Creating Linkages Between MC1 and Envision

Envision treats “autonomous change processes,” such as ecological succession, within a state-and-transition model framework. It was therefore natural to use this framework to bridge the gap between Envision and the DGVM, MC1.

I. Building a STM

First, it was necessary to create a STM that describes both current and potential future vegetation for the areas of interest. This STM must be sufficiently detailed to capture important differences in vegetation, but not so detailed as to be uninterpretable or computationally inoperable.

For our project, we used the idea of a moisture gradient to guide our selection of dominant vegetation types. From most xeric to most mesic, these are: pine, madrone, oak, Douglas-fir, big-leaf maple, and grand fir. Within dominant vegetation types, we differentiated states on the basis of tree size and canopy structure.

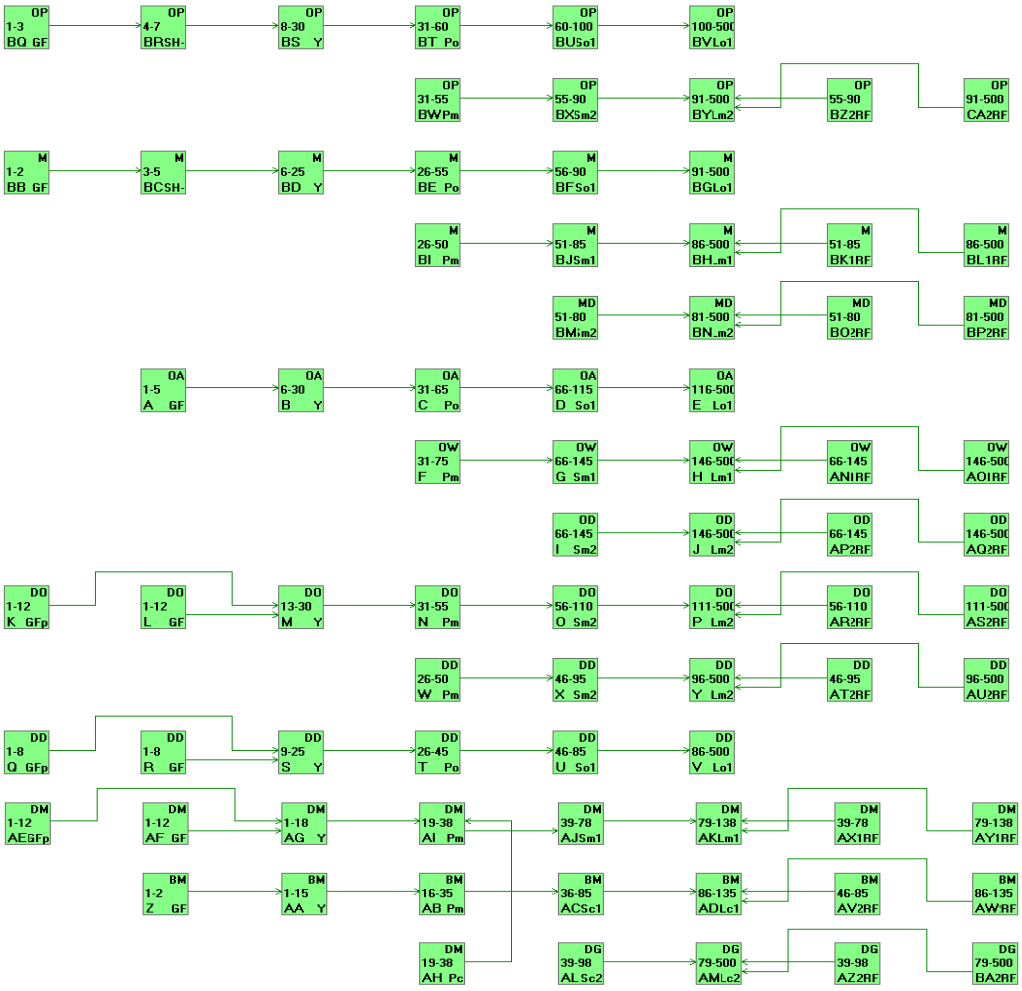


Figure 1. A wire diagram of the states in the full state-and-transition model.

