EVALUATING MANAGEMENT STRATEGIES IN THE ALBANY PINE BUSH

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Introduction

The Albany Pine Bush Preserve (APBP) contains remnants of a globally rare Inland Pitch Pine-Scrub Oak Barrens Community Type (PP-SOB). This community is characterized by scattered pitch pines (*Pinus rigida*) that emerge over a sub-canopy of scrub oaks (*Quercus ilicifolia* and *Q. prinoides*) and other shrubs. Gaps in the shrub canopy house a diverse assemblage of grasses and herbs, many of which are rare in the region and contribute to the ecological significance of the site. One species, the wild blue lupine (*Lupinus perennis*) is the only host plant for the larvae of the federally endangered Karner Blue Butterfly. The wild blue lupine is shade intolerant and is only found in disturbances and in early successional sites where the tree and shrub canopies are sparse.

Presently, less than half of the approx. 1500 ha preserve is occupied by the high quality PP-SOB community. The remainder of the preserve contains later successional Inland Pitch Pine-Scrub Oak Thicket (PP-SOT) and Inland Pitch Pine-Scrub Oak Forest (PP-SOF) communities and other forest types that develop on former agricultural fields, or PP-SO sites that have experienced invasion by either aspen (*Populus grandentata, P. tremuloides*) or black locust (*Robinia pseudoacacia*). These forest types are coarsely defined collectively as Hardwood Forest (HW). The principle community types are shown in Table 1.

Managers at the preserve employ several different strategies to maintain high quality sites within the preserve. Prescribed fire has replaced natural fires that keep the PP-SOB community from succeeding into thicket and forest types. Mowing with a large-scale brush remover (hydro-axe) is used when fire is difficult to implement. Also, invasive tree species are actively removed from these and surrounding communities to prevent the transition to undesirable hardwood and mixed wood communities. In addition, the preserve actively restores degraded sites using intensive techniques to remove communities or structures like parking lots and planting native species.

Managers at the APBP have established goals that drive their management plans. These goals include:

1. To expand and maintain 1000 ha of PP-SOB community type using prescribed fire when possible.
2. To eliminate black locust and aspen stands (i.e., HW) and restore PP-SOB communities on these sites within 50 years.

There are many different management schemes that could be employed to meet these goals. Unfortunately, there is little experimental field data available to evaluate the options. When such data are absent or difficult to obtain, managers often rely on models

to assess which strategies are most appropriate and/or cost effective. Such models are best when they reflect the nature of the ecological processes and disturbance histories of the site. In lab today, you will develop a landscape-level model using STELLA that will predict community change within the APBP. This model will be parameterized using data from an analysis of community transitions during the interval 1940-1990 within the present APBP. You will employ your model to develop and evaluate a 50-year management plan for the APBP.

Name	Abbreviation	Extent in 1990 (ha)	Description
Developed Land	DL	113	Land with residential and/or commercial use including power lines, and sand/gravel pits.
Hardwoods	HW	28	Closed-canopy deciduous forests that may include invasive aspen and/or black locust; may contain coniferous trees, mainly white pine (*Pinus strobus*).
Pitch Pine - Scrub Oak Barrens	PP-SOB	49	Sparse overstory (<40%) of pitch pine with herbaceous vegetation and patches of scrub oak.
Pitch Pine - Scrub Oak Thicket	PP-SOT	341	Dense scrub oak (up to 60%) cover with scattered pitch pine, may include hardwoods.
Pitch Pine - Scrub Oak Forest	PP-SO-F	953	Closed-canopy pitch pine forest with little scrub oak; often in transition to upland hardwood forest type.

Table 1. Important community types within the APBP. These communities reflect only upland habitats and several distinct community types (e.g., northern and southern successional forests) have been folded into a generalized Hardwood type.

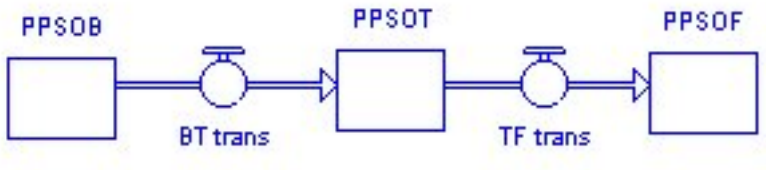
Modeling the Pine Bush Landscape

You will develop a simulation model of community dynamics at the landscape level using STELLA. This model will be based on a matrix of community transitions derived from an analysis of aerial photographs taken between the period 1940-90. Note that these transition probabilities summarize the combined results of biological processes (e.g., succession, invasion, colonization), natural disturbances (e.g., fire, wind or frost damage) and anthropogenic effects (e.g., development, road building, fire suppression) and the effect they have on communities within the APBP.

In this exercise, you will use an approach similar to the one you used to model forest succession as a tree by tree replacement process. Instead of modeling individual trees, you will model community replacements on a landscape. Like the previous exercise, there are two main assumptions that need to be considered for this modeling strategy to be appropriate: 1) transition probabilities are not affected by the previous state of the community, and 2) that the transition probabilities are stable with time. As you perform the modeling exercise, reflect on how violations of these assumptions affect the results of the modeling.

