Sustainable Hardwood Management

in today's Acadian forests

CINR

Proceedings from
the Conference on
Best Management Practices
for Sustainable Forest
Communities

July 8, 9, 2008
Cape Breton
Nova Scotia

SUSTAINABLE HARDWOOD MANAGEMENT
in today's Acadian forests

Sustainable Hardwood Management
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Sustainable Hardwood Management in Today's Acadian Forests
A conference on best management practices for sustainable forest communities.
Held July 8 and 9, 2008 at the Membertou Trade and Convention Centre,
Membertou, Cape Breton, Nova Scotia.
Presented by the Unama'ki Institute of Natural Resources.

This document should be cited as:
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Introduction

Edwin Swift, RPF, CF
Forestry Research Officer
Natural Resources Canada
Canadian Wood Fibre Centre

The Acadian Forest Region has been characterized as a sub-boreal forest region that is a transition zone between the softwood dominated forests of the Boreal Forest Region to the north and the hardwood-dominated forest regions to the south (Rowe 1972). In the United States of America, this forest region is often called the northern hardwood forest or eastern spruce–fir forest, depending on the species mixture. The forests of the Acadian Forest Region consist of pure softwoods, pure hardwoods, or a mixture. These forests consist of dynamic and diverse stand structures which support both a variety of wildlife habitats and uses by man (Beyeler 2002, Harrison 2006 and 2007, Zelazny 2007). The forest structures has also provided social and beneficial environmental factors to man through the ages. Historically, these forests were home and provided materials for survival to the Aboriginal peoples in the region. Likewise, the Europeans and subsequent immigrants to the region have used the forests of the Acadian Forest Region for habitat and services.

Most of the forests of Nova Scotia can be classified as part of the Acadian Forest Region (Rowe 1972). As with other areas in this Region, the present dynamic and diverse stand structures have not only been produced by climatic, geological, and landscape features with periodic disturbances; but also by past management practices. Currently, throughout the temperate and boreal forests of North America, the existing forest industry and, hence management practices, are undergoing a transition to adjust and address the impacts of globalization on society and industry. Although some would regard this transition process as being difficult and uncertain, it does provide the opportunity for innovative new thought and ways to manage forest resources in a more sustainable and ecological manner for future generations.

Silviculture is the science and art of managing forests for the needs and wishes of landowners and society. In recent times, the forests of North America have been managed for fibre volume for a variety of products in a limitless manner. More recently, terms such as ecological management, sustainable management, and integrated forest management have appeared in the language of practicing foresters. However, the concept of viewing forest practices from an ecological perspective is not new to mankind. In the traditional teachings of the Aboriginal peoples of North America, the concept and impact of resource management for seven generations are often found. The practices of the ancient Celtic tribes of the British Isles were often associated closely with nature or Mother Earth. This concept of resource management can be found in the ancient teachings of many cultures around the world. The current transition in the forest industry in North America is shifting management practices towards product value for the present and future, and away from a solely fibre-volume-driven economy.

Since education is the best process to initiate change, the purpose of this conference was to assemble a collection of individual snapshots and experiences of concepts, thoughts, research, and practices of ecological and sustainable forest management and silvicultural practices. This presented a collective picture of potential sustainable hardwood responses to innovative practices for sustainable management for seven generations and beyond in the hardwood forests of Nova Scotia. Individuals attending this conference consisted of researchers and program managers from government agencies and universities, Mi'kmaq forest managers, industrial forest managers, provincial forest managers, silvicultural contractors, consultants, students, and landowners. Collectively, this knowledge will provide a balance of ecological, economical, and social issues to initiate the process of successful ecosystem management for degraded hardwood stands resulting from past management practices. As silviculturists, we are now entering a new and exciting era of practice with limited past knowledge, to guide landowners for value-added products and services in the developing new forest industry that society now demands. The proceedings of this international conference provide the initial baseline information for new and innovative silvicultural systems and practices for us to develop along side landowners.

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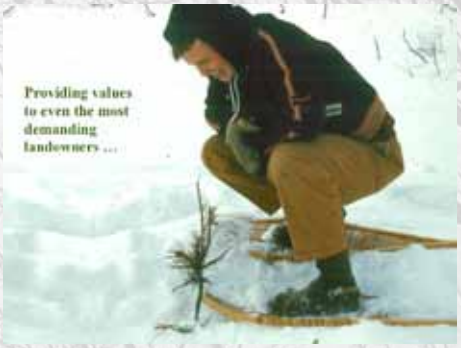
Silviculture and Ecosystem Management

Dr. Ralph Nyland, *State University of New York College of Environmental Science and Forestry*

This conference is about hardwood silviculture and the opportunities it presents. We need to go back to the basics. What is silviculture? What is ecosystem management? We will answer these questions to set a context for the other topics we will discuss.

