Management Techniques for Conifers – Part I
Density Management Diagrams
By Mark Richardson

Whether managing a woodlot for wildlife or for high-value timber production, the importance of making appropriate management decisions cannot be understated. Knowing what you want to do, and having the right tools and information available to help you do it, will go a long way to ensuring that your woodlot is managed in the best possible way.

This is the first in a series of three articles written for landowners interested in managing their stands of pine and spruce. Part I of the series will introduce the concepts behind a relatively new forest management tool called the Density Management Diagram (DMD). Part II will detail how to use the DMD, along with some easily collected stand inventory information to determine what needs to be done in your woodlot. The final article in this series (Part III) will demonstrate crop-planning techniques that allow you to predict future harvests and volumes. Please note that proper management also involves consideration of all forest values including timber, wildlife, health and recreation.

The Density Management Concept

Conifers, unlike most hardwood species, tend to grow in pure stands that are either planted or natural in origin. Regardless of their origin, one basic ecological fact exists for all conifer forests: the number of trees in a stand decreases as the stand ages. A hectare of land can support only so much living material (biomass). As a stand of trees grows, it uses up increasing amounts of resources, namely space, water, and nutrients. Once the stand reaches a certain point, the site can no longer adequately support the number of trees growing on it. Growth slows down, and eventually trees begin to die due to the lack of resources. As these trees weaken, they are more susceptible to insects and disease.

In southern Ontario, the number of trees planted on a site is often more than ten times what will be growing on the same site just prior to the final harvest. For example, a four-hectare (10-acre) block of land might be planted with 10,000 red pine seedlings. The density of this stand at age 0 would be 2,500 trees per hectare. If managed properly, the number of red pine trees growing on that same parcel of land could be as low as 800 by about year 70. At this time, the density of the stand would be 200 trees per hectare. So whether it's you or Mother Nature that does it, your plantation is going to be thinned. The trick to managing is to maintain the optimum growth rate through a series of judiciously timed thinnings. Thinning a stand regulates the number of trees (density), which in turn influences the growth rate, the quality and health of the remaining trees and ultimately the value of the final harvest.

Density Management Diagrams are one of a number of different decision planning tools available to the woodlot owner. Each DMD is developed from a large data set that compares the growth of hundreds of similar stands across the landscape. Although they work well, it is important to ensure that they are being used under the right circumstances. If your stand is even-aged and consists of one species, then a DMD should work for you. It is also important to use the correct DMD; different ones exist for different species and for planted and natural stands. You can find a number of DMDs in *A Silvicultural Guide to Managing Southern Ontario Forests,* or by contacting the author.
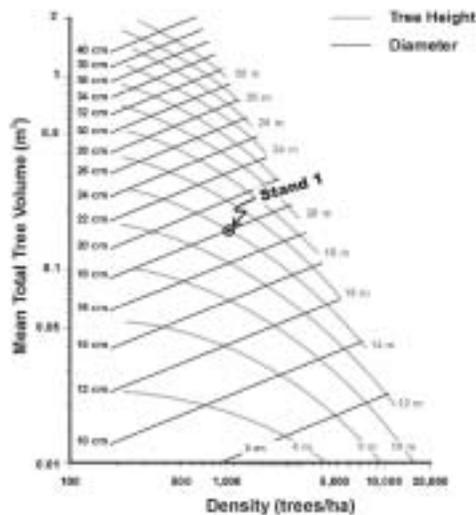
The Density Management Diagram

Figure #1 shows a typical DMD – it is basically a graph that portrays the relationship between four stand variables. These are:

- density or the number of trees per area of land expressed as trees per hectare;
- average tree diameter at breast height (1.3 metres);
- stand height (trees in a conifer stand are usually pretty close to being equal in height); and
- average tree volume, usually expressed in cubic metres/tree.

