CHAPTER 8: STAND ESTABLISHMENT, THINNING AND OTHER INTERMEDIATE TREATMENTS

Chapters 6 and 7 focused on the rotation decision for even-aged stands. This is an important decision in forest management – one of the most fundamental. The analysis of the rotation decision is also relatively straightforward. However, there are many other decisions to be made in managing an even-aged stand. This chapter briefly considers a variety of these other decisions, with a particular emphasis on thinning decisions. The three groups of stand treatments considered here are 1) stand establishment, 2) thinning, and 3) a variety of other miscellaneous intermediate treatments.

Although it was considered first, the rotation decision is not independent of these other decisions. For example, the best rotation for a planted stand could be very different from the best rotation for a naturally regenerated stand. Similarly, an unthinned stand may be managed for pulpwood on a very short rotation, while the same stand, if thinned, might be managed for sawtimber with a considerably longer rotation. In fact, few forest management decisions are independent of the other decisions that must be made. Stand management decisions must therefore be made as a package with the other decisions that must be made for the stand. Indeed, stand management decisions are seldom independent of the management decisions that are made on the rest of the forest – as you shall see in later chapters.

When one considers the many management options available for individual stands, the number of possible combinations rapidly becomes very large. An analytic approach is required in order to analyze such a large number of decisions. The specific method generally used for such analyses is called dynamic programming. Dynamic programming is too advanced for this class, however, so we will take a more qualitative approach.

1. Benefits of Intermediate Treatments

The purpose of any silvicultural treatment is to direct the development of the stand through a different set of expected future states than those that one would expect to occur without the treatment. These alternative states would be desired because the products and services they are expected to provide are deemed more desirable than the products and services that would be obtained without the treatment. In general, a treatment is financially sound if the difference between the present value of the products and services obtained with the treatment and the present value of the costs and benefits that would be obtained without the treatment exceed the present value of the costs of the treatment. This chapter considers how different stand treatments affect stand development and the amounts and timing of products and services from the stand.

Stand Establishment

Many treatments are used in forest management to encourage adequate regeneration of harvested stands or to control the type of regeneration. In much of the northeastern U.S., for example, deer fencing is necessary to obtain adequate regeneration of many desirable species. Often, some kind of site preparation is used – including mechanical methods, prescribed burning, and herbicide applications – to reduce the competition from grasses, forbs, shrubs, and undesirable tree species. Even the method and the timing for harvesting the existing stand is often selected to encourage the regeneration of desirable species, as in seed tree and shelterwood harvests, or harvesting an aspen stand in the winter to maximize the vigor of root sprouts.

New stands often are established through planting. In most cases – especially in the regions of the world with temperate climates – when a stand of trees is harvested, a new stand of trees will grow up to replace the harvested stand without any human intervention. Why then should foresters spend money to plant a new stand? Generally speaking, the reason is to direct the stand through a different developmental pattern than would occur with natural regeneration. Obviously, planting is necessary when the desired species would not regenerate naturally. Even if the desired species would regenerate naturally, planting may be used to establish trees that have been selected or genetically improved for certain traits such as fast growth, disease resistance, form, cell structure, and even herbicide resistance. Planting also tends to speed up the process of establishing a new stand, as the planted seedlings may already be one or two years old, and natural regeneration is not always immediately forthcoming. In addition, planting gives the forest manager more control over the density and spacing of the trees in a stand, possibly reducing or eliminating the need for precommercial thinning. Through a combination of some or all of these advantages, well-planned plantations typically grow considerably faster than naturally-regenerated stands – producing an equivalent amount or more wood in a shorter time period.

Planting trees has the obvious disadvantage of being relatively costly, and incurring a cost early in the rotation that must be carried and capitalized over the entire life of the stand. Also, planted seedlings may not be matched to a site as well as the natural progeny of trees that originated naturally on the site that potentially have the benefit of many generations of natural selection to adapt them to the specific characteristics of that site. Furthermore, with natural regeneration it is common to have thousands of seedlings per acre, and considerable natural selection occurs as a result of the intense early competition of among these seedlings.

Thinning

From a silvicultural perspective, thinning is done to capture mortality and improve spacing, concentrating the resources of a site on a smaller, select set of trees in order to increase their growth rates. By increasing the growth on a smaller set of trees, these trees reach the size needed for valuable products such as sawtimber and veneer much faster than they would otherwise. From a financial perspective, this set of trees should be selected based on their potential to increase in value.

Depending on ownership objectives, trees may also be selected for their value to particular wildlife species – for example, mast-producing trees – or for aesthetic reasons. Besides species selection, thinning can be used to increase the capacity of the stand to provide non-timber benefits in many ways; for example, by producing bigger trees with larger crowns and larger branches to provide better habitat for some species, or by encouraging the growth of understory plants to improve forage values.