At the heart of the practice of silviculture is the idea of satisfying the needs of the landowner. We provide values to the people we work with. It's not just about timber, and that is a major change in forestry. Traditionally, the focus in forestry was on producing volumes. Now we consider a broader array of the landowner interests, from non-industrial private owners to major corporations, and determine what benefits and ecosystem services each landowner wants and needs, and how can we sustain those needs into the future.

The Iroquois of New York have a saying that we should be aware of the impact of what we do today for seven generations into the future. That is consistent with the idea of sustainable forestry.



So the idea of silviculture is how we can change the forest in an ecologically appropriate manner so that we can provide the values of interest. Even if we go into a stand that has been abused, we can look at how we can restore that stand to a more productive and useful state. Also, we need to think about future generations, as much as seven generations into the future. We are accustomed to thinking 100 years into the future, but we need to be on an ecologic time scale now.

The words "creating" and "maintaining" when defining silviculture are appropriate because they identify the two functions of silviculture: to create age classes, and to maintain them through time. The focus has to be on the interests of those who own the land. Silviculture requires us to blend the science that comes from research and the information we have through experience into this artful application that takes into account the difficulties faced and the economics, etc. That is the art of forestry, taking our technical knowledge and putting it to use in a creative way, so that we can create and sustain the values of interests seven generations into the future. We must provide many different values; not just timber yields, but a whole host of values and ecosystem services.

There are four functions of a silviculturalist. One is control, and this is the most important "hands-on" thing we do. This does not mean dominate, but rather that we can harness natural stand dynamics to change the patterns of establishment, composition, growth and development in a way that provides more values of interest to the landowner. So the practice of silviculture is a process of controlling how natural stand dynamics work to the advantage of the landowner.

While doing that, we have to be aware that the actions we take can affect other opportunities. Facilitating becomes very important here, facilitating the harvesting that may come in the future, the management now and in the future, etc. So we are trying to integrate what we are doing with the stand now with a variety of other things that might happen now and in the future.

We have to protect the productive capacity of the site if we can, and enhance it if possible. We have to protect the trees from harm during harvesting and other uses. We have to be cognizant of the effect of insects and fire on the stand and have processes in place to handle these. But things happen beyond our control, such as hurricanes, wind and ice storms. So you must react to those things.

Even more importantly, you must prevent mortality. Manage the stand in such a way that you reduce the losses, and place those trees that would've died into the marketplace so they provide value. To control the pattern of natural stand development, to move that development in a way that favours the landowner, is really what silviculture does. So long term is really how we need to be thinking, coming back to that idea of seven generations. This is a concept in Mi'kmaq culture too. Long-term ecosystem productivity is a key issue for us. We must be sure that there is no irreversible ecological change that comes about as a result of our actions. There are three things we can do that will prevent irreversible ecological change:

1. Trees after trees. Deliberately making sure that a replacement age class follows the ones we take away.

2. Stable soils. By the way we operate in the forest, we maintain the stuff that supports tree growth and development, that supplies nourishment and water. An example would be good logging practices.

3. Protect land forms. Focus particularly on drainages so we don't upset the hydrologic balance of the site.

There is a basic premise in forestry, that people value ecosystems because of the goods and services that they provide. That's where economics enters into forestry. That is where the change in forestry must come, going beyond the timber and recognizing that we must support the basic ecological systems to maintain the value of the forest. We work with the forests to enhance what is going on there and realize better values through some kind of management.

There are three aspects to economics. One is the institutional requirements. Corporations need to provide a flow of products. Landowners need to see certain values. There is a social aspect as well. We have to consider how what we do affects our neighbours. Then there is the financial. We must be able to pay the cost of management and ownership. So our management plan must be financially appropriate.

In silviculture, we focus on the stand and we treat one stand at a time. But as we plan our silviculture, we must put that into the context of the forest as a whole. So we must be sure our treatment in one place contributes to the larger scheme for the entire property, and that's the discipline of forest management. We consider what we do at the stand level, and how that builds to managing the forest as a whole.