Figure #1: A density management

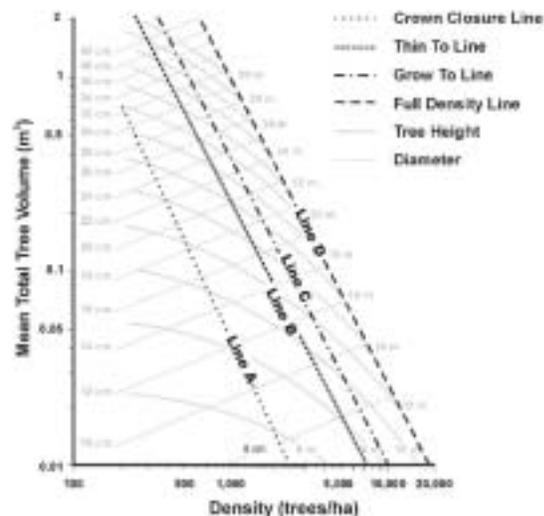You will notice that the scales for the x-axis (tree density) and the y-axis (volume) are not spaced evenly. These are logarithmic representations of the data, which allow us to get all the variables onto one graph. On the graph (Figure #1), Stand 1 represents a forest with a density of 1,000 trees per hectare, an average tree diameter of 18 centimetres, a stand height of 14 metres and an estimated tree volume of 0.16 cubic metres. Part II in this series of articles will explore the relationship of these stand variables in more detail.

Figure #2 shows the same DMD with four additional lines plotted on it. These are:

- Line A – the crown closure line;
- Line B – the Thin To line;
- Line C – the Grow To line; and
- Line D – the Maximum or Full Density line.

These lines are used to determine how your stand is doing. With this tool, you

Figure #2: A complete density management (DMD).

can make decisions on how to manage your stand to meet your personal objectives, combined with the "best" of today's forest science. The next logical question would then be – how do you use it to manage your forest?

Unfortunately, the answer to this is not straightforward until you understand what the various parts of the DMD mean, and how they interact.

What Happens to Your Stand Over Time

As mentioned earlier, a site can only support so much biomass. It is probably best to think of biomass as volume, so in other words, at a given density, a site can only support so much volume. This is further illustrated in Figure #3, which shows the relationship of what happens to an unthinned stand over time. This hypothetical stand was planted at a density of 2,000 trees per hectare (Point 1). As the trees grow and begin to occupy the site, they increase in diameter and height. Assuming there is no early mortality because the site can easily support the volume (biomass) growing on it, the number of trees remains fixed at 2,000. Over time, the crowns of the trees begin to touch until eventually they completely close in (Point 2) – at this time, they have reached the line of Crown Closure (Line A).
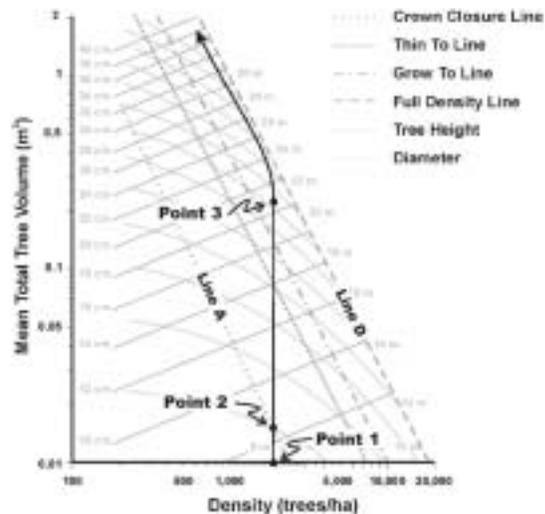

Figure #3: Stand density over time for an unmanaged plantation

As the years go by, the number of trees remains fixed, but the size, height, and correspondingly, the volume of each tree increase. Ignoring the Thin-To and Grow-To lines for now, the trees grow until some of them eventually start to die (Point 3) because the site can no longer support the volume growing on it. The density decreases and the number of trees falls below 2,000 per hectare.

This relationship of trees growing as the total number of trees decreases makes sense when you remember that the site supports only so much volume – the death of one tree frees up resources, allowing others to make use of the space and newly available moisture and nutrients. Left as is, this trend would continue until the number of red pine trees on the site reached zero, although by this time, other species would have long since started taking over. This is the Mother Nature management approach, which is not really recommended if you intend to maximize the monetary return from the stand.

The dynamics of stand density management are more involved than what is mentioned here. For the landowner, the two key points to remember are; 1) a site can only grow so much volume and 2) trees tend to always fully occupy the site. In the next article in this series, the author explains how to use a Density Management Diagram to determine if your stand needs thinning, and how much needs to be thinned.

Mark Richardson is an RPF working for the Eastern Ontario Model Forest (EOMF). The EOMF offers an involved course for landowners covering all aspects of plantation management including the "how, what and when" of thinning, biodiversity values, species autecology and plantation problems. For more information on the course, or to comment on this article, please contact Mark at (613) 258-8416 or <mrichardson@eomf.on.ca>.