

1998 Summary Report On**Developing Forest Habitat Attribute Models At Multiple Scales
For Landscape Assessment Of Wildlife Habitat Quality**

Dr. Paul P. Mou

Department of Forestry
Virginia Tech University
Blacksburg, VA 24061
Telephone: 540-231-4031 Email: pmou@vt.edu

Wildlife species have different habitat requirements at different spatial scales. Thus, wildlife habitat quality must be assessed at multiple spatial scales. For such purpose, a landscape model, LEEMATH, is being developed by Dr. Harbin Li at the Center. LEEMATH requires habitat attribute models to bridge growth models and habitat suitability models. The objective of this study is to develop, for LEEMATH, mechanistic or semi-mechanistic models of habitat attribute dynamics at multiple spatial scales.

The hierarchy modeling approach is one of the few methods that allow for scaling up fine scale information for large scale analysis. In the hierarchy, each model operates at a specific scale and is a simplification of the model of the next finer scale. Although some fundamental mechanisms are lost in the simplification process, many are preserved with or without modification to facilitate scaling. Because the fine scale model is mechanistic (i.e., process-based), the hierarchy modeling approach offers flexibility and extrapolation credibility, two key issues that must be addressed by any regional assessment framework. With this approach, we are developing a suite of habitat attribute models at within-stand and stand scales, based on a mechanistic vegetation simulator, REGROW. These models predict changes in quantity and spatial distribution of many habitat attributes, including canopy cover, snags, coarse woody debris, litter biomass and depth, and understory vegetation. A spatial habitat attribute model at the landscape scale has been developed by Dr. Li to calculate edge density, habitat size, and distance to special habitat for LEEMATH.

The within-stand level model, FHAM, is a modified REGROW and captures habitat attributes and their changes at fine temporal (biweekly) and spatial (with a resolution of 0.1 x 0.1 m) scales. REGROW is an individually based, spatially explicit, and resource driven. The major inputs to REGROW include spatial distribution of each tree, biweekly site conditions (i.e., temperature, light, water) over a year, and species specific parameters for tree growth, crown dimension, and plant impact on resource. It provides very detailed information about spatial distributions and their dynamics of plant species, canopy cover, and various physical characteristics (e.g., light, soil water, nutrients) of the site. It also predicts tree and stand growth. We are in the process of improving functions to predict snags, coarse woody debris, litter biomass and depth, and understory vegetation. REGROW has been used to simulate stand dynamics of loblolly pine and sweetgum.

The stand level model, CHAM, is a simplified FHAM by removing below-ground effects, competition among trees, and the biweekly site factors (i.e., temperature, light, water). CHAM captures average habitat attributes at coarse temporal (yearly) and spatial (with a resolution of 1 x 1 m) scales. The major inputs of CHAM include site index, species composition, density, DBH distribution, age distribution type, spatial distribution type, and parameters for tree growth and crown dimension. CHAM also predicts changes in quantity and spatial distribution of canopy cover, snags, and litter biomass and depth. Models for other habitat attributes, such as coarse woody debris and understory vegetation, are being developed. CHAM has seven subroutines: INPUT, DISTRIBUTION, DIMENSION, INITIAL, GROWTH, ATTRIBUTE, and OUTPUT. Subroutines of INPUT, DISTRIBUTION, and DIMENSION set up a virtual stand for simulation: INPUT reads in system variables and parameters, DISTRIBUTION distribute the individual trees throughout the stand, and DIMENSION calculate their dimensions. INITIAL calculates and outputs the initial characteristics of the stand and some of the habitat (attribute) characteristics. The trees are grown in GROWTH. New tree attributes are then used to calculate wildlife habitat attributes for the stand in ATTRIBUTE. Finally, OUTPUT reports the final characteristics of the stand. CHAM is developed for LEEMATH.