There are three kinds of stands. Even-aged are, in a way, the most straight forward, but it's important to recognize that trees of different sizes are the same age, otherwise you can go astray in your management plan. So we start out with a reproduction method cutting. We establish a young age class and through time the trees grow and becomes larger. We do some intermediate treatments to focus the growth potential on the trees that best serve the interests of the landowner. We regulate the density to maximize the potential of the site for production. Eventually the trees become mature by a standard we set either financially or biologically and, at that time, we start again. We remove the old trees and establish a new age class. That is basically the even-aged approach. The thing that helps us is that these stands develop in a predictable manner. We know that from research. We can go into a stand and look at its characteristics and from that get a rough idea about its age. With that information we can start programming treatments that will foster the growth potential in the direction we want to to meet the landowner's needs. However, as silviculturalists, we only spend a short period of our career doing productive work in the forest. We only get a snapshot in time of the forest. So the tendency is not to think of the long-term pattern. If we are fortunate enough to have stands of different ages, then we can get a broader picture of what is going on through time in even-aged stands.

In even-aged stands, not all trees grow at the same rate, even within a species. So what is the pattern of height development that we traditionally see in even-aged communities? For an individual tree, there is a period of very rapid growth and then slows as the tree gets older and older. Here in higher latitudes, we have ice and snow damage that constrain height development sooner than in more southern latitudes. If we look at the pattern of height development across the stand, we see that different trees grow in height at different rates. So at any point in time we find trees of different heights in an even-aged stand. You will find tall trees, short and medium trees, all of the same age. That is a critical thing for us to recognize. In the case of the even-aged stand, bigger is better. The bigger trees are bigger for a reason; they are the genotypes that are best suited to that environment., and the ones that grew best there.

We traditionally subdivide these into crown classes. The dominants are the trees that have the upper canopy positions, they get the most light from the top and sides. They have grown well in the past and will grow well in the future. The co-dominants are also in the upper canopy. They get light from the top and they have grown pretty well in the past. Then we get down to the intermediates, the runts of the stand. These have not grown well in the past so are not likely to in the future. The over-topped trees are the ones that are essentially hanging on for life. They have no promise for the future. So it is important that we recognize where individual trees are in the social order of the stand to predict their potential future growth and development. Also, trees of best quality are usually the ones in the upper canopy positions, whereas the ones of poorer quality are in subordinate positions. If you release those small trees to grow they may get bigger slower, but they'll never get much better in quality.

There is also a differentiation in diameter growth. The classic "S" curve that you've all seen represents the pattern of diameter growth for an individual tree. As a tree gets older and bigger, the rates of radial lengthening slow. So when you look at the diameter distribution across the stand, some trees are bigger,

the ones in the upper canopy positions, and then there are the subordinate trees of smaller sizes. As an example, Black Cherry and White Ash tend to be less shade tolerant and so you don't see them in smaller diameters because trees that end up in the subordinate canopy positions die, whereas shade-tolerant species like Sugar Maple, Red Spruce or Hemlock will remain alive in the lower canopy positions, giving us a "Reverse-J" type diameter distribution when seen on a graph, even in even-aged stands. So you can't look at the diameter distribution and forecast whether it's even-aged or uneven-aged.

Another example would be an even-aged stand about 50–60 years of age consisting primarily of Aspen and White Pine which are shade-intolerant species. The diameter distribution would appear basically as a "Reverse-J" because of differential rates of height and diameter growth between trees present in the stand. The reason the "left hand tail" of the "J" drops off is because trees that get in subordinate canopy positions don't survive.

Another common example would be a mixture of shade-tolerant and shade-intolerant, or stands of dominantly shade-tolerant species, such as combinations of Sugar Maple, Yellow Birch and White Ash. Then the shade-tolerant trees in subordinate canopy positions, although they don't grow very well, stay alive. Again you get the "Reverse-J" type diameter distribution.

Occasionally we get a stratified species mix, such as Sugar Maple overtopped by emergent White Pine. You would then get a "two-humped" diameter distribution graph, each hump showing the diameter distribution of one of the species.

So the point that even-aged stands can have trees with varying diameters is very important. It is one of the biggest mistakes people make when managing communities of tolerant species. They assume that if there are different diameters, there are different ages and that is not necessarily true.

