State Forest Inventory in Russia

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Lecture content

1. Introduction
2. History of statistical inventory in Russia
3. State forest inventory sampling design overview
4. State Forest Inventory: first results, main problems and perspectives
5. Discussion and Conclusions.
Introduction
Some general figures about Russian forests

• Total area of Russia accounts for 1709,824,6 thousands of hectares
• Total area of the forests is 1,183,385,3 thousands of hectares or 69,2 % of total area
• Covered by forest area is as much as 795,257,2 thousands of hectares
• According the officially published figures, Russia hosts about 22% of the world forest area.
• For comparison, the next largest forest countries own: Brazil – 16%, Canada – 7% and USA – 6% of the world’s forest cover.
• Total growing stock – 83,0 billions (10^9) of cubic meters
• Mean annual gain of wood – 1,019.6 millions of cubic meters or 1,32 cubic meter per hectare of lands covered by forests
• Mean growing stock per hectare for lands covered by forest – 105.0 m^3, in mature and over mature forests – 129.7 m^3.
• Growing stock per capita is 600 m^3 second in world after Canada – 900.1 m^3, in Finland – 328.1 m^3, in Sweden – 272.7 m^3.
Main part of Russian forests – boreal (88%)
10 countries with the largest forest area
Total forest area \((10^6 \text{ ha})\) dynamics
European forests and forests of European and Asian parts of Russia

<table>
<thead>
<tr>
<th></th>
<th>Area, $10^6$ ha/%</th>
<th>Growing stock, $10^9$ m$^3$/%</th>
<th>Annual increment, $10^6$ m$^3$/%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>233.7/20.8</td>
<td>26.8/24.3</td>
<td>903.9/47.6</td>
</tr>
<tr>
<td>European Russia</td>
<td>174.4/15.5</td>
<td>22.9/20.8</td>
<td>377.2/19.9</td>
</tr>
<tr>
<td>Asian Russia</td>
<td>717.5/63.7</td>
<td>60.6/54.9</td>
<td>616.6/32.5</td>
</tr>
</tbody>
</table>
Wood harvest history \((10^6 \text{ m}^3)\). In 2013 – 193,3
Allowable (red) and real cuttings dynamics ($10^6 m^3$)
Share of real cutting from allowable (%)
Some non wood forest resources

- Mushrooms – producing area 81.8 millions of hectares, capacity 4.3 millions tons.
- Hunting animals (10^3 individuals):
  - Bears - 150-160
  - Lynx – 20-22
  - Elk – 500-600
  - Boar – 250-350
  - Roe – 800-850
  - Marten – 200-230
  - Sable – 1200 – 1500
  - Hare – 4500 – 5000
- Hunting birds (10^3 individuals)
  - capercaillie – 3800-4000
  - blackcock – 10000-11000
- Forage (10^6 ha)
  - hay fields – 1,8
  - forest pastures – 11,6
  - north deer pastures – 300
- Fruits (10^3 ton) – 1632
- Nuts (10^3 ton) – 3520
- Berries (10^3 ton) - 8260
- Medical plants – 3000 species
Ownership, Income and Cost in Forestry (green – cost, red – income), \(10^6\) RUR

100% of forests are publicly (state) owned.
History of statistical inventory in Russia
Periodization of forest inventory by statistical method

- Conditionally may be distinguished 3 periods in statistical method of forest inventory development:

1. 1920-30 years
2. 1960-80 years

- So, approximately each 30 years there is some intensification of the interest to statistical method of forest inventory.
### Former experience in forest inventory by statistical approach

<table>
<thead>
<tr>
<th>Year</th>
<th>Region of Russia (or former Soviet Union)</th>
<th>area covered (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925</td>
<td>Floatable district of the river Luga, Leningrad region</td>
<td>241,438</td>
</tr>
<tr>
<td>1928-1929</td>
<td>Karelia Republic and Kola Peninsula</td>
<td>8 million</td>
</tr>
<tr>
<td>1930</td>
<td>Floatable district of river Mezen, Komi Republic</td>
<td>10 million</td>
</tr>
<tr>
<td>1931</td>
<td>Floatable district of river Pechora, Komi Republic</td>
<td>21 million</td>
</tr>
<tr>
<td>1930's</td>
<td>Floatable district of river Angara, Irkutsk region</td>
<td>10 million</td>
</tr>
<tr>
<td>1960's</td>
<td>Siberian exploitable forests</td>
<td>20 million</td>
</tr>
<tr>
<td>1967</td>
<td>Ivanovo region</td>
<td>area not known</td>
</tr>
<tr>
<td>1970's</td>
<td>Lithuanian 18 forest enterprises</td>
<td>area not known</td>
</tr>
<tr>
<td>1980's</td>
<td>Photo statistical inventory of Siberian and Far Eastern forests</td>
<td>area not known</td>
</tr>
<tr>
<td>1990's</td>
<td>Siberian and Far Eastern forests inventory by key plots method</td>
<td>area not known</td>
</tr>
<tr>
<td>2007</td>
<td>State forest inventory for the whole country</td>
<td>in progress</td>
</tr>
</tbody>
</table>
S.A. Bogoslovsky monograph issued in 1926
Paper of M.M. Orlov published in 1929
Article of V.P. Zinoviev in «Forest Specialist» magazine issued in 1930
Monograph of S.A. Bogoslovsky and V.P. Zinoviev on statistical method of forest inventory published in 1932
National forest inventories in the world

