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Management templates for increased biodiversity and economics in intensively managed loblolly pine plantations

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Intensively managed loblolly pine plantations have a significant potential to contribute to biodiversity in the South. This contribution can be enhanced with various stand-level management practices, such as thinning, prescribed burning, and retaining key structural elements (for a complete review, see RTI Fact Sheet 37). While some of these practices are complimentary with timber production and economic goals, others involve trade-offs. To promote increased biodiversity on private ownerships, management strategies should be identified that balance biodiversity and economic goals. RTI has developed a framework for creating management guidelines or "templates" to achieve ecological and economic objectives for riparian forests in western Washington (RTI Fact Sheet 23). Using this same framework, an example template has been created for increasing biodiversity in southern loblolly pine plantations.

The first step in creating a management template is to identify a forest structure associated with the management goals. In southern pine forests, an open, park-like structure with a rich, herbaceous understory is likely to support high levels of biodiversity on appropriate sites. This type of structure is characteristic of the fire-maintained longleaf pine forests that covered much of the South in pre-settlement times. Only a fraction of these forests remain, and they are recognized for the high levels of biodiversity they support (Bragg 2002, Noss 1988).

A reference dataset was used to quantify this structure. The dataset was collected at International Paper's Southlands Experimental Forest in southwest Georgia for a study by Hedman et al. (2000) that identified a set of "benchmark" stands that were characteristic of historic, open longleaf pine forests (*Figure 1*). Four key stand attributes described the structure represented in the dataset: the density and diameter of the large trees and the density and diameter of the small trees. When considered together, these attributes provide a quantitative target that can be used as an objective measure of whether or not the desired forest structure is achieved. Stands whose attributes are within this target have a structure that is statistically similar to the desired structure as quantified by the reference dataset.

Nine management alternatives (*Table 1*) were established representing a range of practices for improving the likelihood of achieving the desired structure for increased biodiversity (see RTI Fact Sheet 37 for a review of these practices). The first alternative was a 25-year chip and saw rotation, and the other eight were 35, 40, or 55-year sawtimber rotations. Each alternative included a commercial thinning at age 15 that was assumed to remove 30% by volume. The sawtimber alternatives included subsequent commercial thinnings beginning at age 25. These thinnings were done from below to a residual basal area (BA) of either 60 or 80 ft^2/acre. The thinnings were repeated at either 10 or 15-year intervals until the final clear-cut harvest.

Each management alternative was projected over 100 years (rotations were repeated as necessary) using the Landscape Management System (LMS). LMS is one of RTI's core technologies that brings together growth, treatment, and visualization models under a single, user-friendly interface that offers integrated analysis capabilities for a variety of ecological and product outputs. Projections were done in LMS using the Southern Variant of the Forest Vegetation Simulator (FVS, SN) growth model. A 10-year-old loblolly pine plantation from the Hedman et al. dataset that was representative of typical conditions for a young, intensively managed plantation was used as the base inventory to test each alternative.

Figure 1: A "benchmark" stand measured by Hedman et al. (2000). The open, park-like structure of this uneven-aged longleaf pine stand supports a rich, herbaceous understory that provides habitat for a variety of species. Photograph taken by Craig Hedman.

Table 1: Nine potential template alternatives were established based on practices likely to achieve the desired structure.

Alternative	Rotation Length	Thinning Target (ft^2 BA)	Thinning Interval
1	25	NA	NA
2	35	60	10
3	35	80	10
4	40	60	15
5	40	80	15
6	55	60	10
7	55	80	10
8	55	60	15
9	55	80	15

When simulating the thinning treatments for each alternative, a component of desirable, mast-producing hardwoods (black cherry, hickory, and various oaks) were maintained to enhance wildlife habitat. It was also assumed that prescribed burning would be done at 5-year intervals beginning at age 20. While this was not directly represented in the simulations, the impacts were indirectly represented by not including the natural hardwood ingrowth that would be expected after heavy thinning treatments but instead assuming that such ingrowth would be killed or suppressed by burning.

For each alternative, the projected stand structure over 100 years was compared to the target to assess how often the desired structure was achieved. The soil expectation value (SEV), which is the net return to bare land assuming perpetual management, was also computed for each alternative. SEV is a commonly used measure of overall economic performance that allows direct comparisons of rotations with differing lengths. SEV was computed using the harvest outputs from LMS and average 1st quarter 2005 stumpage prices for Georgia (Region 2) reported by Timber Mart-South. Cost assumptions included $13.25/acre for prescribed burning, $8/acre for annual property taxes and overhead costs, and $215/acre for stand establishment costs at the beginning of the rotation. SEV was computed before taxes assuming a 5% target real rate of return.

The results for each alternative are summarized in *Table 2*. The 25-year chip and saw rotation (Alternative 1) was not long enough to produce the desired structure and had the lowest SEV. Shorter rotations are generally economically advantageous, but historically low pulp prices ($18.40/cord) have decreased their competitiveness relative to longer rotations that produce higher-value products. The 35 and 40-year rotations (Alternatives 2-5) performed the best economically but only achieved the desired structure 24% of the time or less. The 55-year rotations (Alternatives 6-9) achieved the desired structure the most often and had moderate economic performance.