Uneven-aged stands are quite different. In one stand we have a young age class that grows intermixed with a few other age classes, such that we have at least three but as many as seven different age classes present, but only one of them is mature for financial or other purposes. So silviculture recognizes that to get a new age class going, we have to get rid of the old trees, the mature age class. We also have to tend to the immature age classes, to nuture their growth and development, to focus the growth potential onto trees with greatest promise relative to the goals of the landowner.

So the uneven-aged stand will have this intermixing of trees of different ages and different sizes. Different parts of the stand regenerate at different times. Young, middle-aged and old trees are all present, each coming of age at different times. To maintain that condition we need to tend the immature age classes at the same time that we are regenerating the mature age classes. And the diameter distribution would typically appear as a "Reverse-J".

In managed uneven-aged stands there is a correlation between tree size and tree age. Data taken from an uneven-aged stand of tolerant northern hardwoods that has had two entries with a single-tree selection system, shows that the trees not only have different diameters but they also have different heights. That is, the old trees are tall and the young trees are short. We notice also that in managed stands they all have a 40 to 60 percent live-crown ratio,

meaning 40 to 60 percent of the total height in living branches. Now, in an even-aged stand, you'd get lower live-crown ratios. The dominant trees might have 25 to 30 percent, the co-dominants maybe 20-25 percent, the intermediates perhaps 15 percent, the overtopped trees perhaps 5 to 10 percent of the total height in live branches. But in managed uneven-aged stands, we are finding 40 to 60 percent of the total height in live branches and the effect of that is you'll see good radial increment in trees of all ages. So an uneven-aged stand would have a discontinuous upper canopy. Because the big trees are spaced apart, there is light filtering through the canopy, illuminating the branches on the shorter and younger trees, sustaining growth and development. So our task is to maintain that incontinuity, the dispersion of trees with different sizes, in order to sustain the growth. Then light is available at all levels, from the ground where we regenerate new age classes to the tops of the tallest trees. That is critical in our silviculture, to maintain that interspersion of young and older trees so we can support the growth of all age classes. This is quite different from an even-aged stand where you have "once a runt, always a runt". That's not true in uneven-aged stands.

Then we have two-aged stands. In a two-aged stand there is an older age class that is considerably bigger in height and diameter than the younger age class. As time goes on, the trees get bigger and bigger until at some point, we deem the older trees to be mature by whatever standard we set. The task then is to take off the older age class, thin out or reduce the density of the younger age class, and to establish a new cohort. And that is the basic philosophy of two-aged silviculture. So a reproduction method cutting might leave a tree of the younger cohort every 75 or 100 feet, and establish a new age class in the understorey.

How do we go about managing these different stands? The way we think long term is through the silviculture system. The plan of action goes from the time an age class is initiated until it reaches maturity and we replace it.

The silviculture system has three components: regeneration, tending and harvest. Regeneration is used to establish a new age class. Tending enables us to focus the growth potential of the immature trees onto the best ones. Harvesting is the means to that end. This is a very important point. Harvesting is a tool of silviculture used to bring about the regeneration, and to bring about the tending. And if the plan doesn't provide deliberately for all these things it is not a silviculture system at all, it's simply exploitation. The only way we can sustain the values is if we deliberately plan the regeneration, tending and harvesting. So the only two things that siviculture does is tend the immature age classes and regenerate the mature ones, and we use harvesting as a means to that end. The beneficial thing is, when we harvest we can put the mature trees on the market and generate revenue to pay for the cost of ownership and management and satisfy those who require profit. Silviculture tends and regenerates, period.

The problem with forestry is that our focus has been on harvesting methods, on efficient extraction. If we forget about tending and regeneration we get imbalanced stands. Harvesting serves a way to change the character of the forest, provides us a way to enhance the habitat for plants and animals, enhance visually properties, etc. Whatever the landowners interests are, we use silviculture to get there, and we strive to do so in an ecologically suitable manner. At the same time, if we find that after talking with the landowner that the patterns of natural stand development satisfy all their needs, we don't need to intervene.

Now let us consider where the ecosystem management comes in, what we might call "Eco-Do". It means we are progressing from emphasizing uses as we have in the past, to focusing on creating and maintaining healthy and stable forest systems. We will continue to serve human needs as an inevitable outcome of having created and maintained these viable systems. That is a by-product of having done our silviculture and our management.