• The first national forest inventories were established to assess the quantities of available wood.
• Finland, Sweden, Norway and New Zealand were the first countries to introduce an NFI between 1919 and 1923.
• The United States followed in 1930,
• India and several European countries during the 1980's.
• In the Asia region, China and the Republic of Korea have used a NFI since middle of 70’s, Japan since 1999.
• More recently, Brazil (2005) and Canada (2006) established NFI's.
• FAO continues to develop sampling based inventories and monitoring programs in many Latin American and African countries
Canada – Russia similarity in NFI aspects

• Conditions in Russia and Canada are rather similar regarding environmental conditions and the large scale that needs to be covered.
• The land area of Canada is estimated to cover 9 984 670 km² or 58.4% of that of the Russian Federation with 17 098 246 km².
• In Russia 8 forest growing zones are distinguished. At least three of these, parts of tundra and low density taiga, taiga and conifer-broadleaved forest zones are also present in Canada.
• Some of 15 Canadian terrestrial ecozones partly coincide with some of the 34 forest regions in the Russian Federation.
State forest inventory (SFI) sampling design overview
Two kinds of forest inventory

In Russia now works two inventory systems:

1. National (State) forest inventory. Based on statistical sampling, basic unit – sample plot

2. Forest inventory for management. Based on area field inspection, basic unit – compartment (more or less homogeneous)
National forest inventory introduced by article 90 of the Forest Code and has 3 main goals:

1. Revealing and prognosis of negative effect on forests

2. Estimations on how success are forest protection and regeneration

3. Information support of forest management and administration at Federal level, as well as state forest control and supervision.
Main principles of State Forest Inventory (SFI)

<table>
<thead>
<tr>
<th>Index</th>
<th>Finding of the quantitative and qualitative characteristics of forests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objects of SFI</td>
<td>Forest regions</td>
</tr>
<tr>
<td>Planning principles</td>
<td>According to the Russian state programme «Forestry development» for 2013-2020</td>
</tr>
<tr>
<td>Methodological basis</td>
<td>Landscape-ecological approach– works in forest regions Combination of remote and ground methods</td>
</tr>
<tr>
<td>Technical basis</td>
<td>Documents of forest management, of state database obtained as a result of land planning Earth remote sensing data with spatial resolution better than 5 m</td>
</tr>
<tr>
<td>Reporting</td>
<td>After the completion of work on the object of SFI– forest region Interim reports - Annual</td>
</tr>
</tbody>
</table>
Basic data for SFI

- Documents of forest management (updated forest management boards, plans of forest stands, thematic forest maps).
- Topographic maps.
- Data of State forest register.
Basic data for SFI - 2

- Cartographic documents of state database, from land management.
- ERS data (digital satellite images of optical range with spatial resolution better than 5 m).
- Standard reporting about use, protection, security and renovation of forest.
List of preparatory works before field inspection

- Calculation of necessary number of permanent sample plots according to forest regions in the Russian Federation.
- Creation of digital cartographic basis by using materials of forest management, state forest register, ERS data and maps.
- Stratification of digital basis, generalization to the stratum-level.
- Obtaining information on changes in forests, their quantitative and qualitative characteristics from the forest management documents, state forest register, standard reporting about use, protection, security, renovation of forest since the last forest management.
- Registration of changes caused by economic activity and natural factors (felling, fire, flood, windfall, damage by pests, etc.) in stratified digital cartographic basis.
- Creation of up-to-date schematic maps of SFI forest stratum.
- Laying out the permanent sample plots in the object of SFI annual work according to the stratification scheme in proportion to the area of stratum. Finding the position of the permanent sample plots’ centers.
Stratification of forest fund lands

*Stratum*—sections of forest where some taxation plots with similar taxation characteristics are combined.

*Stratification*—grouping of forest stands in the uniform groups (strata), where reserve variability is less, than in total.

