

**Forest Service Handbook  
National Headquarters - Washington Office  
Washington, DC**

**Forest Service Handbook 2409.13a – Timber Permanent Plot Handbook**

**Chapter 10 - Permanent Plot Planning and Installation**

**Amendment:** 2409.13a-1992-1

**Effective date:** January 29, 1992

**Duration:** This amendment is effective until superseded or removed.

**Approved by:** F. Dale Robertson, Chief

**Date approved:**

**Responsible Staff:**

**Last Change:**

**Superseded Document(s):**

**Digest:** Following is an explanation of the changes throughout the directive by section.

**2409.13a:** Establishes new Handbook, FSH 2409.13a, Timber Permanent Plot Handbook, outlining direction on establishing permanent plots for sharing of timber growth and yield information. It requires consistent and standard information to be collected on permanent plots that are established for growth and yield modeling.

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This chapter provides direction for installing and documenting permanent plots used for timber growth and yield studies.

## 11 - Use of Permanent Plots

Use data from growth and yield permanent plots to:

1. Construct growth and yield prediction systems that allow:
  - a. Relative comparison of alternative silvicultural management treatments.
  - b. Projections of an inventory for a desired period into the future.
2. Estimate the behavior (treatment response) of managed stands over time by comparing actual growth of operationally treated stands (for example, spacing controlled, thinned, and fertilized stands) with predictions of existing growth and yield models to:
  - a. Calibrate models by providing empirical adjustment factors to enable them to predict results expected on an operational basis.
  - b. Detect other possible biases and errors in models.
  - c. Estimate magnitude of variance in dependent variables.
  - d. Provide assurance that models used are a satisfactory basis for growth projections in management planning.
  - e. Develop treatment guidelines.
3. Monitor response to silvicultural treatments applied pursuant to forest plans including evaluating the effect of specific operationally-applied stand treatments.
4. Estimate current conditions, change between inventories, and project changes in land base, area in timber types, species volume, mortality, removals, biodiversity, and so forth, at the local, regional and national planning unit level.
5. Establish a basis for long term study of the effect of potential climatic change on growth and survival of tree species.

## 12 - Documentation

### 12.1 - Implementation Plan

Develop a written implementation plan for surveys, administrative studies, or research studies describing all aspects of growth and yield permanent plot establishment and use. The plan can be included as part of the inventory work schedule (FSH 1909.14, sec. 13.1) or study plans (FSM 4072.3) where appropriate. Include all of the following in an implementation plan:

1. Objectives. State the reasons for establishing the permanent plots.
2. Sample design. Carefully develop an appropriate sample design, including geographic distribution of plots. Consult recognized sampling texts and authorities for adequate sample design (see sec. 08). Consider special designs to sample mortality. Where appropriate, document cluster/transect numbers, location identification numbers, and sample point numbers.
3. Plot design. Consider the design of the plot or plot cluster. State the type, number, and general location of permanent plots. Include maps, if appropriate. Describe strata, if used. Provide for replication, if required.
4. Variables. State the specific variables that are to be measured on the permanent plots. Make certain that all variables needed for the planned analysis are measured. These must include all required variables listed in chapter 20. Measure additional variables to satisfy objectives of the study. Use terminology, definitions, and standards as defined in the Timber Management Information System Handbook, FSH 2409.14, the Interim Resource Inventory Glossary, and chapter 20 as appropriate.
5. Measurements. Use instruments with adequate precision for the measurements to be made. Exercise adequate quality control.
6. Data management. Describe procedures for recording data in the field and entering the observations. Define formats for files where data are to be stored. Edit the new data for logic and proper coding. State methods for long-term storage.
7. Data analysis. State how the data are to be analyzed in order to accomplish the study objectives, and the statistical procedures to be used. Make certain that all variables required for the analysis are being measured. Re-evaluate data requirements frequently.

8. Timing. State the anticipated establishment and remeasurement schedule and how long the permanent plots will be maintained.

a. Remeasure permanent plots used for the development and validation of growth and yield models every 3 to 6 years or up to 10 years to correspond with Forest Planning cycle.

b. For research plots, coordinate with treatment schedules. Remeasure when a treatment such as thinning or fertilization is applied.

9. Budget requirements. State the estimated personnel and funding needed to establish and remeasure the permanent plots and manage the resulting data.