There are key decisions that have to go into this:

1. We need to think of things in an ecological time scale, this idea of seven generations into the future. A logical time scale might even be 15 generations into the future. That's new for us. We need to transcend 100-year thinking into multi-generational thinking. And we need to be certain that anything we do today does not inhibit the potentials of people in the future. The three ideas of ecological, economic and social issues have to come together. In the past, the idea was that convergence of these three things was coincidental. Success in ecosystem management is the convergence of these things. In the beginning, we have to work hard at even some convergence. But the idea is that, as we learn, as we make the effort and buy into the philosophy, we will see more and more overlap of these three things and we will see more success. It will take us time to get there so we need to start working at it today.

2. We have to focus on things at a landscape scale, at a scale much broader than we have traditionally done in forestry. The model by Urban (1987) et. al. emphasizes this. Whether you are treating a stand or a forest or whatever, you need to think one scale beyond that of immediate interest. So as a silviculturalist, I might be treating one stand but I want to be thinking of the effects on other stands around me. So how do I orchestrate the treatment of the stand to give me a balance across the forest as a whole? There are things that affect the options I have at this larger scale. An obvious example is markets. If you don't have a market for low-grade trees, it's going to affect what you do at the stand level. On the other hand, I might be restricted to contributing to the landscape scale by what I have at the stand level. There are forces affecting management from the top down and from the bottom up. But if we are thinking one scale beyond immediate interests we are detecting these things and are able to make greater contributions. Hummel voiced it this way, a term he called "Landscape Silviculture": developing prescriptions for individual stands by evaluating them collectively based on the objectives for forests and the landscape as a whole. That's an adaptation we need to make personally to get farther into ecosystem management. How it will be accomplished hasn't been determined yet, we haven't gone that far. But that is where we need to head.

There is one model that was created by Robert Seymour and Maxwell Hunter at the University of Maine. They called it the Triad. They argued that at a landscape scale you need to have a combination of things. One element is the "Ecologic Reserves". These are areas where no management at all will best provide some value, such as habitat for some creature. At the other end of the scale are "High Yield Plantations", the softwood plantations that operate on short rotations with intensive treatments. These are wood farms. We have them because society demands wood and we need to provide it in a financially efficient way. In the middle we have new forestry, non-industrial private ownerships and, public forests that are operated to integrate some wood

production with non-market values and ecosystem services. Some people call this a kinder, gentler forestry. Seymour and Hunter would argue that within the landscape we need to provide these three kinds of conditions. There are no rules on how much of each needs should exist, you have to figure that out for each landscape situation. But this kind of diversity will provide healthy regional areas.

Stone developed a diagram back in the 70s. The vertical scale on the diagram is the degree of productivity in the broad ecologic sense. The horizontal scale is the site conditions. So, on the left, you have very productive sites and on the right, very poor sites. Stone was conveying two messages. For the most intensive practices that carry the most investment, you need to confine those to the best sites you have. On the right, the sites won't support much investment in the sense of wood production, so they might be the spots for ecologic reserves. The part Stone might change today is; we cannot provide all the ecologic values on only the poorest sites. Our ecologic reserves will have to be spread across the spectrum, in some of our best sites and some of our poorest. But our most intensive management we need to confine to the sites that will sustain those.

There needs to be changes in forestry and silviculture, but it can't happen unless there is dialogue. We need to come together and talk. We need to share ideas.

There are real challenges, because new ways of thinking are threatening.

Question Period

Brendan Hemmens, *DNR*

Q. You said the goal of silviculture is focused on the values, yet the values you are espousing seem different than the values we are observing on a regular basis here in Nova Scotia. Do you see a value in moving those goals?

A. Forestry in the past has focused on efficiently extracting products. This has led to degraded forests. There needs to be a change in thinking. We need a good ecological foundation for everything we do, and this will result in higher quality timber. It takes fewer high value trees to create a good cash flow.

Q. Here in Nova Scotia, we have approximately 70 percent private ownership. Maybe the long term view doesn't work for somebody who is nearing retirement, who is looking at their wood lot, who wants to realize some value from it immediately. Chips have less value, but they have some. What kind of incentives can you give them to manage for that long term value?

A. Industrial corporations in the past did have a long-term perspective. Investment companies today have a 10-year time horizon. They promise a 15 to 20 percent return on investment. The forest grows five to six percent in that time. The shortfall seems obvious. When it comes to private ownership, in most cases 10 to 15 years is ownership tenure. But we have this need for the "quick fix". We think everything should return 15 to 20 percent. There is not long term thinking anymore. This is a society issue. We need to be aware that what we do today impacts people in the future. I don't know how to address that, but I know society has to change. I'm not answering your question but I share your frustration.