To assign states to the initial landscape, collect tree lists from multiple data sources. Develop a set of logical rules to assign these tree lists to individuals states in the STM. For our project, we used phylogenetic relationships,morphology, and natural history to assign many different species to each type of dominant vegetation in the STM. For example, tree-lists dominated by ash trees were assigned to the big-leaf maple cover type, while tree-lists dominated by chinquapin trees were assigned to oak cover types.

II. Initializing Transition Probabilities within the STM

We used FVS to generate the initial transition probabilities for the STM. We chose FVS because of its ability to "grow" tree lists at a range of site index values.

We first took tree lists from our region and used FVS to bin those lists into states from our STM. We then ran each of these tree lists for several time-steps at different categorical values of site index. We then re-binned these output tree lists into STM states. From the transitions that FVS simulated we extrapolated annual transition probabilities for each state in our STM.

It was then possible to build a table of transitions from one state to another, based on different values of site index.

SI	from	to	p
1	a	b	p
1	a	c	p
1	b	c	p
2	a	b	p
2	a	c	p
2	b	c	p
3	a	b	p
3	a	c	p
3	b	c	p
4	a	b	p
4	a	c	p
4	b	c	p

Table 1. A cartoon of the organization of the lookup table of transitions. Blocks of the table are organized first by site index value, then by current state ("from"), then by destination state ("to").

Note that blocks are repeated for each value of site index. Contrary to the above cartoon, each block is not identical; there are differences among blocks because FVS predicted different growth trajectories based on different values of site index. The table does not contain all theoretically possible transitions, i.e., it is not a square transition matrix. Rather, it contains only the transitions that FVS specified.

III. Site Index

MC1 output does not include site index. To relate MC1 output variables to site index values, we correlated MC1 output with available site index data. We performed this correlation for approximately 1800 MC1 cells, ranging from central to southern Oregon, in the Coast Range and valleys. We made this geographic choice on the basis of data availability.

We used a wide range of potential MC1 output variables to find a relationship with site index. Variable considered covered vegetation and climate. We used several statistical techniques to analyze the data, but settled on a regression model, selected using AIC. That model is:

SI = 35.39 + (0.0006071*SC) + (-0.0008315*DC) + (0.06569*FP) + (0.1086*GP) +
(-0.002874*VC) + (.5215*TP) + (1.126*TH)

where

SI = Site Index
SC = Total Soil Carbon
DC = Above-ground Dead Carbon
FP = Forest Net Primary Productivity
GP = Grass Net Primary Productivity
VC = Total Vegetation Carbon
TP = June Temperature
TH = July Maximum Tree Height

The overall adjusted $r^2 = 0.61$.

Using the equation above, it was then possible to produce a space- and time-filling map of SI for our study areas.

IV. PVT (Potential Vegetation Type)

Finally, we wished to constrain the full STM on the basis of potential vegetation type, as predicted by MC1. Since the STM contains vegetation types from multiple potential futures, as well as the present, there is no reason that transitions to all of the types in the model should be allowed at any one time. We developed a rule-base to disallow many transitions for each PVT. This allowed us to expand our initial table, replacing some of the transition probabilities for each PVT with “0”. IDUs that exist in states other than the allowed states (those in the red boxes, see

Figures 2-5) will not immediately be forced to change state. When a transition is called for, however, only transitions to allowed state may have non-zero probabilities. The PVT from MC1 thus constrains where the state-and-transition model may move over the future.

PVT	SI	from	to	p
1	1			p
1	2			p
1	3			p
1	4			0
2	1			p
2	2			p
2	3			0
2	4			p
3	1			0
3	2			0
3	3			p
3	4			p

Table 2. A cartoon of the organization for the full lookup table. Notice that Table 1 is essentially repeated for each value of PVT.

We exported a space- and time-filling map of PVT for our study areas.