10. Statement of responsibility. State the person or incumbent of a position who is responsible for establishing and maintaining the set of permanent plots and the associated data, and who has the authority to abandon them.

11. Field instructions. Develop field instructions as necessary, detailing all aspects of plot selection, establishment, measurement, treatment, and remeasurement.

12. Field forms. Develop either electronic or paper forms for recording plot information. Include examples of the forms in the implementation plan. Format for recording variables must be consistent with formats found in the Chapter 70, FSH 2409.14 or the Interim Resource Inventory Glossary, or administrative unit must have the capability of converting the data to the standard formats.

13. Statistical review. Authors of the implementation plan must consult a known sampling authority and request review and comment on adequacy of the plan. Review of research studies and plans by statistical consultants or Station biometricians is required.

14. Plan approval. The implementation plan must have the appropriate line officer approval prior to the establishment of the permanent plots.

## **12.2 - Activity Reports**

Prepare and file with implementation plan, an activity report or equivalent documentation each time any treatment is done on research plots or observed on inventory plots that are used for developing growth and yield information. Include the following in activity reports:

1. Locations of all affected or noted permanent plots and reference points.

2. The date(s) during which the activity took place (at a minimum, record the month and year if known).

3. A complete list of all persons who actually conducted the activity and a description of what each person did, if available.

4. Any other pertinent information, such as the immediate need for the data to be summarized for use in a particular report.

5. Note all records of quality control, including results of plot checks, and actions taken to correct any problems identified.

6. Activity reports with signatures of the same line officers as the implementation plan.

### **12.3 - Filing and Maintenance**

File and maintain copies of the approved implementation plans and activity reports at the appropriate Region, Station, or field office.

## **13 - Design**

The design of permanent plot systems should:

1. Distinguish between normal and abnormal trends in forest and rangeland conditions.

2. Identify plausible cause-effect hypotheses for apparently abnormal trend observations.

3. Support spatial and temporal extrapolations.

4. Provide information for current resource management issues and regulations.

### **13.1 - Sample Design**

Permanent plots are used for different purposes. Their use dictates where plots are established and their configuration. Sample design may utilize purposive, random or systematic sampling depending on the objectives of the inventory or study.

1. Use purposive sampling to determine treatment responses to minimize the sources of uncontrolled variation and to efficiently sample the range of desired conditions which often include extremes or stand conditions not currently available.
2. Use random or systematic sampling for trend surveys and some types of monitoring.
3. Use stratification for allocating sample plots, where appropriate. Rank strata for sampling based on objectives in the implementation plan.

### **13.2 - Sample Intensity**

Sample intensity (that is, the size of the sample) depends upon the precision desired in the attribute estimates, and the existing variation in the attributes to be estimated. Consult sampling texts (sec. 08) and sampling authorities to determine the number of plots needed. When determining sampling intensity, consider:

1. Selection of a population attribute to be estimated (for example, mean volume in cords/acre).
2. Selection of a plot size (sample unit) on which to measure the attribute (for example, 1/5 acre plots).
3. Statement of the precision desired in the estimate of the mean of the attribute (for example, +/- 2.5 cords/acre or +/- 0.5 cord per 1/5 acre plot).
4. Statement of the probability level assigned to the precision of the estimated mean (for example, unless a 1-in-20 chance has occurred or at the 5% probability level).
5. An estimate of the variance of the attribute among the population of sample units.
6. Amount of funding available for the inventory.

### **13.3 - Plot Configuration**

1. Use a plot size that includes sufficient area and/or a sufficient number of trees to adequately represent the site and stand conditions affecting the growth of the trees.
2. For treatment or response studies, locate plots well within strata or stands so that the plot edge is at least one tree length from the edge of the stratum or stand boundary or from the outer edge of any buffer strip. Locate plots such that

none is on more than one land form and allow as little variation as possible in slope and aspect on the plot. The tree length used should be that expected at the end of the planned period of observation.

3. For inventory and forest health monitoring plots, make no attempts to avoid edge effects in stands having high proportions of ecotonal conditions. If plots (subplots or points) straddle distinct strata or stand boundaries, identify points or trees by stratum or stand condition, so weighting can be modified during compilation.

## **14 - Monumentation**

### **14.1 - Plot Location Monumentation**

1. Establish and mark a field reference point for each permanent plot or group of permanent plots. Include the name and location of agency and unit responsible for the plot.