Bob Bancroft, *Biologist*
I think we need to broaden our perspective. The thinking is there, but the will to do it is not. We need a land ethic that is connected to the water and the wildlife.

A: When it comes to wildlife, one example is we've learned that certain songbirds require a certain number of conifers to thrive. So we try to maintain a percentage of conifers in a stand or insert them if they aren't present. We are learning to make those adaptations. But we have to remember to do it one stand at a time and it takes time. We need to develop an attitude that we want to do it.

Mark MacPhail, *UINR*

Q: I read a journal article recently that talked about global warming causing a transition in species. Is there anything out there in your experience that you have seen that is forecasting a change in species composition with global warming?

A: This is about the fifth crisis issue we've faced. I'm not saying global warming won't occur, I'm saying we haven't got the foggiest idea what its effects will be, in my opinion. The key is adaptive management. We need to watch changes that are occurring and learn to adapt our strategies to accommodate. It is a long, slow process and that gives us time to adapt as we see changes occurring. I don't want us to panic. That's what forestry and silviculture is, it's a problem-solving process.

Ed Swift, *CWFC*

Q: My question is about fibre attributes. We have noticed when thinning Jack Pine that the larger diameter trees, what we might call "Super Dominants", that grow really fast lose their wood density. Density is an important feature. It seems the bigger the diameter, the less the wood density. Is it true with hardwoods as well, that you can grow a tree to fast and lose fibre density?

A: We know that summer wood is more dense. We also know that faster growing trees have more summer wood. The goal should be to maintain constant and good rates of growth. We also must realize that the model for softwood is not going to work with hardwood.

Q: So you are implying we have had too much of a "softwood" mentality in our hardwood management?

A: There are many things you can transfer back and forth, but hardwoods and softwoods are different and this may be one of the ways that they are different.

Uneven-aged Management

Dr. Ralph Nyland, *SUNY-ESF*

Uneven-aged refers to multiple age classes present within the stand. The silviculture system we would use is going to be different from what we would use in an even-aged stand. We have regeneration, tending and harvesting as the three components of silviculture. Silviculture focuses on the regeneration and tending, and harvesting is a means to an end. The feature about uneven-aged silviculture is you have to do those three things concurrently. Every time you enter the stand, you regenerate and you tend and it is done together, never separate. That is the unique feature about uneven-aged silviculture. Harvesting is used to remove the mature trees to create a new age class, and to tend the immature age classes. If we do that, we can sustain the values into the future, changing the habitat for plants and animals as we go along.

It is important to remember that we must tend the immature age classes. One of the issues we face today is that people cut the big trees and ignore the small ones. If you do that you cannot sustain the values at consistent levels.

The advantage of applying silviculture is that we can take the excess and the mature trees, and we can put them in the marketplace and generate revenues. That can cover the costs of doing the non-market treatments we want to include. It can also provide the revenues that a landowner needs to pay cost of operations, management and returns to their shareholders.

In taking a look at an uneven-aged stand, we see young trees that tend to be small in stature and they are intermixed with trees that are a little bit larger. The interspersion can be uniform or it can be in clusters. But you see trees of all different ages growing together within the stand. So there is a mature age class that we have to remove to regenerate a new one, and there are immature age classes as well.

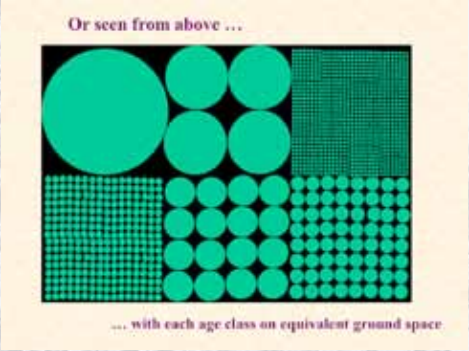
The preferred silviculture method to manage uneven-aged stands is the selection system. Every time we enter we have to start a new age class, that is the reproduction method, and the plan is that each age class will occupy an equivalent amount of space. That's a key to consistency with uneven-aged silviculture.

