these developments, but were not considering any major change in their inventory procedures or in the manner of preparing reports summarizing the quantities of timber available for utilization.

The remote sensing and computer-assisted mapping operation in Moscow, although used operationally, seemed to be in a research and development stage. It was dificult to determine how they were handling their large masses of inventory data since the appropriate software was not complete. For example, the system could not handle either the batch complexities of polygon or the automated labeling of maps from the attribute list. Translation difficulties and the interpreters' limited knowledge of computer terminology resulted in some frustration on the part of the delegation in attempting to ascertain how their new data base is being constructed and how they now handle the plot and stand records developed from the digitizing process.

Our assessment of their map production facilities was limited to the procedures used for mapping and tabulating areas and volumes of burned and cutover lands. The data on the boundaries of the disturbance are generated from the space photo-digitizing-classification process and plotted automatically on base maps prepared by the national cartographic agency. The completed maps also contain detailed tabular information on the stand volumes either harvested or burned.

While they have the capability of producing forest cover maps in this manner, particularly for the reserve forests and desert lands, our review of their maps for the level III inventory (general forest management planning) indicated that they were drafted by hand and only prepared in limited

quantities. At the national level, the map seen in Leningrad, showing the distribution of forest types throughout the country was also compiled and colored by hand.

It seems, therefore, that the methodology of computer-assisted photo interpretation and map production is confined to the Moscow offices of V/O Lesproekt and is not yet available for transfer to the regional Enterprises of the survey organization. The completion in 1985 of the data base software that will accommodate cover type information, as well as digitized boundary data, will permit computer-assisted mapping to take place at all inventory levels.

Our general impression of the computing facilities in the Enterprises we visited was mixed. The operations appear to be efficient; however, there still seems to be a fairly extensive use of punched paper tape and the noise level within the computing area was high. No terminals were seen outside the computer room and, even within the computer room, there were no video screens or remote terminals that could be identified. They do not seem to use an interactive mode on their computing systems, and all their information seems to go in batch processes.

To assess the USSR research effort in forest inventory, we visited the All-Union Research Institute of Silviculture and Mechanization of Forestry and the Ukrainian Agricultural Academy. There we discussed the broad concepts of modeling and the objectives of V/O Lesproekt in applying the models for inventory update and the forest regulation process.

It was our impression that the approach to modeling is basically a stand approach using nonlinear equations to describe the volume-age relationship. They are well aware of the approaches used in North America, but are probably approaching the problem in this way because of the inventory data available for projection and update purposes.

It is difficult to evaluate the level of mensurational practice on such a trip; but it did seem that they had stand volume tables, empirical yield tables, and other tables for all their growth types and for all forest regions. A brief review of the published material provided to us at each of our visits, suggest that they have developed the necessary mensurational tools required to quantify the forest and manage it for their objectives. Emphasis appears to be on stand parameters and estimates rather than tree parameters.

Manpower does not seem to be a problem in carrying out their work, but they are seeking new ways to reduce costs. The application of the computer-assisted mapping program and the implementation of growth models is aimed at maintaining their inventory in an updated manner and increasing the interval between inventories from 10 to 20 years.

During the tour, we presented slide shows on the British Columbia forest inventory and the national forest inventory. It was at these sessions that we were introduced to many of the working foresters and scientists. Our hosts found these presentations to be of great interest as evidenced by the many questions asked about our equipment and the processes involved.

The hospitality on the trip was excellent. Mr. Moroz and his staff, including those in the Enterprises, made a genuine effort to make us feel comfortable and to introduce us to the cultural features of each region. The opportunity to meet with scientists and operating personnel associated with the V/O Lesproekt organization was greatly appreciated by the authors.