Application of sampling method in Lithuanian national forest inventory

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As a result of investigation continuing in Lithuania since 1966 the design, technology and contents of national forest inventory (NFI) were based. Practical implementation of NFI on the whole Lithuanian territory was carried out in 1998 along with standwise forest inventory. The first remeasurement of established permanent plots will be finished in 2007 year. NFI is based on the method of continuous, combined, multistage, systematic with random start sampling design. Continuity is guaranteed by combining permanent – regularly remeasured, invisible for foresters and temporary – regularly renewed sample plots. Measurements in forest and database of digital satellite image map are combined in sampling design. The main aim of NFI is to conduct complex and reliable monitoring of natural resources in the forests. It allows us to control the dynamics of forest areas, cuttings, tree damage, reforestation and efficiency of silvicultural measures at the state level in the most effective way – growing stock increment balance. Information obtained by NFI will provide the basis for objective forest statistics, forest resources forecast, and simulation of the dynamics, strategy of policy and control of its efficiency.

Key words: continuous forest inventory, sampling design, permanent plots, forest statistics.

Introduction

The methods of traditional forest inventory in individual stands are aimed at obtaining information on detailed and effective planning and organization of forestry on a certain territory. Without essential changes in assessment methods and technologies used at present, it is impossible to guarantee effective and sufficiently precise parameters needed to ascertain changes in the state of forests, to perform strategical planning and assessment at the level of the whole country. A great deal of important parameters at present, such as timber increment, mortality and allowable cut, tree damages, in general, cannot be reliably determined by applying previous methods. Many problems in forest inventory have arisen after appearance of the private forest sector in Lithuania with very small holdings. These circumstances have led to the organization of national forest inventory (NFI) based on a sampling method.

Along with standwise forest inventory, continuous national forest inventories at country level are carried out in Sweden (Ranneby et. al., 1987), Finland (Kuusela, 1978; Tompo, Sittonen, 1991), Norway (Tomter, 1993), Switzerland (Schmid – Haas et. al., 1993), Austria (Schieler et. al., 1995), in other European (Study..., 1997) and North American countries (Barton, 1960). In the USA such inventories are usually conducted not at national level, but at the level of different forest companies, states, on an area of several million hectares (Bicford et. al., 1963; Smith, 1986).

Experiments of NFI in Lithuania

Following experimental forest inventory carried out by a sampling method in 1966-1968 in the Kazlų Rūda and Prienai forests, in 1969 all state forests in Lithuania were inventoried by statistical method (Kuliešis, 1971; Antanaitis, Repšys, 1973). Then it was foreseen to repeat statistical inventories every 10 years, however, they ceased due to a series of reasons.

First of all, the inventory of 1969 was aimed at single sampling. The sampling design contained no permanent observation plots guaranteeing sampling continuity. Forest inventories carried out at that time in the Democratic Republic of Germany (Grossmann, 1968) every year by using only temporary plots have shown a considerable variation in the results which cannot always lead to reliable assessment of the dynamics of forest resources. In Lithuania such work lacked methodical background. There were no methods or standards for the estimation of stand parameters on an individual plot by applying small-size samplings. Some foresters 5) control the state of forest sites, their yield dynam

were confused by the obtained high volume of the growing stock (on average 165 m³/ha), as compared to 120 m³/ha which was announced at that time and referred to in 1958-1963, or the one found in forest resources assessment of 1966- the mean volume 113 m³/ha. It was not taken into account, that inventories, the volumes of which were being compared, had been separated by an interval of 10 years and that actual volume differences from the viewpoint of time, comprised only 7.3%. For these reasons sampling inventory in the forests of the country failed to be carried out regularly.

However, inventory of state forests in 1969 by sampling method has played a significant role in improving inventory of forests. In post-war years, seeking to protect Lithuanian forests against boundless felling, growing stock volumes were considerably reduced. Growing stock volumes ascertained in 1958-1963 and later were "growing" faster than it could be explained by stand volume increment or its accumulation in a stand. The data of sampling inventory in 1969 allow us today to balance out the dynamics of growing stock volume in post-war Lithuanian forests, ascertain forest inventory discrepancies of that time, and obtain a valid growing stock increment balance.