Other Treatments

Many other stand treatments can be employed. Release treatments – either mechanical, chemical, or by fire – are used to kill competing vegetation in young stands which are just becoming established. Fertilization, and, more recently, even irrigation, are used to overcome the nutrient and water limitations of a site. Prescribed burning is used to achieve a variety of objectives, including site preparation, release, understory control, and fuel load management. Many forest management activities are done to protect the stand from fire, insects, and excessive browsing – e.g., fencing, seedling tubes, and fire and disease control.

2. Huge Number of Possibilities

The previous section discusses many of the stand treatments that can be applied in a stand. For each treatment, a decision must be made either to employ or not employ that treatment in each stand. For most treatments, decisions must also be made about how and when the treatment should be applied. For example, in the case of thinning, decisions must be made about how many times – if at all – a stand should be thinned, the timing of these thins, the intensity of the thin (i.e., the proportion of the stand to be removed), the type of thin (row thinning, thinning from below, crown thinning, etc.), and specifically which trees should be removed. Many, if not all of these decisions depend on the decisions made regarding other treatments. For example, the decision of whether or not to thin a stand may depend on the planting density. Similarly, the financially optimal rotation will often depend on the schedule of thinnings. The number of possible combinations of different treatments that could be considered is potentially very large.

Consider a relatively simple example with only a few decisions. On a given stand, a manager might consider whether or not to thin. If the stand is thinned, the manager would then have to decide when to thin – for example, at ages 40, 45 or 50. When the stand is thinned, a decision will have to be made about the intensity of the thin – for example whether the 40, 50, or 60 percent of the basal area should be removed. Finally, the manager might want to consider three rotation ages – such as 60, 70 or 80 years. How many possible management scenarios result from these decisions? Figure 8.1 depicts this set of decisions in the form of a decision tree. A decision tree shows a series of interrelated decisions as a network of lines (called *arcs*) with decisions represented as a point where arcs branch (called a *node*). Each branch represents a possible choice for the decision corresponding to that node. Each path through the tree from the root (at the top) to a terminal branch, or arc, (at the bottom) represents a possible complete stand management prescription for a stand from the time of stand

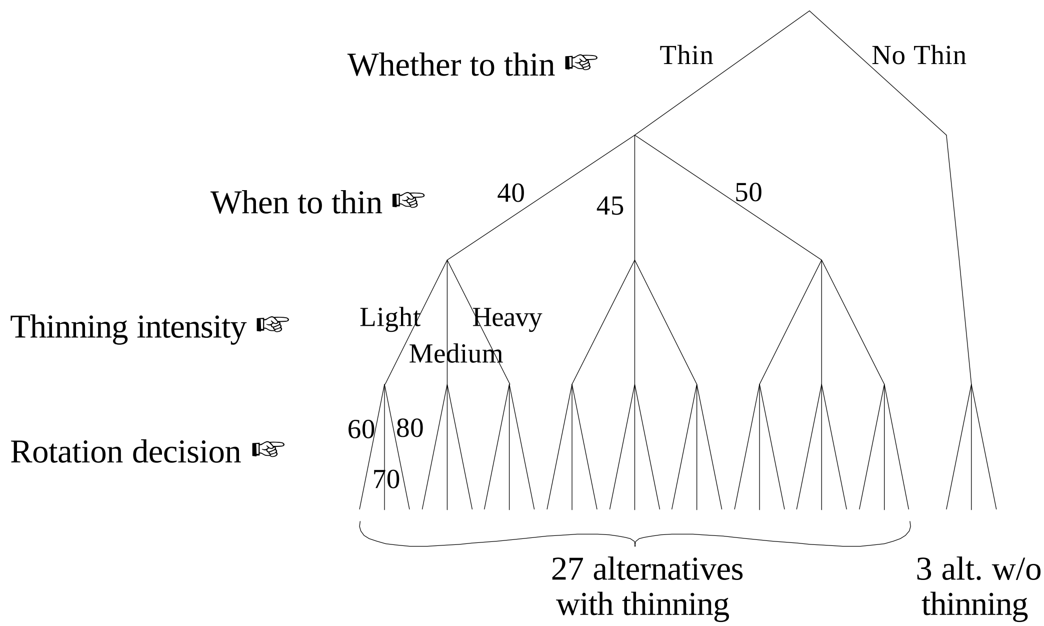

Figure 8.1. Decision tree for a hypothetical stand with one potential thin, three possible times to thin, three possible thinning intensities and three possible rotations, resulting in 30 possible stand prescriptions.

establishment to the time of the final harvest. In this example, there are 30 possible complete prescriptions, 27 involving thinnings and 3 without thinnings.

You should be able to see that a stand management decision tree such as the one in Figure 8.1 could get very complex very easily. For example, what would happen if four regeneration options – e.g., natural regeneration, planting with 400 trees per acre, planting with 600 trees per acre, or planting with 800 trees per acre – were also considered? The number of possible paths through the decision tree (complete stand prescriptions) would immediately be increased fourfold to 120. It is not hard to generate examples with thousands of possible treatment combinations.