**Stratification necessity:**
Reducing the number of sample plots within the forest region by decrease of reserve variability

**Stratification scheme:**
Unified scheme of forest stratification in the Russian Federation

**Stratification basis:**
Documents of forest management of different years, ERS data
Forest regions and accuracy of wood stock assessments (red -1%, yellow-2%, green – 3%, grey – 4%, blue -5%)
Stratification scheme

- STRATIFICATION PARAMETERS:
  - I level – forest regions:
    - 34 forest regions;
  - II level – taxation indicators:
    - number of strata – 49.

- STRATIFICATION PARAMETERS:
  - GROUPS OF TREE SPECIES AND LAND CATEGORIES:
    - SPARSE FOREST, NATURAL OPEN STANDS, FUND OF FOREST RENOVATION
    - YOUNG NATURAL STANDS;
    - YOUNG PLANTED STANDS;
    - SOFTWOODS (pine, larch, cedar);
    - HARDWOODS (spruce, fir);
    - VALUABLE TREE SPECIES (oak, beech, hornbeam, ash, maple, elm, stone birch);
    - SOFT TREE SPECIES (aspen, grey alder, poplar, willow);
    - PARVIFOLIATE TREE SPECIES (birch, black alder, linden).

- Nominal division into age groups, yield groups, species groups in names of strata for finding the quantitative and qualitative characteristics of forest during state forest inventory, without reference to classification in the forest management

- Duration of age class for cedar – 40 years; oak, beech, hornbeam, ash, maple, elm, stone birch, pine, larch, spruce, pine – 20 years; birch, fir, linden, aspen, grey alder, poplar, willow – 10 years.
Final map of strata - example
List of field works on sample plots of SFI

✓ Making positions of sample plots centers to the landscape using geodetic and geopositional tools.
✓ Finding the trees’ parameters on the sample plot.
✓ Measuring required indicators on the sample plots.
✓ Control over the completeness of collected information on the sample plots.
✓ Input of the data (received while laying out sample plots) into the statistical processing programmes and updating the reference information.
✓ Processing of data on permanent sample plots.
List of field works on sample plots of SFI - 1

1. Locating of the sample plot center and reference points on the landscape.
2. Fixation of the sample plot center.
3. Description of the sample plot.
4. Description of live ground vegetation.
5. Description of forest undergrowth and non-tree species.
6. Description and mapping the trees.
7. Description forms of trunks and wood quality (assortment).
8. Assessment and description of biodiversity of forest stand.
9. Description of forest renovation.
10. Description detritus (brushwood, stumps, windfall).
11. Control over the database before leaving permanent sample plot (PSP).

Field works are done by field teams, equipped by program-measuring systems (PMS SFI) for collecting data. Information of sample plots coordinates is not public and confidential.
Sample plot of SFI
Measurements on sample plot of SFI

<table>
<thead>
<tr>
<th>Circle diameter, m</th>
<th>Area, m²</th>
<th>Measured objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>12,62</td>
<td>500</td>
<td>Trees with DBH &gt;20cm, dead wood with diameter &gt; 6 cm, stamps with diameter &gt; 12 cm</td>
</tr>
<tr>
<td>5,64</td>
<td>100</td>
<td>Trees with DBH&gt;12 cm</td>
</tr>
<tr>
<td>2,82</td>
<td>25</td>
<td>Trees with DBH&gt;6 cm</td>
</tr>
<tr>
<td>1,78 (two)</td>
<td>20</td>
<td>Natural and artificial regeneration with H&gt;0,2 m and DBH&lt;5,9 cm, undergrowth,</td>
</tr>
<tr>
<td>Belt (10*1 m)</td>
<td>10</td>
<td>Ground vegetation</td>
</tr>
</tbody>
</table>
Sample plot establishment - example
Measurements on sample plots
Measurements on sample plots - 1

- Total number of parameters 117 grouped in 8 blocks:
  1. Landscape, soils, tree stand description
  2. Tree data including dead trees
  3. Ground vegetation
  4. Unger growth and under canopy vegetation
  5. Stamps and dead wood
  6. Regeneration
  7. Biodiversity
  8. Model trees parameters
Office processing of field data

<table>
<thead>
<tr>
<th>Stages of office processing</th>
<th>Types of work</th>
</tr>
</thead>
</table>
| Original data inspection    | – Checking database integrity  
 – Checking project structure  
 – Automatic monitoring of the data following the methodological instructions for carrying out the SFI RF |
| Preparation for statistical processing | – Updating field projects with software updates  
 – Adding field project to the central database  
 – Preparatory calculations  
 – Filling areas by strata  
 – Classification  
 – Data rearrangement (reclassification)  
 – Additional dimension classes of small trees  
 – Preparation of guide tasks  
 – Calculation of carbon stock |
| Consideration of tasks for statistical processing | – Consideration of tasks (if calculation of individual tasks is necessary) |
| Achievement of the results of statistical processing | Setting necessary print parameters and launch of all tasks |
Main points of criticism of ongoing SFI

- Stratification based on old forest inventory data actualized by remote sensing data
- Random sampling design and clamping of sample plots
- Single sample plot instead of clusters (tracts)
- All sample plots are permanent
- Big number of measured parameters (117) – one sample plot per day of work instead of cluster
- Low intensity of SFI – in 10 years covered 44% of needed area
- Non focused only on quantitative forest parameters estimation, have a number of other targets - monitorings
- Deal with only forest lands
The main reason why sample plots may falls not in prescribed strata

- The reason why a sample plots may not be located in the target stratum are mainly related with the heterogeneity of forest compartments which are the basic units for the determination of a stratum.