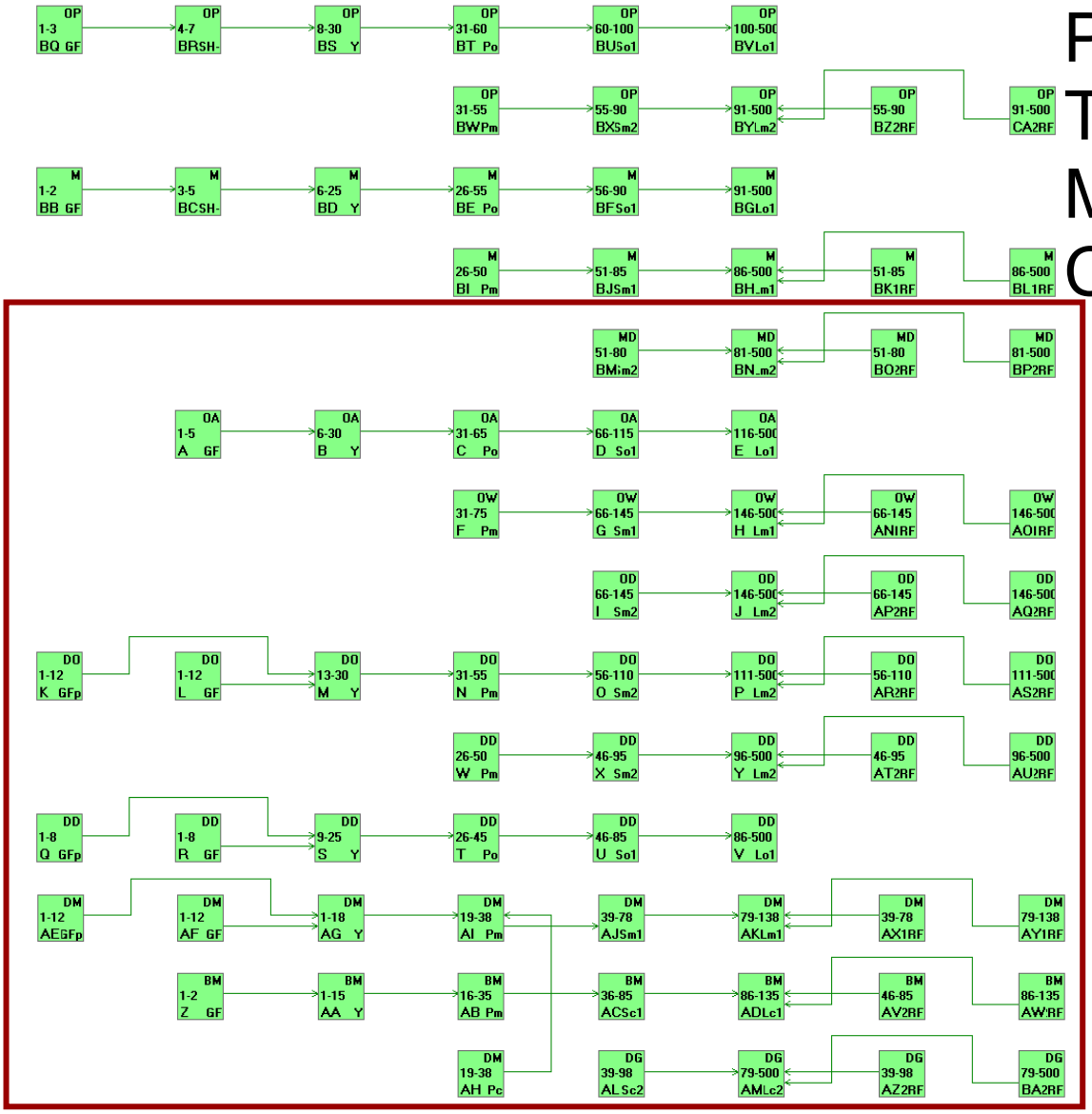