As mentioned in the introduction to this chapter, there are systematic techniques for finding the best path through decision networks like the one shown in Figure 8.1. The most common of these is called *dynamic programming*. Researchers use dynamic programming, combined with growth and yield models and a variety of economic assumptions, to analyze forest management decision trees with thousands of possible prescriptions to develop management guidelines. Some of the more sophisticated companies with large forest land areas to manage also utilize dynamic programming in their management planning. However, because of its complexity, dynamic programming has not been widely adopted in the forestry profession.

3. The Sawtimber/Pulpwood Price Ratio and Three Basic Thinning Strategies

In most cases, thinning is applied in forest stands in order to produce sawlog or veneer sized trees in the residual stand. Ironically, however, the direct product of thinning is usually pulpwood. Thus, thinning typically occurs where there are good markets for both pulpwood and sawtimber. If sawtimber prices are very high relative to pulpwood prices, sawtimber will typically be grown in unthinned stands over very long rotations. Conversely, if pulpwood prices are high relative to sawtimber prices, unthinned stands will be harvested to produce pulpwood using very short rotations. Which of these three basic management models will be followed is determined largely by the *sawtimber/pulpwood price ratio*, and thinning occurs only for the middle ranges of this ratio.

Consider each possibility, beginning with high sawtimber/pulpwood price ratios. When sawtimber prices are high and pulpwood prices are low, thinning is economically difficult because most thinnings will be pre-commercial – i.e., rather than generating returns, they cost money to perform. Without thinnings to hasten the development of sawtimber-sized trees, rotations will typically be long. In this case, natural regeneration will be more common than planting because the long rotations and lack of intermediate returns make the cost of carrying stand establishment costs too high. When planting is done, planting densities will be low to ensure that trees will have enough space to grow without thinning. In this management model, extensive management – i.e., management with low investment levels – is dictated by the lack of good markets for pulpwood. Even very high sawtimber prices are unlikely to significantly increase the level of management intensity. This type of management is common in the management of oak-hickory and northern hardwood stands in the northeastern U.S.

At the other extreme, with low sawtimber/pulpwood price ratios, pulpwood production dominates. Pulpwood production typically does not benefit from thinning, so thinning does not occur. Rotations are relatively short, and, if planting occurs, planting densities are high in order to maximize the utilization of the site resources. Due to the short rotations, management intensity tends to be relatively sensitive to price increases. This management model is common in pine management in the southeastern U.S. – particularly in Georgia and South Carolina. This is also the dominant management model for aspen in the Lake States.

Only when sawtimber/pulpwood price ratios are in the medium range and good markets exist for both pulpwood and sawtimber-sized material is thinning common. In this management model, rotations are in the medium range because trees reach sawtimber-sizes much faster with thinnings. In these cases, management intensity tends to be relatively sensitive to prices because costs can be recovered more quickly with the early returns from thinning. Where planting occurs, initial densities tend to be high – again to maximize the utilization of the site resources, and to produce thinning returns more quickly. Multiple thinnings are sometimes performed, and the overall product mix from the stand includes both pulpwood and sawtimber. This model is less common in general, but it is used in pine management in the Gulf states (Alabama to Texas) and in Douglas-fir management in the Pacific Northwest.

An important point that you should take away from this discussion is that thinning and stand establishment decisions often are driven largely by economics. Silviculture is obviously important, but if the economics change, the silviculture will generally change to reflect the new economic conditions. For example, when good pulpwood markets are established in a region which has not had good pulpwood markets, one could expect to see a shift in management from a sawtimber-only model to a sawtimber-pulpwood model which would include thinning, shorter rotations, and generally increased management intensity.

4. Study Questions

1. Explain the statement that “stand management decisions must therefore be made as a package with the other decisions that can be made for a stand.”

2. What is the purpose of silvicultural treatments in a stand?

3. What criterion must be met for a silvicultural treatment to be financially sound?

4. Why are stands planted when a new stand can be obtained through natural regeneration?

5. What are the advantages and disadvantages of planting versus natural regeneration?

6. What are the silvicultural benefits of thinning? What are the financial benefits?

7. How can thinning contribute to non-timber objectives?

8. How many possible complete stand prescriptions – covering stand establishment to the final harvest – are generated if three possible thinning times, two possible thinning intensities, and four possible rotation ages are considered?

9. What is a decision tree?

10. Construct a decision tree for a stand management problem involving zero or one thin, with two possible times when the thin can occur, two possible thinning intensities, and three possible rotation ages. How many complete stand prescriptions are there in this problem?

11. Why does thinning not occur when sawtimber/pulpwood price ratios are very high?

12. Why does thinning not occur when sawtimber/pulpwood price ratios are very low?

13. Describe the management model that usually occurs when sawtimber/pulpwood price ratios are very low. (Or very high, or in the middle range...)

14. What is likely to happen in a region that has always had low pulpwood prices and moderately high sawtimber prices if new markets for pulpwood are created in the region?