In order to devise a method of controlling stand yield in 1976 in the Dubrava forest continuous NFI on large forest scale was initiated, while in Sviloniai forest district of Jonava Forest Enterprise- experimental inventories of individual stands (Kuliešis, 1980, 1981, 1982, 1985, 1989). Essential difference of these inventories from former ones lies in the combination pattern of permanent inventory plots which are used also for the control of management activities with temporary plots in sampling design. In 1976 in the Dubrava forest on the area of 5.7 thous. ha 188 permanent sample plots were allocated and measured. In 1981, 1986, 1991 and 1996 they were remeasured. In the Sviloniai forest district of Jonava Forest Enterprise at the same time experimental work was done in 14 stationary pine, spruce and birch stands of thinning age. A quite new methods for plot allocation, marking, data processing and analysis were elaborated, theoretical and methodical basis for the estimation of the growing stock increment and its balance dynamics was laid (Kuliešis, 1989, 1991, 1994, 1998).

In 1996 experimental continuous NFI was proceeded in the forests of Jūrė forest district of Kazlų Rūda Training Forest Enterprise (Kuliešis, 1996). The aim of this work is to prepare for continuous sampling inventory in Lithuanian forests by improving its methods, sampling units, their construction, by elaborating technologies based on modern measurement tools and the means of data recording, and by working out a method of data collecting, control, storage and PC processing programs. For the first time in sampling inventory of Lithuanian forests in 1996 ultrasound distance measurers were applied, the position of trees was determined according to the distance and direction measurements, the data were recorded by field computers as well as other up-to-date measuring equipment. As a result of studies, theoretical, methodical and practical preconditions to organize continuous NFI by a sampling method in Lithuania were created.

Aims and objectives of NFI

The aim of national forest inventory is to conduct thorough monitoring of Lithuanian forests for efficient (with the accuracy planned in advance) assessment of the main forest parameters in the country or its regions. The structure of parameters, their accuracy have to meet the requirements of assessment of the state – of – art of forests, forest policy - making and changes in forests under strategical planning. The data obtained during NFI are used for official statistics on Lithuanian forests.

The object of national forest inventory is the whole territory of the country, which according to the Lithuanian Forest Law is qualified as land used for growing forests and at the time of inventory subordinated to forest enterprises, national parks, strict reserves, other state institutions, private persons or is to be returned to former owners. In order to guarantee observation of the dynamics of land property, evaluation of afforested land, national forest inventory will help us control the whole territory of the country.

The main task of NFI in all Lithuanian forests according to ownership property forms is to:

1) control the dynamics of forest areas,

2) estimate growing stock resources, their structure and the dynamics at desirable precision,

3) determine the validity of other inventory methods of wood resources,

4) provide guarantees in the most effective way – the balance of the growing stock increment:

-control of growing stock resources, their utilization,

- control of management efficiency at the state level,

- control of forest felling and reforestation,

- reliable strategic planning of forestry development;

5) control the state of forest sites, their yield dinamics, utilization efficiency,

6) assess the state – of – art of forests,

7) assess the dynamics of forest ecosystems, their health, damage and biodiversity.

Besides, by using the network of plots, other silvicultural and nature - protective questions may be tackled:

1) game fauna abundance, account of its damage,

2) efficient evaluation of damage caused by storms, pests or diseases,

3) continuous survey of changes in soil fertility,

4) account of other forest resources, etc.

Sampling design

National forest inventory started in Lithuania in 1998 was based on the method of continuous, combined, multi-stage sampling. Sampling of units is carried out systematically at random start by combining repeated inventory of permanent plots with measurements of temporary plots, and by combining overground measurements with the measurements and assessment on satellite image maps and aerial photos.