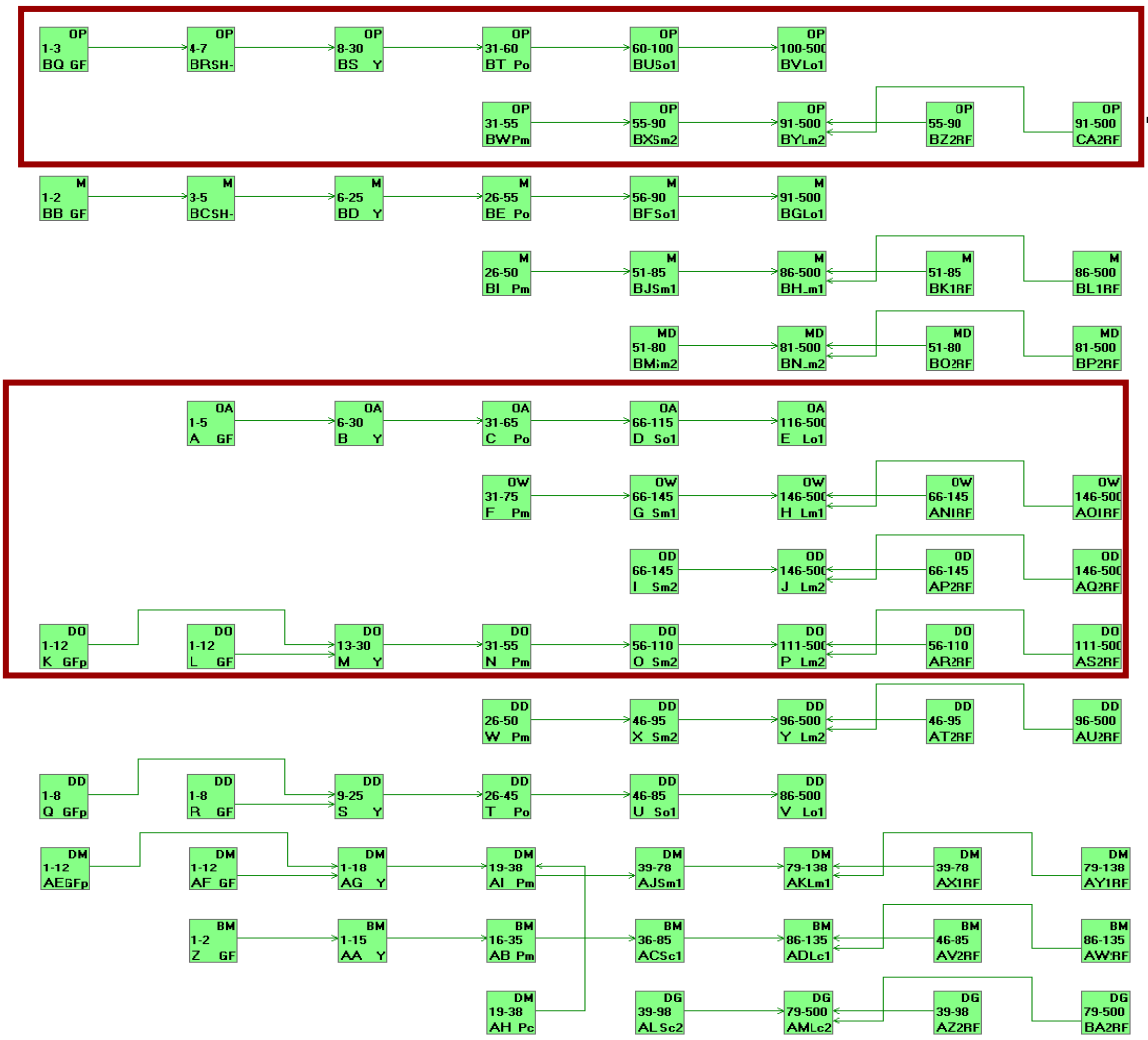


