Division of Statistics
Master's Thesis Defense

ANALYSES OF CAVITY TREE DISTRIBUTION AT MULTIPLE SCALES

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Tuesday, July 22, 2003
10:00 a.m.
CNR 14

ABSTRACT

This study combined a set of statistical models and procedures to systematically explore the distribution of cavity trees at the individual tree, stand and landscape levels in Missouri. At the individual tree level, a tree was labeled as either a cavity tree or a noncavity tree based on whether it had at least one cavity > 2.54 cm minimum diameter. We used classification and regression tree (CART) analysis in conjunction with statistical bootstrapping to predict the probability of cavity tree occurrence based on a set of individual tree attributes. By aggregating the important individual tree-level covariates influencing the presence/absence of cavity trees over individual plots and combining them with other stand (plot)-level covariates, we used CART to identify the most significant stand (plot)-level covariates and classified stands into disjoint groups that differ significantly in cavity tree abundance. We then used the Weibull probability density function (pdf) to quantify the frequency distribution of cavity trees for each of these disjoint groups. Given those fitted probability distributions of cavity trees for groups of stands characterized by specific stand structure and conditions, we simulated cavity tree density and variation for landscapes of varying sizes and structure. We used bootstrapping to aggregate data for multiple landscapes and constructed a series of regression models to facilitate the prediction or monitoring of cavity tree density for any landscape with known structure and size.

At the individual tree level, CART in conjunction with bootstrap provides a flexible nonparametric approach to analyze/predict the probability of cavity tree occurrence based on individual tree attributes. This approach is superior to logistic regression in that it can be applied to any data structure and used for both exploratory analysis (e.g., identifying significant covariates and interactions) and confirmatory data modeling (e.g., probability prediction). The hierarchical structure of CART and the associated disjoint groups differing in cavity tree occurrence can be readily used in cavity tree selection and retention. The application of logistic regression for cavity tree estimation is hampered by the lack of observations for certain combinations (e.g., species by decay class) and was used to local data to compare the difference of species groups and decay classes in cavity occurrence, separately.

Individual tree-level attributes are weakly associated with the presence/absence of cavity trees. Cavity tree density varies dramatically at the stand level, even among stands that are similar in many other respects. Therefore, it is more informative to quantify the probability of cavity tree density across significant stand covariates using Weibull pdf than to predict the mean cavity tree density via regression and generalized additive models. The fitted Weibull pdf at the stand level was readily aggregated, via resampling methods such as the bootstrap to evaluate cavity tree density and spatial variation at the landscape level which the mean-based models (e.g., regression, generalized additive models) cannot. The probability-based models (CART and Weibull pdf) at the individual tree and stand levels are statistically sound, but at the landscape level the mean-based models such as regression are superior.

The study provides a comprehensive and integrated approach for sparse binary data modeling at multiple scales. The study hypotheses and management questions are addressed by different models and integration of these models across multiple spatial scales. There are no uniformly robust models and procedures available for sparse binary data analysis at multiple scales. Different models and procedures should be chosen based on the study objectives and model performance. Resampling can be used for both between-scale integration and intensive probabilistic analysis.