The aim of allocation of permanent plots is to estimate reliably (by way of repeated measurements) volume increment of trees, mortality and allowable cut, to control the dynamics of forest area in the country. Transformation of other land into forest is controlled by satellite image maps and aerial photos every 5 years. Temporal plots are aimed at controlling sampling representativeness of permanent plots, at increased tree volume estimation efficiency by applying regression estimation methods. NFI sampling units were based on the division of Lithuania's territory into of 5x5 km squares on LKS-94 maps, on the scale 1:10000. Each square of 5x5 km is subdivided into 25squares of 1x1 km, while the latter into four squares of 500x500 m (Fig. 1).

At the first stage sampling data basis of satellite map (scale 1:50000) is used. On the whole territory of Lithuania sample plots are scattered, every 250 m according to which the area is assessed by land categories: forest land, forests, formed on abandoned agricultural land, brush, sands, quarries, peatlands, arable land, urban territory: towns, settlements, farmsteads; waterbasins: rivers, lakes.

For the second sampling all the plots were taken, which at the first stage had been ascribed to forest land category. Every sixty-fourth plot from the first stage was chosen for continuous permanent overground measurement. Optimizing inventory design according to time consumption and object representation degree of sample units of different construction, the purposefulness of grouping the plots in four were ascertained. For this purpose on square of 1x1 km 4 groups were formed. In each of them 4 plots were set up. A group of plots in the NW corner the square of 500x500 m was used for continuous and permanent measurements, other groups – for temporal ones. (Fig. 1B).

In order to distribute permanent plots more evenly on the whole territory, as well as regularly control transformations of other land categories and forest growth there, a strictly systematic distribution pattern of permanent plots was applied. Groups of temporary Tree

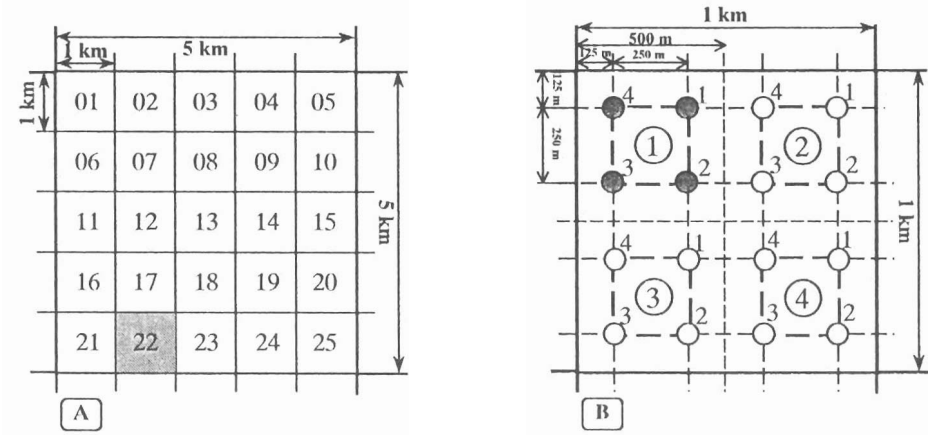

Figure 1. Sampling of NFI plots

A – subdivision of primary square of 5x5 km on 1:10000 scale map into squares of 1x1 km;
B – allocation of sample plots at the first sampling stage;
①, ..④ – numbers of plot groups; 1, 2, 3, 4 – numbers of sample plots
○ – permanent and ○ – temporary plots at the second sampling stage.

plots were selected randomly from plot groups of the first stage which had been attributed to forest land and inappropriate for continuous permanent inventory.

Given the number of homogenous stands (strata), minimal growing stock volume and increment estimation accuracy, it is planned to establish not less than 1000 plots in the forest and measure every year, and over a five-year period 5000 permanent sample plots. During the following 5-year period every year permanent plots will be remeasured and a similar additional number of temporary plots will be set up. At the second stage sampling intensity of forest land over 10 years will comprise 0.02%, on permanent plots – 0.0125%. Thus, one group of permanent plots falls per 16 km² of the territory. In accordance with kilometric network of coordinates, groups of plots were distributed every fourth line and every fourth kilometric column alternately every 4000 m. (Fig. 2A).

