8.0 Forest Assessment Methods

8.1 Multiple Resource Inventory

The type of information needed for the management of any forest includes a multitude of resource values. Gaining this information has stimulated the development of integrated *multipurpose resource* (or *multiresource*) inventories.

“Timber is trees, but trees are MUCH more than timber.”

Non-timber attributes include –

- Non-tree vegetation – species abundance, biomass, vegetation profile
- Wildlife habitat – edge, animal use & browsing, snags, LOD, cover & shelter
- Forested range for livestock – grazing suitability
- Recreation – opportunity assessment, usage
- Soils – landscape context, physical characteristics
- Water – type, proximity
- Other – wildfire potential, firewood potential, woodland assessment, spatial coordinates, …

Timber attributes include –

- Accessibility
- Legal restrictions (protected areas, silvicultural requirements)
- Non-utilizable species
- Minimum quality characteristics and sizes of trees / logs
- Losses due to breakage in harvesting operation / transport of logs

Purpose is to choose a sampling system to determine the attributes of interest in the forest as precisely as desired – given available time, money, personnel, and the size, density, and distribution of trees

In general, we need to know the quantity, quality and extent of the resources.

Need reliable estimates of forest area (acreage), and measurements of all or an unbiased estimate of sample trees.

Relative priority given each resource (L, M, H) depends on the objectives:

Survey Objective	Area Est.	Owner Patterns	Access-ibility	Volume Est.	Growth & Drain	Critical Habitat	Scenic Views	Other Uses
Stumpage	H	L	H	H	L	M	L	L
Recreation	M	H	H	L	L	H	H	M
Mgt. Plan	H	M	M	H	H	H	M	M

Stumpage value: sale value of standing timber – depends on species, size (volume), quality of timber, accessibility, and distance to primary markets

Inventory Planning Checklist

A comprehensive plan ensures all facets of the inventory are considered as well as the data to be collected for some of the parameters above, including financial and logistical support needs and compilation procedures.

Be sure to consider the following (not all items apply in all cases):

1. Purpose of the inventory
   - Measured parameters to be estimated
   - How the information will be used
2. Background information
   - Past surveys, reports, maps, photographs, etc.
   - Individual / organization supporting the inventory and available funds
3. Description of Area
   - Location, size, transport facilities, accessibility
   - Terrain, general character of the forest
4. Information required in final report
   - Narrative report, tables and graphs, maps, mosaics, other pictorial material
5. **Sample survey design**
   - **Define target population**
   - **Define sample unit**
   - **Define required accuracy and precision**
   - **Decide how samples will be collected**
     - **Know what equations will be used to compute estimates**
   - **Decide how many sample units will be measured**
   - **Know budgeting limitations for field work**
6. Photo, satellite, other remotely sensed info. interpretation procedures
   - Location of sampling units
   - Determination of current stand information, insect damage, forest cover types, fuel types, etc. coordinated w/fieldwork
   - Personnel, instruments, recording of information, quality control, data conversion editing

7. Fieldwork procedures
   - Crew organization, logistical support, transportation
   - Location and establishment of sampling units on the ground
   - Determination of current stand information, including instructions on all vegetation measurements, determination of growth, regeneration, insect damage, mortality, forest cover types, fuel types, coordinated w/photo interpretation
8. Compilation and calculation procedures
   - Conversion of remote sensing material and field measurements to desired quantification
   - Calculation of sampling errors
   - Specific methods and computer programs to use
9. Final report
   - Outline, estimated preparation time, method of reproduction, number of copies, distribution
10. Maintenance
    - Storage and retrieval of data, plans for updating inventory

Designing a Sample Survey (Checklist Item 5 in more detail …)

Sampling provides the necessary information in less time and at lower cost than trying to measure the entire forest (i.e., doing a 100% inventory)

By sampling, more time and care can be exercised in measurement so that more precise measurements will result; also, fewer, more well-trained personnel can be used and better field supervision can be performed

The essential problem is to obtain a representative sample of the population

Given a representative sample, all characteristics of the population can be inferred from the sample

i. Define target population
   - All red squirrels in a certain watershed area
   - All invasive vegetative species
   - All conifers in a certain project area with minimum DBH of 5.6”
   - Specify units of measure: “…bd.ft. volume of all conifers …”, “… total biomass of invasive vegetation …”

ii. Define sample unit
  - Fixed-area plots: 1/5, 1/10, 1/20, 1/40-acre sizes common for overstory trees; 1/200-acre, or less for seedling regeneration
  - Variable area plots
  - Transects: lower canopy vegetation, downed woody detritus
  - Individuals: a deer, a tree, a log, a hiker on a trail
  - Groups: herd of deer, truckload of logs, group of hikers

iii. Define required accuracy and precision
  - Depends on survey objectives (and convention)
    - Management plan / multiresource surveys
      - Designed to provide info on timber and non-timber info
      - Generally low intensity – info collected to make broadly-based management decisions for long range planning
      - Want est. of mean within 10 –20% of pop. mean w/ 70 –90% C.I.
    - Timber sale / Land acquisition surveys
      - Designed to provide info on net volume or value of merchantable trees growing in "operable" areas
      - Land acquisition requires additional info on site quality, soil characteristics, proximity to markets, info on other environmental services
      - Want est. of mean within 2 – 5 % of pop. mean w/ 90 – 99% C.I.
    - Special surveys (timber trespass, regen, insect/disease)
      - Varies with application –
        - Regeneration survey
        - Timber trespass survey
        - Availability of browse, mast, etc. for wildlife
        - Etc.

iv. Decide how sample units will be selected
  - Simple Random Sampling (SRS)
  - Systematic sampling
  - Ratio / Regression estimation
  - Double sampling (sampling for a ratio or regression)
  - Stratified random sampling
  - Two-stage, Multistage sampling
  - Cluster sampling

v. Decide how many sample units will be measured

- Know what equations will be used to compute estimates
- Use of statistical formulas preferred

vi. Know budgeting limitations for fieldwork

- Simple cost model

  $C_t = C_o + n\ C_1$,

  where

  C_t = Total cost of survey

  C_o = Overhead cost, including planning, organization, analysis, compilation, etc.

  C_1 = Cost per sampling unit

  n = number of sampling units to be measured

- Number of sample units is then limited by:

  $n = (C_t - C_o) / C_1$

A Note on Errors in Forest Inventory

Precision of a forest inventory based on sampling is indicated by the size of the sampling error and excludes the effects of non-sampling errors

Accuracy of an inventory refers to the size of the total error, including the effect of non-sampling errors

Sampling errors result from the fact that we only measure only a portion of the entire population, so we might not produce statistics that are identical to the population parameters

Non-sampling errors are not connected with the statistical problem of sample selection and may occur whether or not the entire population is measured

Categories of non-sampling errors:

- Design errors – Errors that produce bias in estimations due to non-observance of the probability of selection or the independence of sample units
- Operational errors – erroneous location of samples, inaccurate establishment of sample unit boundaries, errors in measurement of tree or non-timber elements. Minimized by appropriate training of personnel, quality control, etc.
- Estimation function errors – using inappropriate mathematical models, errors in model coefficients, etc.
- Area determination error – map preparation errors, map scale errors, etc.
- Data mgt./processing errors – incorrect codification or registering of measurements, errors in transfer from field forms, programming errors in data processing, etc.