

Modeling Forest Dynamics Using Field Data from Zoar Valley, Western New York State

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The goal of our project was on reconstructing and modeling ecological *processes* within the wooded riparian zone of Zoar Valley. We focused on processes such as forest succession and disturbance regimes, fluvial landform deposition and erosion, stream hydrology, and watershed land uses into a comprehensive understanding of ecosystem structure and function. The study of old growth forests can offer insight into the processes of a forest ecosystem. There are a lot of factors that exist in the world today that may alter the overall structure of these forests in the future, such as exotic diseases and global warming. The data that has been collected from previous studies of the riparian old growth forest of Zoar Valley in western New York has been applied in this project to two simulation programs called Simforest and Netlogo. Through the use of these programs we further aim to develop and validate predictive simulation models for this site, which will prove invaluable both in understanding the dynamics of intact riparian systems and in managing and/or restoring impacted systems.

A review of the literature revealed that a program called LANDIS is the most utilized for research of this nature. Due to problems with the LANDIS website we chose two other programs to work with instead: NetLogo and SimForest. Completing this project required collaborating regularly, generally once a week, with the other project members, either in person or via internet communication channels such as a blog and Skype. In addition, group members read through published literature on Zoar Valley and existing forest modeling software such as the LANDIS program. In attempting to create our own modeling software, we used NetLogo, a fully programmable modeling environment geared towards recreating natural and social system dynamics. This required familiarization with the NetLogo interface and programming language.

The SimForest program was used in conjunction with NetLogo, both to obtain the various equations that would provide the basis for our own model, and as a way of cross-checking the results obtained from NetLogo. SimForest itself came in two different versions, "Glass Box" and "Black Box." The first was characterized by an increased level of transparency – the user could examine and modify the different equations upon which the model was based. The second version has a more developed graphical interface and did not allow the user to see any equations beyond the three primary ones: birth, death and recruitment. The equations themselves were based upon those created by Daniel Botkin, published in his book *Forest Dynamics: An Ecological Model*. We also took the opportunity to look through this book, as it contained a few secondary equations that we could not find using SimForest alone.

Simforest appeared at first to be perfect for our project, but it became apparent over time that the program has so many problems that it would be another project in itself to fix them. Despite the cumbersome nature of SimForest, some of the desired results were achieved after a lot of coaxing and manipulation. Three site quality tables were produced using weather data from a town ninety miles from Zoar Valley called Brockport, N.Y. This was as close as we could get to our study site and it produced much different results than the default weather conditions of New Hampshire. There are tables for the years 1890, 1986 and a third with adjusted rain and temperatures to reflect conditions potentially brought on by global warming. These site quality tables were used in together with a species table composed of

trees that have been recorded in the canopy and understory of Zoar Valley. An initial forest was set up in the simulation using data from actual sampling quadrats from Zoar Valley. Each simulation started out with the same number and recorded species of trees that were sampled from two particular terraces of Zoar Valley. Three sets of data were produced for each terrace, one for each site table. The data from each simulations run by Simforest and Netlogo, was exported and analyzed further with Excel as well as SPSS.

Since the project required communication of progress and results via the Internet, knowledge of Macromedia Dreamweaver was also needed. Basic tasks such as uploading files, modifying code, and adding links and pictures needed to be learned.

We set out to accomplish several goals when we initially began our project, but we were only successful in modeling different weather conditions. We found that similar results are accomplished with both programs, but NetLogo still needs a lot of adjustments. Particular species of trees seem to do well despite the weather conditions, such as American Elm, Sugar Maple and Beech. Two species that grew as predicted were White Ash and Hemlock. Graphs and charts made from the simulation data can be seen on our website.

The two histograms containing South Branch Terrace data show a large difference between the two site tables for “current climate” and “global warming”. The global warming conditions produced many more trees and seemed to favor white pine and white oak. The current climate conditions produced half of the trees and favored the very prolific white ash, which is a common tree in the world today.

The NetLogo model used trees that were present in the Zoar Valley Species Table also used in the SimForest simulation. These trees included American Elm, Beech, Basswood, Hemlock, White Ash, Sugar Maple and Yellow Birch. After running each tree separately for a period of approximately 270 years, certain characteristics were observed, such as the aforementioned successful growth of White Ash, Sugar Maple, and Birch. Both the NetLogo and SimForest models showed Hemlock and Basswood growing poorly with other trees. Both also displayed Sugar Maple as obtaining the greatest diameter. However, the NetLogo model also deviated from its SimForest counterpart. Most noticeably, Sugar Maple was overwhelmingly dominant in the NetLogo model, whereas White Ash was the tree that grew the most in SimForest. Other differences can be attributed to differing values for the site parameters, a different number of trees of each species initially planted, and actual differences in the code of the two programs.

Even if we encountered many setbacks involving our chosen programs, we plan on continuing with our project and presenting it at the Ecological Society of American next year, as well as writing and submitting a paper for publication. As well, Irena plans on continuing this research for her senior project.

4. Webpage

Our Webpage can be found at <http://www.cis.ysu.edu/~creu/> and we also have a blog at <http://zoarvalleymodelling.blogspot.com/>

5. Papers and Posters

This research was presented orally (with an accompanying PowerPoint component) at QUEST, an event where students can present their research at YSU. The presentation was called:

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This research was also presented as a poster at an event at YSU called Biology Days, under the same title and authorship. Both can be viewed on the website.