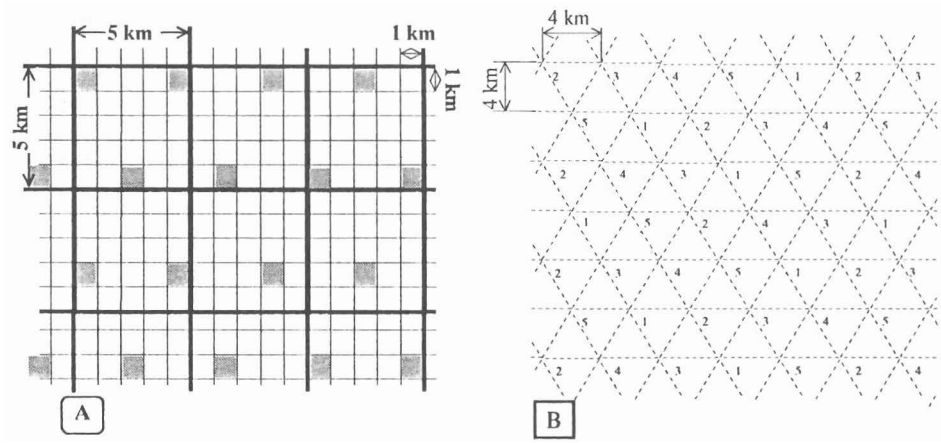

Figure 2. Sampling of plot groups – tracts at the second stage (A) and design of their distribution by years (B)

In order to eliminate sampling subjectivity, the location of the first permanent tract is determined at random. The following procedure is used: sampling starts from square of 5x5 km in the centre of Lithuania (Fig. 1A). In this square, randomly, from 25 squares of 1x1 km twenty – second square has been chosen, in which according to Figure 2A the first tract is marked.

At the third stage in measurable plots trees are selected to estimate their height, age, increment, quality, damage. They are chosen by using sampling proportional to the size of chosen trees, most often to their diameter, as well as systematically, or systematically with random start. Sampling intensity comprises 20-30% from all trees, the diameters of which have been measured. In permanent plots, seeking to protect trees from injuries while boring holes, their age is determined according to analogous trees growing nearby the plot in the same stand. This is usually done in angle count plots.

Types of sample units, their functions

The principal sample unit is a permanent plot of fixed radius (Figure 3).

The area of the main plot in horizontal projection is 500 m² (R=12.62 m). For plots allocated on sloping location, their radius is increased taking into account the surface of sloping. On the main plot all trees over 14.0 cm in diameter are measured. In the centre of the plot another a plot of 100 m² in size is singled out, where all trees over 6.0 cm in diameter are measured. In the first quarter of the plot of 100 m² in size, i.e. on 25 m² area of naturally growing saplings, shoots over 2.0 cm in diameter at 1.3 m height, as well as all planted trees independing of their dimensions are measured and mapped.

Undergrowth and underbrush are taken into account in a 3x20 m strip-like plot allocated within the main plot in the movement direction of 10 m to both sides from the plot centre (Fig. 3).

At the distance of 20 m from the centre on both sides of the movement direction 2 plots of angle count with transfer coefficient K=2 are allocated. The data of this inventory are used to determine stand species composition, age and increment according to primary measurement data.

Sample plots are allocated in tracts, the edges (250 m long) of which are orientated in N-S, E-W directions (Fig. 4). The centre of a circular plot is 25 m away from the edge of a tract. By using measurement tape of 50 m long the objectiveness of plot centre selection is ensured.