- Even compartments with a minimum area of 3 hectares may be heterogeneous regarding species composition, age, yield and density class. A sample plot with an area of 500 m² or 1.7% of 3 hectares may easily fall into a part that belongs to a stratum which differs from the target stratum, which is more likely to happen in large compartments.
Example - strata uncovered by forest lands appears to be covered by forest on 80% by a number of tree species

<table>
<thead>
<tr>
<th>Преобл. порода</th>
<th>Страта / Площадь</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Не покрытые лесной растительностью земли</td>
</tr>
<tr>
<td></td>
<td>га</td>
</tr>
<tr>
<td>СОСНА обыкновенная</td>
<td>66,302.9</td>
</tr>
<tr>
<td>ЕЛЬ сибирская</td>
<td>4,420.2</td>
</tr>
<tr>
<td>ПИХТА сибирская</td>
<td>4,420.2</td>
</tr>
<tr>
<td>ЛИСТВЕНИЦА сибирская</td>
<td>13,260.6</td>
</tr>
<tr>
<td>КЕДР сибирский</td>
<td>-</td>
</tr>
<tr>
<td>КЛЕН ясенелистный</td>
<td>-</td>
</tr>
<tr>
<td>БЕРЕЗА бородавчатая</td>
<td>70,723.1</td>
</tr>
<tr>
<td>ОСИНА</td>
<td>39,781.7</td>
</tr>
<tr>
<td>ТОПОЛЬ бальзамический</td>
<td>-</td>
</tr>
<tr>
<td>ТОПОЛЬ белый</td>
<td>-</td>
</tr>
<tr>
<td>ТОПОЛЬ черный</td>
<td>-</td>
</tr>
<tr>
<td>ИВА (древовидная) белая</td>
<td>4,420.2</td>
</tr>
<tr>
<td>ИВА (древовидная) ломкая</td>
<td>4,420.2</td>
</tr>
<tr>
<td>РЯБИНА обыкновенная</td>
<td>-</td>
</tr>
<tr>
<td>ЧЕРЕМУХА кистевая</td>
<td>-</td>
</tr>
<tr>
<td>ИВА (тальники) козь</td>
<td>-</td>
</tr>
<tr>
<td>ИВА (тальники) остролистная</td>
<td>-</td>
</tr>
<tr>
<td>Сухостойный лес</td>
<td>4,420.2</td>
</tr>
<tr>
<td>Не покрытые лесом земли</td>
<td>53,042.3</td>
</tr>
<tr>
<td>Итого</td>
<td>265,211.6</td>
</tr>
</tbody>
</table>

17.07.2017 Seminar 2 of the SURGE project: "Forest management and GIS - Federal and Regional levels". 26.06.2017 - 02.07.2017
Example of random sampling design for Bryansk region – clustering of sample plots
Road map of Bryansk region
## SFI activity dynamics

<table>
<thead>
<tr>
<th>Years</th>
<th>Number of sample plots</th>
<th>Covered area, millions ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>9810</td>
<td>26,1</td>
</tr>
<tr>
<td>2009</td>
<td>6033</td>
<td>23,0</td>
</tr>
<tr>
<td>2010</td>
<td>4926</td>
<td>40,5</td>
</tr>
<tr>
<td>2011</td>
<td>4549</td>
<td>38,3</td>
</tr>
<tr>
<td>2012</td>
<td>6585</td>
<td>61,6</td>
</tr>
<tr>
<td>2013</td>
<td>2428</td>
<td>21,7</td>
</tr>
<tr>
<td>2014</td>
<td>4800</td>
<td>42,0</td>
</tr>
<tr>
<td>2015</td>
<td>1869</td>
<td>19,8</td>
</tr>
<tr>
<td>Total</td>
<td>41000</td>
<td>273,0</td>
</tr>
</tbody>
</table>
SFI plans according to State program of forestry development

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21</td>
<td>29</td>
<td>39</td>
<td>44</td>
<td>52</td>
<td>63</td>
<td>71</td>
<td>80</td>
</tr>
</tbody>
</table>
SFI extent (violet – finished, green – ongoing)
Thank you for attention!