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Report of Progress in First Year of DOE Grant FG02-90ER60933

A Theory of Forest Dynamics: Spatially Explicit Models and Issues of Scale

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Good progress has been made in the first year of DOE grant # FG02-90ER60933. The purpose of the project is to develop and investigate models of forest dynamics that apply across a range of spatial scales. The grant is one third of a three-part project. The second third was funded by the NSF this year and is intended to provide the empirical data necessary to calibrate and test the small-scale (≤1000 ha) models. The final third was also funded this year (NASA), and will provide data to calibrate and test the large-scale features of the models. Collaborators on the NSF grant include Dr. Charles Canham of the Institute of Ecosystem Studies (Milbrook, NY) and Dr. John Silander of the University of Connecticut. Collaborators on the NASA grant include Drs. W. Philpot and W. Philipson of Cornell University.

Because all phases of the project have now been funded, we have adopted a coordinated time table. We have devoted our first half-year of DOF funding to developing and implementing spatial computer models of forest dynamics both at the University of Connecticut and Cornell. First, we now have a simple grid-based model of competition similar in structure to FORET but with internal recruitment on the National Super-Computing Center mainframe at Cornell. We are in the process of systematically varying the sizes of grid-squares and dispersal distances to determine how these scaling parameters affect competitive outcomes. Second, we have veloped a spatial version of Dr. David Tilman's model ALLOCATE. We have also used sensitivity analysis to reduce this model to a simple analytically tractable analogue. Studies of the analytically tractable model have demonstrated that temporal and/or spatial fluctuations in the environment of intermediate frequency should lead to the presence of limiting similarities in plant communities whereas higher or lower frequencies should not. This work is completed, half-written and will be submitted this Fall. Third, we have developed an extremely fast and efficient algorithm to handle three-dimensional shading effects. Briefly, this algorithm mimics an empirical forester's fish-eye camera and literally prints a digitized polar coordinate image of a modeled canopy onto a set of registers that are reserved for the task. This algorithm has been the chief impediment to object-oriented spatial models without an underlying grid. We are currently coding a full simulator that includes the algorithm.

This summer, a crew of 9-20 people gathered data on a forest in Northwestern Connecticut. This work was funded by the NSF grant mentioned above. We now have sufficient data to fully calibrate our spatial models for five species: hemlock, beech, sugar maple, red maple and yellow birch. Over the next six months, we will estimate the functions in models from these data and will use the calibrated models to ask a series of questions:

1) Is there a spatio-temporal scale at which the system can be said to equilibrate? 2) Why do these species coexist? 3) What are the principal determinants of pattern at each of a series of scales? We anticipate that we will produce a minimum of four papers from this work: a paper on mortality, a paper on recruitment, a paper on the concept of equilibrium and a paper on the factors governing the community's dynamics.

The enclose budgets are identical to those tentatively approved by the DOE last year. All funds from the first year of funding will be exhausted by the end of the first year with one exception. Funds in the University of Connecticut budget were internally reallocated from computer equipment to a graduate assistant who is helping with the computer programming. Permission to reallocate was obtained by telephone from both the Chicago Operations Office and Dr. Clive Jorgensen. The student's stipend will be paid from 9/90 - 5/91. Thus, five months of his stipend will be paid during 1991.

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