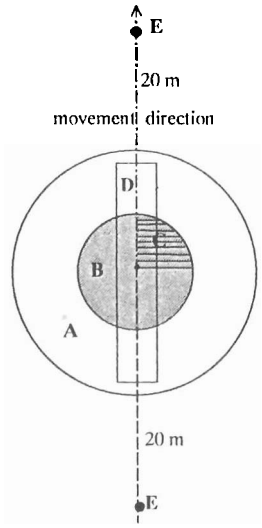

Figure 3. Construction of the main sample plot

A – sample plot for inventory of trees and stumps with diameter over 14.0 cm
B – sample plot for inventory of trees and stumps with diameter over 6.0 cm
C – sample plot for inventory saplings with diameter over 2.0 cm and all planted trees
D – strip sample plot for inventory of undergrowth, natural regeneration and underbrush
E – angle count sample plot for basal area estimation

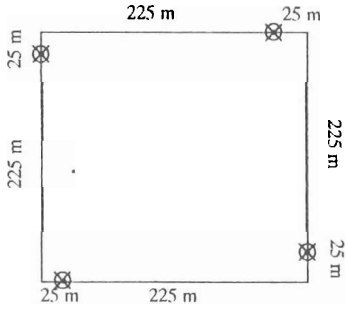

Figure 4. Allocation of sample plots in tracts

○ - sample plot of trees
• - sample plot of area estimation
\ - sample plot of stumps
/ - sample plot of natural regeneration

sampling plots are allocated on forest land overgrown with forest (forest plantations up to 10 yr.) and bare forest land (cutting area, dead stand, glade, and land area for afforestation).

Plots of angle count are allocated in stands with the mean diameters over 10 cm. In stands with less mean diameter the volume increment during the first inventory is ascertained by a simplified method according to tree volume in the main plot and their age determined behind the borders of the permanent plot.

The main characteristics of NFI in Lithuania and other European countries

National forest inventories by using permanent sample plots in North American countries have been carried out since 1930, while in Europe only since the 1980. Scandinavian countries having the oldest traditions of NFI by sampling method started using permanent sample plots only in 1983, Austria – in 1986. At present the most forested European countries perform national forest inventories using permanent sample plots (Table 1). Sampling schemes applied in European countries represent the peculiarities of forests of each country, their importance, other originalities of these countries. In most cases plots are grouped. Only in France with less forests or Switzerland with hilly relief sample plots are allocated individually. In most countries 4 plots are distributed in each square tract. Scandinavian countries in northern low yielding and heavier accessible forests use bigger groups. Groups of plots are often allotted every 4 km and only in northern forests every 8-16 km. Plots within a tract are allotted every 150-600 m. This is preconditioned by the size of sites, road network and accessibility of the location. Most countries use circular plots of 250-500 m^2 and only Austria, Germany, partially Finland – angle count plots. The size of sample plots depends on forest diversity, their composition peculiarities. In northern more homogeneous forests smaller plots are used, while in countries with high yielding forests – bigger ones. One sam-

Table 1. The characteristics of national forest inventories of European countries by a sampling method

Country	Start year	Characteristics of continuous inventories								
		Start of permanent plots application	Grouping of plots					Permanent sample plots		
			Tract shape	Distance between tracts, m	Tract edge length, m	Number of plots per tract	Distance between plots, m	Type	size, m^2	repre - sented area, ha
Austria	1961	1986	square	3.9	200	4	200	Angle count	K=4	377
Norway	1919	1986	square	3.0		2 and >		Circular	250	900
France	1962		Individual plots				600	Circular	1963	36
Finland	1921	1984	square	7-16	1300-2100	3-4	400-600	Circular	300	7644
Sweden	1923	1983	square	4-16	300-1200	4-8	300-600	Circular	314	1000
Switzerland	1983	1983	Individual plots				1400	Circular	500	200
Germany	1986	1986	square	4	150	4	150	Angle count	K=4	400
Lithuania	1969	1998	square	4	250	4	250	Circular	500	400

ple plot on average represents a forest area of 200-1000 hectare.

The Lithuanian NFI sampling design was based on investigation results obtained over 30 years. Lithuania's forest area coverage, the role of forests in the country's economy at present and in the future, accessibility of forests, stand size, species composition, diversity of site conditions were taken into account as well. In accordance with many parameters Lithuanian NFI conforms to the parameters of inventories of European countries with long-lived traditions in forestry and forest inventory.