The basic structure of these models have been completed, although new functions are still being added. With newly added subroutines for simulating canopy shadows and calculating habitat attributes, FHAM has successfully simulated site dynamics and associated changes of the habitat attributes. This work has been reported at Ecological Society of America 1997 Annual Meeting at Albuquerque, NM. CHAM is being tested with different compositions (i.e., pine to hardwood ratios) and densities in both even and uneven aged stands. We will report the results of CHAM simulations at Ecological Society of America 1998 Annual Meeting at Baltimore, MA. The preliminary results indicate that these habitat attribute models at the within-stand, stand, and landscape scales can provide the necessary information for effective assessment of habitat quality of multiple species.

We will do the following in the next few months.

- We will improve the habitat attribute functions for canopy cover, snags, coarse woody debris, and litter biomass and depth.
- We will refine the models to include more habitat characteristics, such as amount of browse production, amount of mast production, and availability and distribution of wildlife shelters (i.e. cavity trees, dense brush, standing and downed woody debris).
- We will develop a model for understory vegetation to predict understory biomass and structure. We will incorporate FHAM and CHAM into LEEMATH and test them in LEEMATH simulations.
- Finally, we will keep working on model parameterization and validation. Specifically, we will make three comparisons: (1) between FHAM and CHAM and REGROW, (2) between the response surfaces generated by REGROW and results from FHAM and CHAM, and (3) between real data sets and model outputs.

Appendix: Abstracts to ESA Annual Meetings

1. Abstract for ESA 1998.

LI, HABIN and PU MOU. USFS Center for Forested Wetlands Research, Charleston, SC 29414; Virginia Tech University, Blacksburg, VA 24061. **Modeling habitat attributes at multiple scales for landscape habitat assessment.**

Predicting habitat attribute dynamics at multiple scales is essential to large-scale assessment of habitat quality. The hierarchy modeling approach was used to develop a suite of habitat attribute models at within-stand and stand scales, based on an individual-based and spatially explicit vegetation simulator, REGROW. These models predict changes in quantity and spatial distribution of many habitat attributes, including canopy cover, snags, coarse woody debris, litter biomass and depth, and understory vegetation. Simulation experiments were conducted to evaluate model performances under combinations of tree species composition, density, age structure, and spatial distribution. Model output was compared to data of loblolly pine stands and to simulations by REGROW. The results show that spatial distribution and age structure of trees exert significant effects on habitat attribute dynamics, and that the models differ primarily in predicting variability of habitat attributes, but not their averages and general spatial patterns. The stand-level models were further tested in simulations of LEEMATH, which has a spatial habitat model to calculate edge density, habitat size, and distance to special habitat. The results indicate that these habitat attribute models at the within-stand, stand, and landscape scales effectively assess habitat quality of multiple species in southeastern forested landscapes.

2. Abstract for ESA 1997.

LI, HABIN and PU MOU. USFS Center for Forested Wetlands Research and Virginia Tech University. **A multi-scale habitat attribute model for wildlife habitat evaluation in forested landscapes.**

Sustainability of forest resources requires land managers to consider effects of management activities on both economics (e.g., timber production) and ecology (e.g., wildlife habitat). Our objective is to develop a habitat attribute model to bridge growth models and habitat suitability models in a decision support system for forest management. The model operates at both within-stand and stand scales. The fine scale submodel (FHAM) is a modification of REGROW, a vegetation simulator that is individual-based, spatially explicit, and resource-driven. FHAM predicts habitat attributes such as litter biomass, species composition, vertical structure, and spatial distribution of plants. The coarse scale submodel (CHAM) is a simplification of FHAM; it is diameter-based and non-spatial. This multi-scale modeling approach is essential for two reasons. (1) Organisms require different habitats at different (or multiple) scales. A single-scale model will not provide sufficient information for comprehensive habitat evaluation. (2) Scaling up of fine-scale information is a necessity for regional assessment of wildlife habitat. CHAM provides the landscape linkage, while FHAM provides biological meanings to habitat evaluation. We test our model with southeastern forest data and the landscape model LEEMATH. The results suggest that our model should provide detailed, biologically meaningful information for effective evaluation of forest management impacts on wildlife habitat.