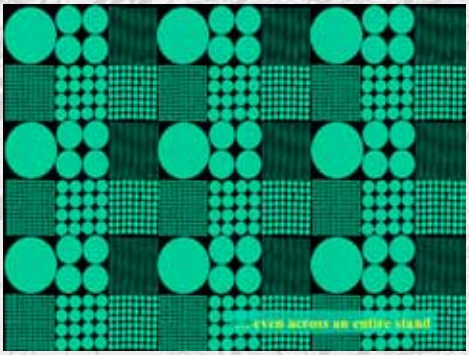
In addition to that, you have to tend the immature age classes. You want to reduce crowding within those age classes. You want to concentrate the growth onto the trees that have the best quality relative to the objectives of the landowner. If you do these two things together you will create what we call a "balance" between the different age classes.

The historic model for this is the Plenterwald from Germany, where the age classes are intermixed. Remember that the younger trees are not only small in diameter, but also short in height. The intermediate aged trees are taller and bigger. The oldest trees are tallest and even bigger. And they all have a 40 to 60 percent live crown ratio. A successfully balanced uneven-aged stand will have a

resulting "green wall", where you can't even see through it.

David Smith at Yale presented a model to explain the concept of balance: in the model there is a cone marked "90". That represents the oldest age class. The base of the cone is large, representing how much space that age class occupies. To the right of it, you will see two cones marked "75". In order for the 75-age class to occupy the same amount of space as the older one, you need two of them. When you get to the "60", you will need three of them. At "45", we need four, etc. So each age class covers the same amount of horizontal ground space, but because trees in each age class are smaller and smaller, we need more and more of them to fill that space.





When we get them balanced that way, we get consistency and sustained yield at the stand level. You could envision it this way: each of those age classes represented by the different sizes of circles require a different number of trees to occupy an equivalent amount of ground space. Then we can extrapolate that across the stand level. Once we develop this, once we allocate that space equivalently, then we have a stand that is balanced. What that is going to give us is consistency through time: consistency in yields, habitat, hydrologic effects, etc. That is what the selection system offers, consistency through time. It may not be optimal; that depends on the landowner. But where the attributes of an uneven-aged stand serve the interest of a landowner, consistency through time is what we can promise with a selection system.

To calculate the number of age classes in a given time is very simple. The formula is: R/CC, where R= the period of time to grow an age class to maturity, defined by financial needs or other criteria, and CC=the cutting interval. We don't have a rotation with uneven-aged stands. So if we wanted to grow a tree for a hundred years, and we went in every 25 years, we would have four age classes. And each age class would occupy one quarter of the ground space. That would give us a balanced condition which leads to the consistency referred to previously. In the example of a managed uneven-aged stand with the age classes interspersed, an important point is that there is a correlation between tree size and tree age. The oldest age class is tallest and largest in diameter and the youngest age class is shortest and smallest in diameter. Also we are finding that in managed stands that we are getting 40 to 60 percent of the total height in live branches which sustains good growth and development of all age classes. That is a key point, that the long live-crown ratio allows us to sustain good growth and development of the young, intermediate and old trees.

In Selection System Silviculture within uneven-aged stands, we can use the diameter distribution to control the age class distribution. We regulate the number of trees in each size class and thus the number of trees in each age class. Typically we are using a "Reverse-J" type curve to represent the idealized stand structure. Essentially we are trying to balance out the ground space, so the goal is that each of those age classes covers equivalent space. We need, then, a lot of small trees to fill that space but relatively few big trees. That is what we do to control Selection System Silviculture.

We have different parts of the stand regenerating at different times. We have different age classes intermixed in the stand. The historic definition is that for uneven-aged silviculture you need at least three age classes; probably we are going to have four or more in most arrangements. Each of these age classes comes to maturity at a different time, so we remove the mature one as a

reproduction method. In the intermediate classes, we do tend to focus the growth potential on the trees that serve the interests of the landowner.

There is a diameter distribution which was developed through the research in the upper lake states of the U.S. by some cutting trials established by Eyre and Zillgitt back in the 1920s, and later melded together into a management guide by Carl Arbogast in 1957. The idea here is that they have studied diameter distributions and found that if you leave a residual stand that is distributed as outlined in their guide, it should remain structurally stable into the future and you should get good growth on the trees that are present. To reach that conclusion they had a series of cutting trials. It included uncut reserves shown in the lower left., a clear cut, and some partially cut plots. So graphically (below), the bottom line, which is dot/dashed, shows the residual stand. The upper line is the ending stand.