Organizing of measurement, data processing and perspectives

Inventory is carried out each year on the whole territory of Lithuania. Over the first five years the network of permanent sample plots is consistently thickened. During every following five year period permanent plots are remeasured and temporal plots may be renewed. Time span between remeasurements of permanent sample plots is 5 years ±20 days.

During every five-year period according to available recent mapping material, satellite and aerial photos, the appearance of new forests is controlled. There, according to the accepted sampling scheme new temporary and permanent sample plots are established.

The State Forest Inventory and Management Institute conducts national forest inventory. A total of 2-3 fieldwork groups and one control group make measurements in the forest. A group of 5-6 specialists plans inventories, controls data collected, processes them, analyses, elaborates programs, prepares statistical issues. The institute is responsible for timely inventory according to foreseen technologies described in the corresponding instructions of field work, as well as for statistical publications based on study results.

The members of control group regularly check measurements in permanent and temporary sample plots. Not less than 5% of all sample plots are checked in the absence of the measurement group. Control results are used to correct major mistakes, to estimate the quality of work done and the competence of the employees, to improve the methodology of measurement.

All measurement data are recorded in field computers with a special checking program. Every 2 weeks the data are brought to the institute and loaded on PC. Additional control is exercised. Mistakes found in the data are sent back to the measurement groups for correction. Specified and finally checked data comprise primary database, which is kept in PC. They are used for the assessment of the statistics, and any correction afterwards is not allowed. Primary data, separately on permanent and temporal sample plots, are stored according to measurement years. Each year database is supplemented by the data of measurement years. Primary data are stored in an original form and used for data processing. During calculations, primary data are copied; temporal databases are formed. While processing the data of recent years, the data on permanent and temporary sample plots of not less than a decade are combined. For processing identical regression functions of tree stem volume, the increment and related indices are applied. Under changes in functions, the impact of these changes on the assessment of the main indices is ascertained. These data will be announced in annual statistical reports.

During NFI such statistics and their accuracy (sampling errors) concerning all Lithuanian forests will be estimated (by property form, natural yield regions, sites, other administrative subdivision as well):

- object area,
- area distribution according to land category, tree species, age, stocking level, sites,
- tree species composition on an area and growing stock volume,
- growing stock volume and its structure (distribution of tree species and diameters),
- the growing stock volume increment over 5, 10 years, its structure,
- cutting area and its distribution according to the kind of cuttings,
- felled out volume of trees and its structure,
- the volume of dead, windthrown trees and their structure,
- the balance of the growing stock volume increment and its structure,
- the spreading of tree damage, causes and intensity,
- abundance of undergrowth and natural regeneration, structure and damages,
- abundance of underbrush and damage.

The characteristics obtained in the course of national forest inventory by objective sampling methods are valid, of known precision. They comprise the base of Lithuanian official forest statistics and can be used to estimate the validity of characteristics obtained by other methods, including individual sites. Multiple regression functions among different forest stand parameters, ascertained by measurements on NFI sample plots, are used to test or control parameters of the growing stock volume, its increment, balance, mortality or felled out volume of standwise inventory.

Along with NFI practical work, studies concerning inventory improvement will be continued. The main trend in inventory improvement is the following: the development of estimated parameters nomenclature, greater estimation validity and accuracy of parameters' reduced labour input, wider application of remote sensing methods, analysis of forest resources dynamics, improvement of inventory standards, simulation of stand growth and formation functions depending on a series of factors.

Summary

The main parameters of the Lithuanian NFI design based on the investigations conducted over thirty years are adequate to the design of countries having greater experience in forest inventory by sampling method. The network of permanent sample plots established on the territory of Lithuania will ensure estimation of the main parameters of forest area dynamics and a forest growing there. Combination of the results obtained by small overground sample plots with information received with the help of remote sensing methods will ensure vast possibilities in the future to increase efficiency of the method.

The NFI results will ensure an efficient estimation and control of forest area coverage, its dynamics, cuttings, reforestation, potential yield, its utilization and silvicultural measures for yield regulation in Lithuania.