Table 2: Comparison of the percentage of time that the desired structure was achieved and economic performance for nine template alternatives.

Alternative	% Time Desired Structure Achieved	SEV/Acre	SEV Cost/Acre	Cost/% Time Desired Structure Achieved
1	0%	-$20	$639	NA
2	14%	$423	$196	$14.00
3	14%	$480	$139	$9.93
4	24%	$466	$153	$6.38
5	14%	$619	$0	$0
6	48%	$305	$314	$6.54
7	48%	$413	$206	$4.29
8	48%	$382	$237	$4.93
9	38%	$415	$204	$5.37

From a cost-benefit standpoint, Alternative 5 achieved the desired structure some of the time and had no economic cost, as it achieved the highest SEV. The other alternatives each had an opportunity cost, which was the loss in SEV relative to what could be achieved with Alternative 5. Of these other alternatives, Alternative 7 had the lowest cost per percent time that the desired structure was achieved. Alternative 7 was one of three alternatives that achieved the desired structure most often (48% of the time). In contrast, Alternative 5 achieved the desired structure least often (13% of the time), not counting Alternative 1 which did not achieve the desired structure at all.

Alternative 7 appears to be a good template option that balances the management objectives of increased biodiversity and economic performance. It achieved the desired forest structure a high percentage of the time, producing an open stand that can support a rich understory and a diversity of wildlife (*Figure 2*). At the same time, the economic performance was still competitive such that it may be acceptable to landowners or at least minimize any needed incentives. There may also be increased opportunities for supplemental income from hunting leases, as the resulting stand structure is good habitat for game species and aesthetically pleasing.

The template described above provides one example approach for managing for biodiversity and economics in southern loblolly pine plantations. The template incorporates some key principles for managing for biodiversity, such as longer rotations, early and frequent thinning, and prescribed burning. The alternatives that were examined were not an exhaustive list, and there are many other potential templates that could also achieve good results. In particular, even longer rotations may provide for more time in the target for landowners willing to accept lower but still reasonable economic returns. Earlier, more frequent, or heavier thinnings may achieve target conditions sooner than the alternatives examined.

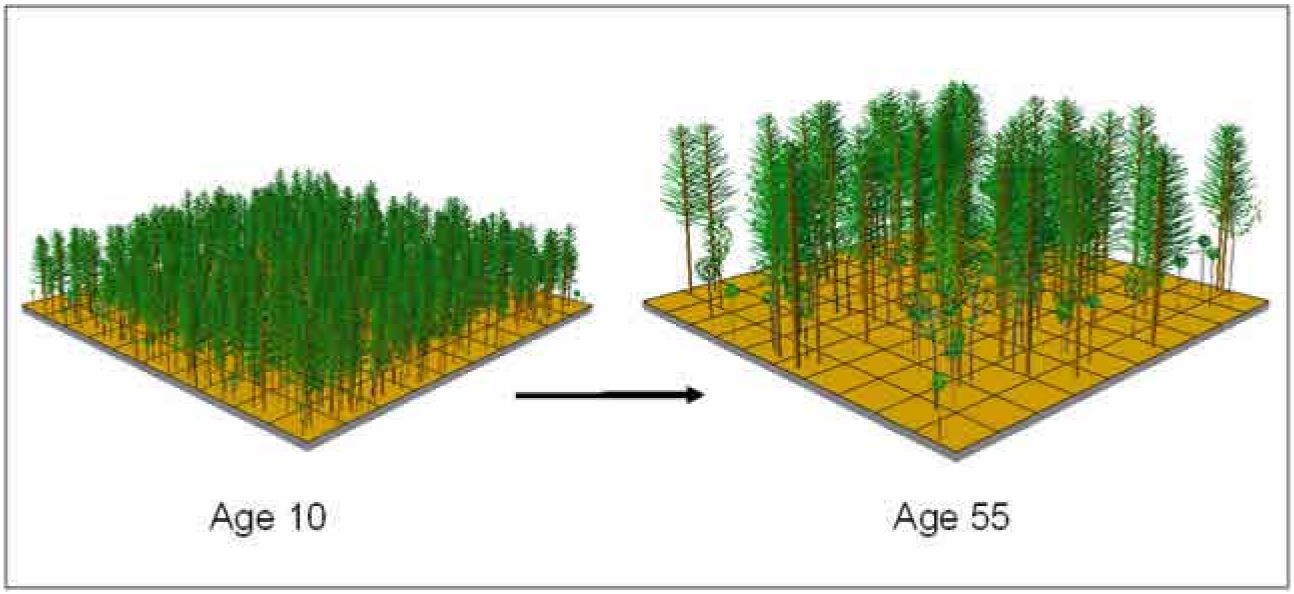

Figure 2: Projected stand development from age 10 to 55 under Alternative 7.

The example southern template above demonstrates that the RTI template framework is not limited to western Washington riparian forests but can also be successfully applied in other regions. This framework shows promise as a proactive approach to managing forests for multiple objectives in a way that minimizes economic impacts, management complexity, and the potential for unintended consequences.

A complete report of this research is available in Technical Report D of RTI Working Paper #5: http://www.ruraltech.org/pubs/working/ncssf/tech_d/index.asp

References:

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