- a. Establish a readily recognizable, relatively permanent reference point off the plot but on the margin of a permanent access road or other travel way.
  - b. Record the azimuth and distance from the reference point to the plot center on the appropriate field forms.
  - c. Mark the reference point with a sign, scribe, or paint. If trees are used as reference points, place markers below stump height.
  - d. If aerial photographs are available, locate the reference point and plot center on aerial photographs and describe on the back of the photo.
2. Determine and record the Universal Transverse Mercator (UTM) or latitude and longitude coordinates, using global positioning systems or other means, so the plot can be used in future geographic information systems.
3. Specify the appropriate field unit to contact on any matters relating to the plot.
4. For plots located on National Forests, show permanent plots in stand records in the management record.
5. Permanently mark the center of each plot (or corners of rectangular plots). For monitoring control plots and most research plots, use conspicuous means so plots will be avoided by forest workers. For most other permanent plots, use



inconspicuous means of monumenting the plot center so that resource users handle the plots no differently from surrounding areas.

6. Where appropriate, use long-lived metal materials such as steel rebar, galvanized pipe, heavy copper wire pins, and so forth, as plot center (or corner) monuments. Dense metal markers facilitate recovery with metal detectors and can be made conspicuous, if desired, with bright paint.

7. For monitoring control plots and most research plots, also prominently mark the plot or plot group boundary with bright paint and protective warning signs.

## **14.2 - Tree Monumentation**

When using variable radius plots, measure the diameter of all borderline trees and document their diameters, limiting distances and azimuth from the plot center on the appropriate field forms. Mark all borderline trees to show that they were considered, and to reduce ambiguities at remeasurement.

1. As a minimum, positively identify each tree on the plot by affixing a permanent numbered tag or unique mark on each tree, preferably below the stump and facing plot center.

2. Alternatively, on plots that can be conspicuous, plot trees can be systematically numbered (consecutive by azimuth from North) at about 6 feet height and facing plot center with aluminum aerosol paint, providing that the species are not sensitive to such paint. This scheme greatly facilitates inventory and treatment of research plots, as well as remeasurement, since all trees are easily identifiable from plot center.

3. Positively locate and mark the breast-height point on each stem at plot installation. Aluminum aerosol paint is suggested if plots can be conspicuous and species tolerate it. Unobtrusive methods include painting a spot of tan or gray tube-paint in a bark fissure or using the indexed tag wire procedure.

4. Generally, avoid affixing tags by driving nails at or near breast-height (BH) because they either cause callus growth which distorts DBH, tend to become overgrown because nails are not re-set, or, if nail re-set is timely, the re-setting process causes loss of bark at BH resulting in distorted diameter measurements.

5. If nails are used to affix tags on stems of slow-growing species to locate BH, then use the longest aluminum nails available, and drive them at a fixed distance several inches above or below BH so that they will not disturb DBH when re-set.

## **15 - Destructive Sampling**

1. Do not use destructive sampling on permanent plots except where it might occur as part of a thinning treatment, a normal timber sale, or a planned forest change event compatible with study or inventory objectives.
2. Allow other inventory activities which might be superimposed on an existing permanent plot system only to the extent they do not affect the utility of the plots for their original purposes.

## **16 - Remeasurement**

Remeasure at the intervals specified in the implementation plan. Provide for reconciliation of remeasurement data with previously measured data.

1. Carry a copy of previous plot records to the field to compare with current data. Make tally sheets or use programmed field computers that provide previous individual tree measurements for quick reference.
2. Correct all confirmed errors in the field in an unbiased manner. Run machine edits as soon as possible after the field work so that gross discrepancies can be field-checked.

## **17 - Plot Maintenance**

Where research plots or monitoring control plots are retained in the field through several remeasurements, provide for their maintenance and protection against inadvertent destruction except where monitoring is to measure change in normal land use.

1. Maintain adequate contact with cooperators to minimize accidental plot loss.
2. For research plots, employ a warning system which will periodically call such plots to the attention of field personnel, to remind them of their purpose and importance, and prevent their being included in any activity that would adversely affect their designed utility. For the National Forest System, this may be the Regional timber stand record systems.
3. At each remeasurement and as needed, re-monument plot centers or corners, remark boundaries, and retag or mark individual trees.