Forest Inventory and Analysis
Tree Growth

FIA Fact Sheet Series

Changes over time in the structure of forest resources are largely driven by stand dynamics (rates of regeneration, growth, and mortality), as well as timber removals and changes in land use.

Tree growth is an important facet of stand dynamics. Information about growth can be used to determine if there are any unusual spatial or temporal patterns in growth rates; or if the balance between growth and mortality is adequate to sustain a forest ecosystem.

Tree growth data contribute to the investigation of several key forest ecosystem attributes such as sustainability, productivity, and aesthetics.

Data Collection. Forest Inventory and Analysis (FIA) maintains a systematic network of permanent ground plots (Figure 1). After initial plot establishment, trees are remeasured until they die or the plot is converted to a nonforest land use. Individual plots are remeasured in cycles of approximately 5-7 years in the eastern U.S., and 10 years in the western U.S.

Trees 1.0-4.9 inches in diameter at breast height (dbh) are measured on 1/300-acre microplots, and trees 5.0-inches dbh and larger are measured on 1/24-acre subplots. As new trees grow into the microplots and subplots, they too are tracked until death.

Growth is computed from sequential measurements of tree dbh over time. Tree dbh is usually located at 4.5 feet above ground line on the uphill side of the tree. Crews identify which trees have survived since the previous inventory and which trees have grown into the plot, with a series of codes used to track tree history.

FIA crews also measure tree heights, which are used in estimates of tree growth requiring height, such as tree volume growth.

Quality Assurance. Several site and environmental conditions can affect collection of tree growth data, including: (1) accurately relocating the measurement point at dbh when remeasuring trees in subsequent years; (2) irregularities or deformities at dbh; (3) unusually formed trees with multiple stems or forks; and (4) difficulty viewing the tops of some when measuring heights.

These effects are minimized by thorough training and certification of field crews, marking dbh to increase measurement accuracy, and special rules to accommodate trees with forks or abnormalities at dbh. Errors are further minimized by audits of field personnel.

Data Analysis. Growth is commonly expressed in terms of change in volume or basal area per year. Basal area is the cross-sectional area of trees at dbh. Basal area and volume increment are obtained by subtracting initial tree size from the terminal (most recent) tree size measured during each inventory cycle. Field data used for these calculations include initial and terminal tree dbh, initial and terminal tree height, and the time interval between measurements.

Growth can be analyzed at the tree-level (e.g., average annual growth by species and initial dbh); at the stand level (e.g., average annual growth per acre per year); or at the population level (e.g., total net annual growth of live timber for a given region).

Depending on the analysis, stand-level and population-level growth are commonly divided into a variety of components. For example:

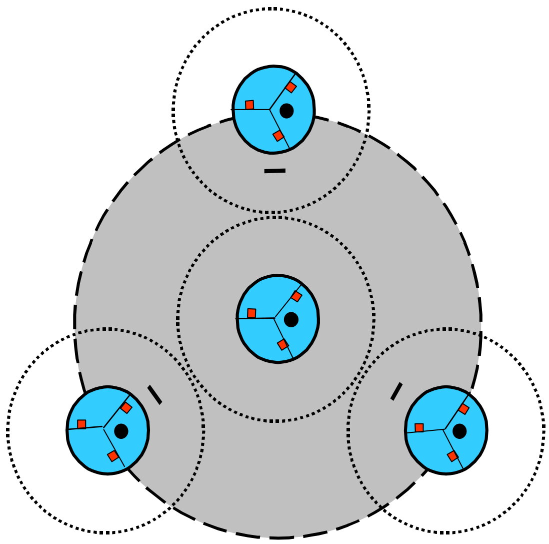
- Survivor growth is the growth of sample trees alive at both the initial and terminal inventories of a given measurement cycle.
- Ingrowth refers to trees that grow across the minimum dbh thresholds (1.0 and 5.0 inches) between the initial and terminal inventories.
- Gross growth is survivor growth plus ingrowth plus the subsequent growth on ingrowth.
- Net growth represents gross growth minus the loss of volume (or basal area) due to mortality.
- Net change is net growth minus the loss of volume (or basal area) due to removals (cutting).

Additional Information. More detailed information regarding FIA growth and change estimation can be found in Chapter 4 of *Forest Inventory and Analysis National Sample Design and Estimation Procedures*, which is posted on the web site: http://www.srsfia.usfs.msstate.edu/FIA_Internet/statistics_band/stat_documents.htm.

Fact Sheet Author: William A. Bechtold

For more information about the FIA Program:
- See our “FIA Contacts” Fact Sheet
- Visit our National FIA website: http://www.fia.fs.fed.us

Phase 2/Phase 3 Plot Design



Subplot	24.0 ft (7.32 m) radius
Microplot	6.8 ft (2.07 m) radius
Annular plot	58.9 ft (17.95 m) radius
Lichens plot	120.0 ft (36.60 m) radius
Vegetation plot	1.0 m^2 area
Soil Sampling	(point sample)
Down Woody Debris	24 ft (7.32 m) transects

Figure 1. FIA field plot design