Figure 2. A wire diagram of the states included in the state-and-transition model. States within the red box are included in PVT 3, Temperate Maritime Coniferous Forest.



PVT 4 - Temp. Cont. Conif.

Figure 3. A wire diagram of the states included in the state-and-transition model. States within the red boxes are included in PVT 4, Temperate Continental Coniferous Forest.

PVT 6 - Sub.Trop. Mix.

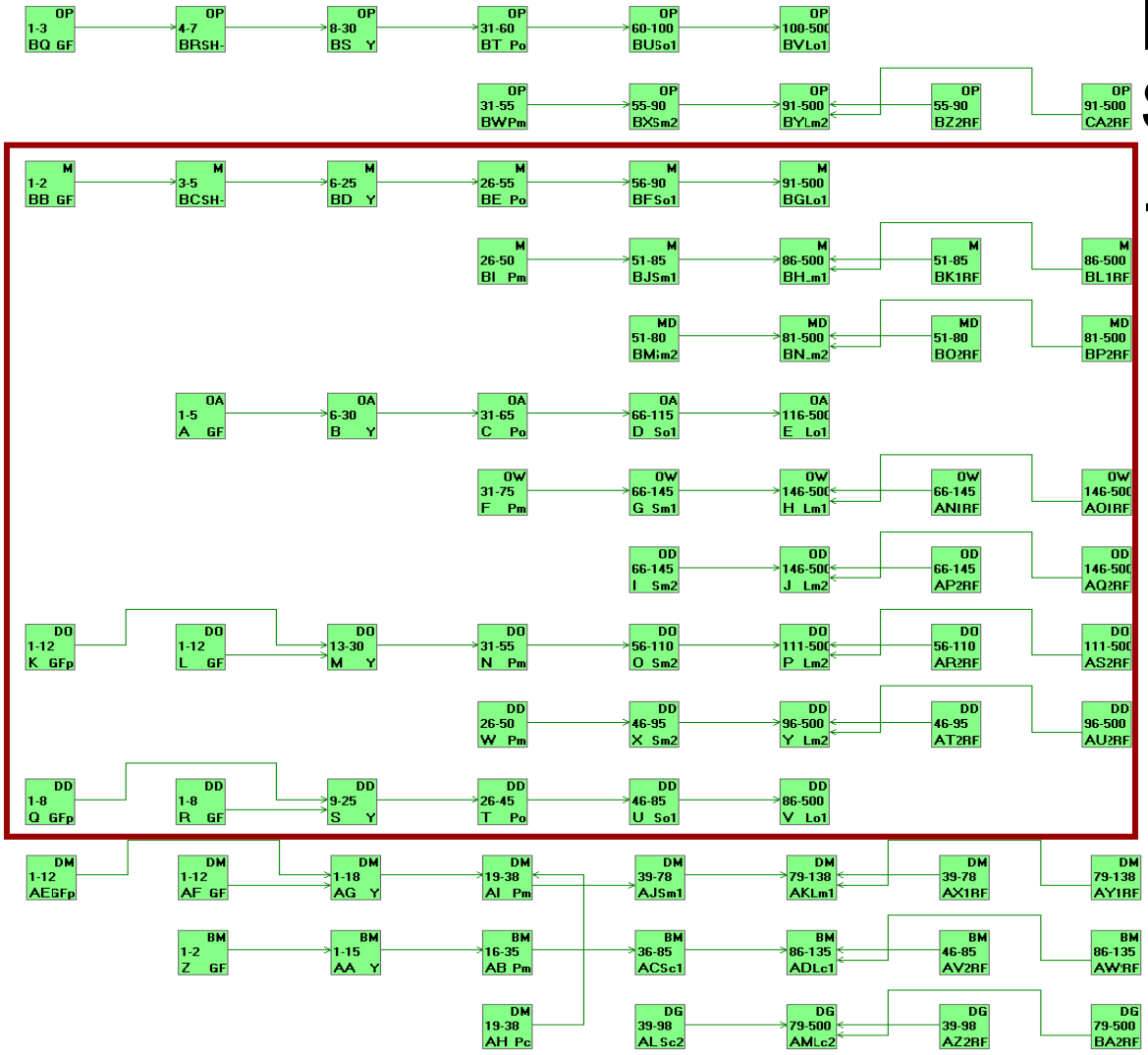


Figure 4. A wire diagram of the states included in the state-and-transition model. States within the red box are included in PVT 6, Subtropical Mixed Forest.

