“Can mature patch constraints mitigate the fragmenting effect of harvest opening size restrictions?”

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Growing timber is not the primary management objective for many landowners. For example, the national forests must be managed to maintain the populations of all native and desired nonnative plants, fish, and wildlife under the National Forest Management Act. Similarly, only a small percentage of private landowners own land primarily for income generation from timber production (Birch 1996). As the emphasis on ecosystem management goals increases, harvest scheduling models must be modified to incorporate new objectives.

When forest ecologists discuss ecosystem management, they are interested in things such as age distribution, patch size distribution, the amount of edge, the amount of interior forest, and the connectivity of the forest (Hunter 1990). With the exception of age distribution, these things are difficult to model directly in a mixed-integer harvest scheduling model. Models have been developed that incorporate a variety of spatial factors such as wildlife dispersal and amount of edge (Hof and Bevers 1998), maximum harvest opening size (Thompson et al. 1973, McDill et al. in press, Barrett et al. 1998, Borges and Hoganson 2000), and minimum habitat patch size constraints (Bettinger et al. 1997 and 2000, Hof and Joyce 1992, Sessions et al. 2000), which require large patches of mature forest to be present at all times. Often, incorporating these factors results in complex models that are difficult to solve to optimality. However, methods for modeling two factors in a spatially-explicit, mixed-integer harvest scheduling model – maximum harvest opening size and minimum patch size – have been proposed that can give optimal solutions to small problems (McDill et al. (in press), Rebain and McDill (in review)). This paper considers how controlling these two factors indirectly affects factors that are not directly controlled, including the age distribution, patch size distribution, and the amount of edge of a forest.

The general model used in the study was a mixed-integer harvest scheduling model, with maximizing net present value as the objective. The planning horizon is 60 years, consisting of three 20-year periods. Four possible prescriptions were considered for each stand—harvest in period 1, 2, or 3, or not harvested at all. Flow constraints limit fluctuations in the harvest level from period to period, and ending age constraints are imposed to ensure that a desirable forest will be left at the end of the planning horizon. The yield and economic information used in the model is loosely based on a Pennsylvania oak forest.

Ten variants on this general model were developed. One version of the model includes no maximum harvest opening limit and no patch requirements. The remaining nine variants include maximum harvest opening constraints and, in some cases, habitat patch size
constraints. An area-restriction model (Murray 1999) based on the Path Algorithm proposed by McDill et al. (in press) is used, so the concurrent harvest of adjacent stands is prevented only if the combined, contiguous harvest area exceeds the maximum harvest opening size. The three different maximum harvest opening limits are 40, 50, and 60 ha. The patch requirements call for at least 15% (135 ha) of the forest to be at least 60 years old and in patches of a certain size. Three types of minimum patch size requirements are considered—no patch requirements, 50 ha patches, and 70 ha patches.

All ten variants were used to find optimal harvest schedules on a sample of 50-stand, 900 ha hypothetical forests. Preliminary results have been obtained from an initial sample of four such hypothetical forests, and we expect to increase this sample to ten forests. The age distribution, border distribution, and patch size distribution of the forests at the end of the planning horizon were then determined. Results show that smaller maximum harvest opening sizes and larger mature patch size requirements tend to result in slightly lower harvest levels and consequently more mature forest. Smaller maximum harvest opening sizes are shown to lead to more edge and, hence, greater fragmentation. Mature patch size requirements, however, require the merging of patches and help mitigate this effect. The mature patch size requirements often led to the creation of patches larger than 100 ha, even though smaller patches could have met the requirement. Fortunately, the opportunity cost of imposing these constraints does not seem that high. The most restrictive model resulted in a net present value only 10% less, on average, than the least restrictive model.

Literature Cited