Constructing the Model

Since the model represents a successional process, it may be best to use flows to model the transition of one community type to the other. Consider the simple map of a successional transition from a PP-SOB to a PP-SOT to a PP-SOF community. Using connectors, parameterize this successional trajectory using the transition matrix shown in Table 2. Now, add the additional two community types and develop a fully parameterized model. Initial extents of each community type are shown in Table 1.



Final Class	Initial Class				
	DL	HW	PP-SOB	PP-SOT	PP-SOF
DL	1.0000	0.0018	0.0076	0.0074	0.0092
HW		0.9942	0.0026	0.0034	0.0046
PP-SOB			0.9702		
PP-SOT		0.0002	0.0196	0.9834	0.0002
PP-SO-F		0.0038		0.0058	0.9860

Table 2. Community Type Transition Matrix. The annual transition probabilities from the initial community (initial class) to the final community (final class) shown are derived from analysis of community types using aerial photographs for the fifty year period from 1940-90 (see Figure 1; transition probabilities based on Finton, A.D. 1998. Succession and Plant Community Development in Pitch Pine-Scrub Oak Barrens of the Glaciated Northeast United States. Master's Thesis, University of Albany). Abbreviations are shown in Table 1.

NOTE 1: The transitions for each community to replace itself are close to unity for any given year and are shown in the matrix. However, when constructing the model as described above, these numbers do not have to be connected to flows. Any portion of a community that does not transit to a different type will remain within the same type.

NOTE 2: When constructing a complicated model map, use the "shift" while you are forming flows to allow the flows to turn at right angles.

Exploring Model Dynamics

1. Predict the community distribution of the APBP 50 years into the future by running your model. Are any of the APBPs management objectives met? Look at the transition matrix. What do you think limits the attainment of the goals?

2. In the 1980s, the Albany Pine Bush Preserve Commission was established and land was purchased that formed the core of the present day APBP. In effect, this altered the transition probabilities from all community types to developed land. What do you think will happen if these are all zero as they are within the present day APBP? Try this out. Did the establishment of the preserve allow the goals to be met? Why or why not?

3. It was clear that fire suppression within this century limited the transition to PP-SOB community types from PP-SOT and F communities. Unfortunately, fire is not easy to manage within the APBP. The preserve is within a congested area and PP-SOF communities have too much fuel and fires are difficult to manage within that community type. Consequently, the fire management plan instituted in the early 1990s implemented prescribed fires to convert PP-SOT communities to PP-SOB. Unfortunately, the number of hectares burned each year varies and is lower than expected. Use your model to determine whether prescribed burns of 30 ha per year (an “average” year) will allow the management goals to be achieved (note that this is a number of ha, not a percent of the community type—consider how you will incorporate this into your model).

4. An alternative to prescribed fire is mowing. A large-scale machine called a hydro-axe can mow PP-SOT sites and convert them to PP-SOB types. Although expensive, this technique can be employed regardless of environmental conditions. Consider how a combination of mowing and burning 60 ha per year will affect the 50-year landscape trajectory.

5. The two closed-canopy forest types can be restored to PP-SOB communities by harvesting the trees and replanting native plants, many of which are absent within the shaded forest understory. This strategy is carried out in the hardwood forests first since they are the most degraded type and invasive species within them threaten the APBP landscape. The APBP has hired a contractor to remove approximately 20 ha of hardwood forests. Consider how this action carried out on an annual basis as well as a similar action within the PP-SOF community will affect the community dynamics.

6. The remaining restoration strategy is to restore developed sites within the preserve. Within the last two years, a parking lot was purchased near a high quality PP-SOB site and restored. Such efforts are intensive, but can be a feasible management option under certain circumstances.

7. Using the combination of strategies, have you attained the stated APBP management goals?

Evaluating Your Management Plan

You have explored the dynamics of the landscape model and figured out how to incorporate different management strategies into the model. Now, you will use the model to determine the most cost effective plan to meet the 50-year goal. Each strategy can be employed in a manner related to the extent of each community type or as an annual amount. Ask your instructor for help with instituting this in STELLA. Also, use a “cost” stock (the circle tool) to sum up the annual costs. When this is divided by the number of years, you get the annual cost. Make a converter (circle tool) that takes the "cost" and divided it by the number of years (do this by double-clicking on the converter and dividing by the "TIME" option in the "built-ins" menu. The approximate cost of each restoration strategy is shown in Table 3.

Strategy	Approximate cost \$ ha^{-1} yr^{-1}
Prescribed burning	5,000
Mowing with hydro-axe	4,000*
Harvest and restore forest	4,000
Restore developed land	3,000

*NOTE that 35 ha are performed for free by the National Fish and Wildlife Service each year. Above that amount, you will have to pay.

7. What is the mimimal cost for 50 years of management that meets the stated goals?

8. List three conditions that may limit this model as a tool for predicting actual landscape states in the future?

9. What factors may influence the ability of the model to accurately predict management expenses?

10. Is prescribed burning sufficient to either restore or maintain the PP-SOB community types within the preserve? What limits its application?