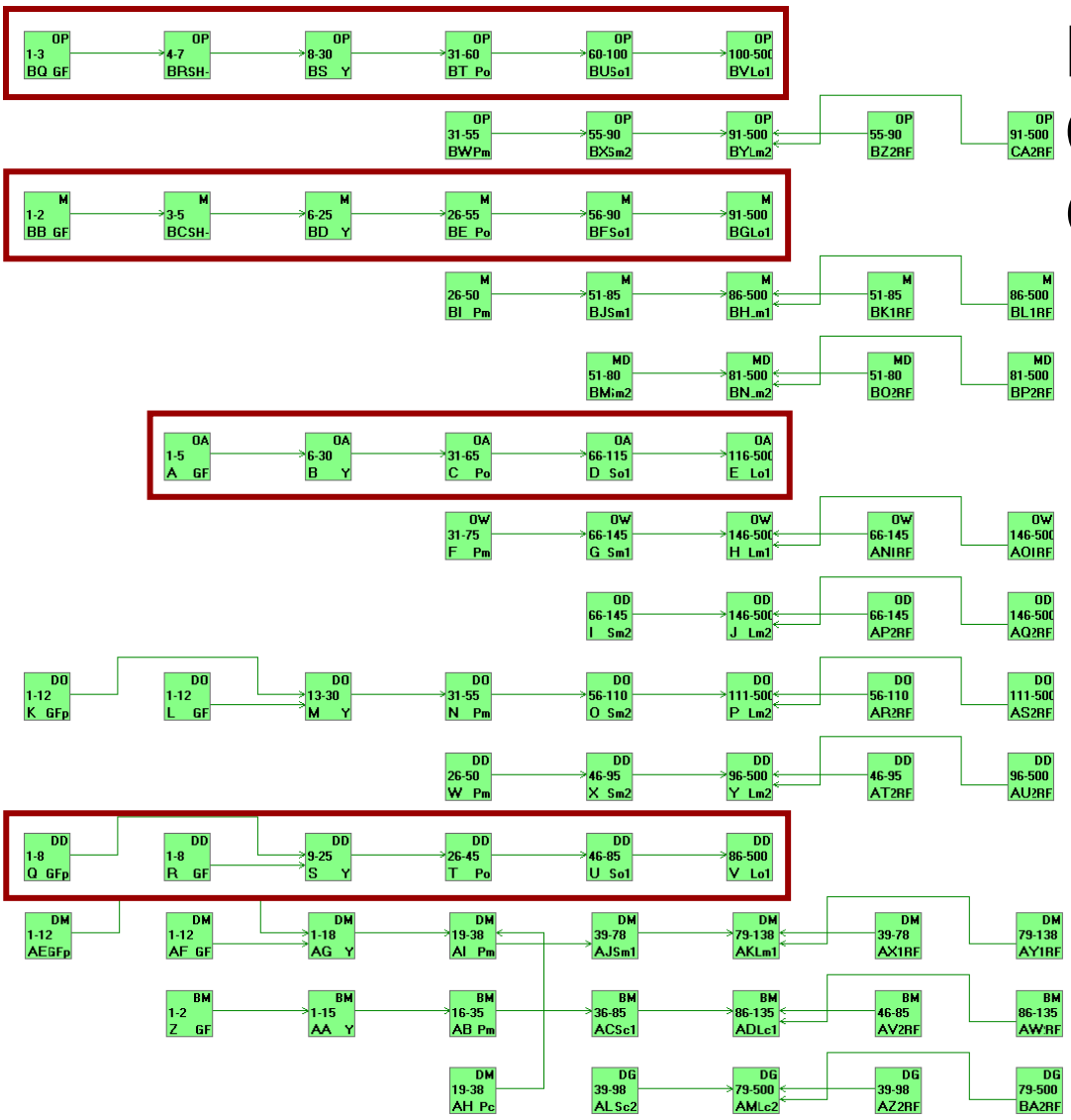


Figure 5. A wire diagram of the states included in the state-and-transition model. States within the red boxes are included in PVT 17, C3 Grassland.

V. Final Procedure

Using the two space- and time-filling maps, one of SI and one of PVT, it is now possible to select a suite of suitable transitions, with adjusted probabilities, all based on the current vegetation for an IDU, and informed by MC1.

At each time step, the subset of the table that corresponds to an IDU's current values for PVT, SI, and "from", contains all of the potential "to" transitions. These potential transitions are then implemented with their corresponding probabilities, using an algorithm similar to that in VDDT.