Ecological Archives A/E/M000-000-A#

Jeremy W. Lichstein, Jonathan Dushoff, Kiona Ogle, Anping Chen, Drew W. Purves, John P. Caspersen, and Stephen W. Pacala. 2009. Unlocking the forest inventory data: relating individual-tree performance to unmeasured environmental factors. *Ecological Applications* VOL:pp–pp.

Appendix C. FIA subplot designs and implementation.

FIA subplot designs

Prior to 1999, FIA subplot designs in most regions used fixed-radius sampling for saplings (dbh 2.5-12.7 cm) and variable-radius sampling for trees (dbh > 12.7 cm) (e.g., Doman et al. 1981, USDA 1992, Waddell and Hiserote 2005). Fixed-radius samples include all individuals (in the appropriate size class) within a fixed-radius circle. In contrast, under variable-radius sampling, the sample radius is proportional to trunk diameter (Beers and Miller 1964): Let D be the distance between the centers of the sample area and the trunk. An individual is 'in' (included in the sample) if $D < C \times$ dbh, where C is a constant.

For our ENA sites, we used a subplot design that was widely used by the FIA in the eastern U.S. prior to 1999 (USDA 2006). Saplings were sampled in a 2.07 m radius circular 'microplot.' Trees were sampled in a variable-radius subplot centered on the microplot center. Trees were 'in' if $D < 0.17 \times$ dbh, where D is measured in meters, and dbh is measured in cm; this corresponds to a wedge prism point (Beers and Miller 1964) with a 37.5 basal area factor (English units).

We followed the pre-1999 FIA design for Oregon (Waddell and Hiserote 2005) for our WOR sites. Saplings were sampled in a 2.35 m radius circular 'microplot.' Trees with dbh 12.7-90 cm were 'in' if $D < 0.19 \times$ dbh. Trees with dbh > 90 cm were sampled in a 17 m fixed radius circle.

Implementation of FIA subplots

Subplots were implemented with two different methods:

(*i*) Trees and saplings were mapped within defined areas. Light measurements (see *Methods*) were taken over 'focal saplings,' which included all saplings located far enough from the edges of the mapped area to accommodate a subplot. Subplots were then calculated from stem maps according to FIA subplot designs. For these calculations, the position of each subplot center was randomized with respect to each focal sapling so that our subplot data mimicked as closely as possible the type of data collected by FIA field crews. The randomization procedure was as follows: Let r_m be the sapling microplot radius (2.07 m for ENA; 2.35 m for WOR). The subplot (and microplot) center for a given focal sapling was placed at a randomly chosen distance (between 0 and r_m) and a randomly chosen azimuth from the sapling.

(*ii*) Transects were established along arbitrary azimuths. At 50 m intervals along each transect, we mapped a subplot around the nearest sapling. The position of each subplot center was chosen at random (see randomization procedure above), with the constraint that the sapling microplot should include as many additional saplings (typically zero, one, or two) as possible. This constraint increased the number of saplings per subplot but does not bias the types of analyses presented in this paper. Light measurements were taken over all saplings in microplots, and each of these saplings was treated as a focal sapling in our analysis.

For a given amount of effort, method (*i*) yielded three to four times as many focal saplings as (*ii*), but resulted in greater statistical dependence among saplings. We sampled 1976 and 152 focal saplings using methods (*i*) and (*ii*), respectively. To investigate the impact of spatial dependence among saplings on our results, we included spatial random effects in our light model to account for stand-scale autocorrelation in sapling light availability (Lichstein 2007). Including these random effects did not change our main results; the models presented in this paper do not include these effects.

References for Appendix C

Beers, T. W., and C. I. Miller. 1964. Point sampling: Research results, theory, and applications. Purdue Univ. Agric. Exp. Station, Indiana, Res. Bull. 786.

Doman, A. P., R. Ennis, and D. Weigel. 1981. Resource evaluation field instructions for Wisconsin 1981. USDA Forest Service, North Central Forest Experiment Station.

Lichstein, J. W. 2007. Theoretical and empirical perspectives on the dynamics of U.S. forests. Ph.D. dissertation. Princeton University, Princeton, New Jersey.

USDA. 1992. Field manual, Michigan 1991. Second Printing April 1992. USDA Forest Service, North Central Forest Experiment Station.

USDA. 2006. Users guide to the Forest Inventory Snapshot Database Version 2.1. Forest Inventory and Analysis Program, USDA, Forest Service.

Waddell, K., and B. Hiserote. 2005. The PNW-FIA Integrated Database User Guide: A database of forest inventory information for California, Oregon, and Washington. Forest Inventory and Analysis Program, Pacific Northwest Research Station, Portland, Oregon.