Information obtained by NFI will provide the basis for objective forest statistics, forest resources forecast, simulation of the dynamics, strategy of economy and control of its efficiency. Biodiversity and its dynamics in Lithuanian forests will be controlled permanently. The network of permanent sample plots will allow us to conduct complex and reliable monitoring of natural resources in the forests.

References

Barton W. W. 1960. A method of Continuous forest inventory. Division of state and private forestry. U. S. Dept. Of agriculture, Upper Darby, Pa.

Bickford C. A., Mayer C. E., Ware K. D. 1963. An efficient sampling design for forest inventory the Northeastern forest resurvey. Journal of forestry, vol. 61. No. 11.

Grossmann H. 1968. Zielstellung, Methode und Ergebnisse der in der DDR durchgefuehrten permanenten Grossrauminventuren. Internationale Zeitschrift der Landwirtschaft, No 6. (in German)

Kuliešis A. 1985. Dendrometrinės informacijos apdorojimas ESM. [Processing of dendrometric information by ESM Recommendations, LFRI, manuscript, 19p]. Rekomendacijos, LMŪMTI, rankraštis, 19 p. (in Lithuanian)

Kuliešis A. 1985. Medienos pricaugio dinamikos tyrimai Dubravos miškų tyrimo stoties miškuose.[Studies on timber increment dynamics in the forests of Dubrava Forest Experimental Station. Timber increment simulation questions: Proceedings of LAA]. Kaunas - Norcikiškės, p. 23–25. (in Lithuanian)

Kuliešis A. 1989. Medynų našumas ir jo panaudojimas. [Yield of forest stand and its use]. Vilnius, 141 p. (in Lithuanian)

Kuliešis A. 1991. Medienos išteklių apskaitos tobulinimas Lietuvos miškuose. [Improvement of timber resources assessment in Lithuanian forests]. Girios, No. 10, p. 24. (in Lithuanian)

Kuliešis A. 1994. Medynų statistikų įvertinimas pagal skirtingo ploto apskaitos barelius. Lietuvos miškų instituto mokslo darbai. [Estimation of stand statistics by plots of varying size. Proceedings of Lithuanian Forest Research Institute]. Miškininkystė, 34t., p. 112-128.

Kuliešis A. 1996. Nacionalinės miškų inventorizacijos Lietuvoje metodikos tobulinimas. Lietuvos miškų instituto mokslo darbai. [Improvement of national forest inventory methodics in Lithuania. Proceedings of Lithuanian Forest Reseach Institute].Miškininkystė, 2 (38) t. Kaunas, p. 81 – 95. (in Lithuanian)

Kuliešis A. 1998. Medynų našumo ir jo balanso įvertinimo nacionalinėje miškų inventorizacijoje metodiniai pagrindai. [Methodical basis for the estimation of stand yield and its balance in national forest inventory]. LŽŪU; Konferencijos "Miško ūkio ir aplinkos apsaugos problemos" tezės, p. 14 – 15. (in Lithuanian)

Kuliešis A., Kenstavičius J. 1977. Miško ūkinės veiklos įvertinimas permanentinės inventorizacijos metodu. Žemės ūkio ekonomika. [Estimation of silviculture activities during permanent inventory. Agricultural economics]. LŽŪA mokslo darbų rinkinys. Kaunas - Noreikiškės, p. 64 – 65. (in Lithuanian)

Kuusela K. 1978. The national forest inventory in Finland. Joint meeting IUFRO groups S 402, S 404. Bucharest, p. 368-377.

Nacionalinės miškų inventorizacijos darbo taisyklės. [National forest inventory manual.] 1998. Paruošė A. Kuliešis, A. Kasperavičius. Kaunas, p. 123. (in Lithuanian)

Ranneby B., Cruse T., Hägglund B., Jonasson H., Swärd J. 1987. Designing a new national forest survey for Sweden. Studia Forestalia Succica No 177, 29 p.

Repšys J., Kuliešis A., Verbyla V. 1973. Lietuvos TSR valstybinis miškų fondas 1969 metais ir jo analizė. [State forest fund of the Lithuanian SSR in 1969 and its analysis]. Lietuvos Žemės ūkio akademijos mokslo darbai, t. 19, 3 (52), p. 17-30. (in Lithuanian)

Schieler K., Büchsenmeister R., Schadauer K. 1995. Osterreichische Forstinventur. Ergebnisse 1986/90. Forstliche Bundesversuchsanstelt Wien, 92, S. 267. Study on European forestry information and communication systems, 1997. Reports on forestry inventory and survey systems. Volume 1-2. Belgium, Luxembourg: office for official publications of the European communities. 1328 p.

Schimid-Haas P., Baumann E., Werner J. 1993. Foret inventories by unmarked permanent sample plots: instruction.-Birmensdorf: Swiss Federal institute forest, snow and landscape research, 135 p.

Smith W. B. 1986. Timber resourse of Wisconsin's Northwest Survey Unit, 1983. North central forest experiment station. Resource Bulletin NC 73, 97 p.

Study on European forestry information and communication systems, 1997. Reports on forestry inventory and survey systems. Volume 1-2. Belgium, Luxembourg: office for official publications of the European communities. 1328p.

Tompo E., Siitonen M. 1991. The National forest inventory of Finland. The Finnish forest research institute. 8 p.

Tomter S. M. 1993. Statistics of Institute of Land Inventory, AS. 96 p.

Антанайтис В., Репшис Й. 1973. Опыт инвентаризации лесов Литвы математико-статистическим методом. [Experience on forest inventory in Lithuania by mathematical – statistical method]. М., Лесн. Пром-ть. 104 p. (in Russian)

Кулешис А. 1971. Опыт определения запаса древесины государственных лесов Литовской ССР выборочным методом. [Experience of growing stock resources estimation in the state forests of Lithuania by sampling method]. Диссертация на соискание канд. с.-х. наук. Каунас, 183 с. (in Russian)

Кулешис А. 1980. К вопросу создания нормативной базы контрольного хозяйства. [Standard basis to control forest management]. Научные труды Лит.СХА. Лесное хозяйство и лесная промышленность. Каунас, с. 26-28. (in Russian)

Кулешис А. 1982. Моделирование динамики некоторых параметров сосновых древостоев при непрерывных выборочных лесоинвентаризациях. [Modelling the dynamics of some parameters of pine stands under permanent sampling forest inventory]. Комплексное ведение хозяйства в сосновых лесах. Тезисы докладов. Гомель, 103-105 с. (in Russian)

Кулешис А. 1989. Теоретическое и экспериментальное обоснование системы контроля производительности древостоев.[Theoretical and experimental basis of stand yield control system]. Диссертация на соискание учёной степени доктора сельскохозяйственных наук. Каунас, 484 с. (in Russian)

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ПРИМЕНЕНИЕ ВЫБОРОЧНОГО МЕТОДА ДЛЯ НАЦИОНАЛЬНОЙ ИНВЕНТАРИЗАЦИИ ЛЕСОВ ЛИТВЫ

А. Кулешис

Резюме

В результате исследований проводимых в Литве с 1966 г. были основаны схема выборки, технология и содержание национальной инвентаризации лесов (НИЛ). Для НИЛ использована многоступенчатая, комбинированная, систематическая со случайным началом схема выборки. Непрерывность гарантируется сочетанием не менее 5000 постоянных регулярно переизмеряемых не видимых для посторонних и временных - вновь закладываемых учетных площадок. Сочетаются измерения в лесу с оценками на картах космического изображения и ортофотокартах. Главная задача НИЛ - создать комплексный и надежный мониторинг лесных ресурсов. НИЛ позволяет контролировать динамику лесных площадей, рубок, лесовостановления и облесения, эффективность лесохозяйственых мероприятий на государственом уровне самым надежным образом - на основе метода баланса текущего прироста. Информация получаемая НИЛ является основой для лесной статистики, прогноза лесных ресурсов, моделирования их динамики, обоснования стратегии лесной политики и контроля эффективности её внедрения.

Ключевые слова. Непрерывная инвентаризация леса, схема выборки, постоянные площадки, лесная статистика.