The diagram shows change in the one plot of special interest, called "Overmature and Defective Number 1". They took out the big trees as a reproduction method. They also went through the intermediate classes and took out the poorest trees to focus the growth on those with the best potential. You will notice that the growth occurred across the diameter distribution. That is characteristic of a stand we would call structurally stable. Allan Eck's definition of stability says that, at the end of the cutting cycle, you could recreate the diameter distribution that was there at the start, or at the end of the growth period there are at least the same number of stems per acre that were there at the beginning in each size class. So in that sense, of all of the stands included in those cutting trials, the one that remained most structurally stable was the plot called "Overmature and Defective Number 1", as described above. It gave the best consistency in structural characteristics through time. Growth occurred in all the diameters in all the age classes. And they could come back at the end of the 25-year period and recreate that diameter distribution.

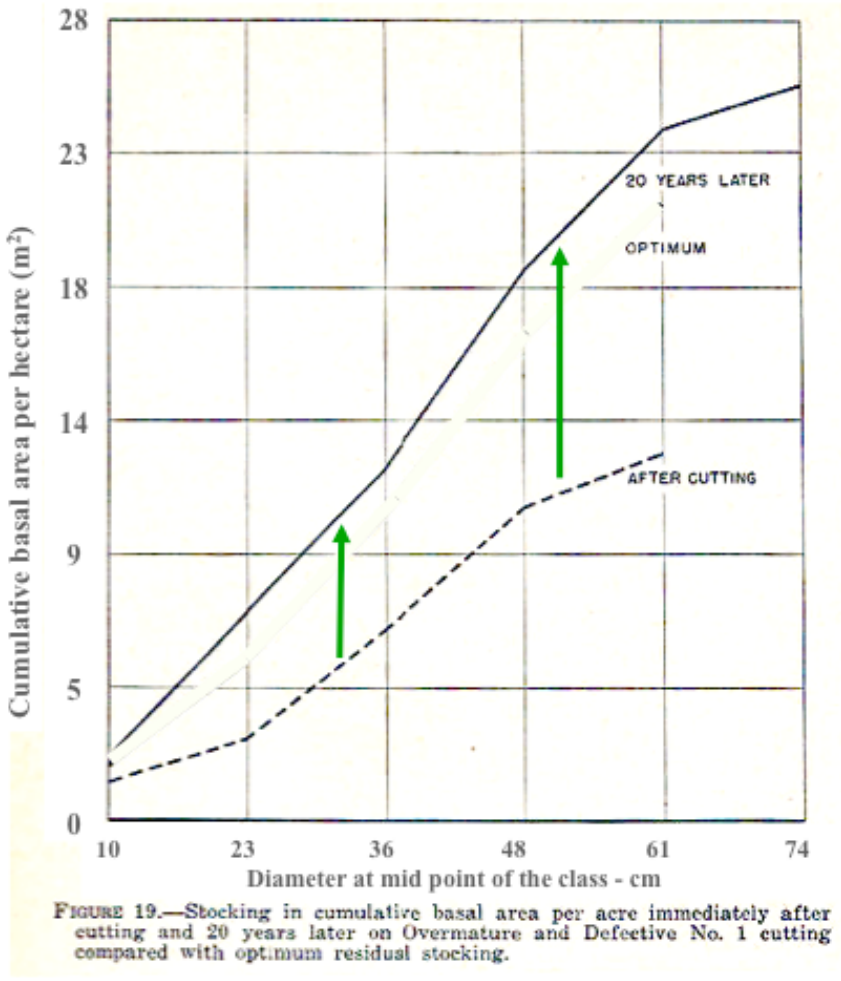


FIGURE 19.—Stocking in cumulative basal area per acre immediately after cutting and 20 years later on Overmature and Defective No. 1 cutting compared with optimum residual stocking.

From Eyre and Zillgitt 1953

Now, this was in a 25-year period. What they ended up recommending was about 12.8m^2 per hectare with about 530 trees per hectare distributed amongst the age and size classes. At the time, the general thinking was 25 years was too long to wait, and people wanted to operate more on a 10-year cycle. So Eyre and Zillgitt went back to a series of their cutting plots and they found

out that for a 10-year cycle, to maximize production they had to leave about 65ft^2 to the acre (approximately 15m^2 per hectare) in trees 10in (approximately 25cm) and bigger. They felt with a 10-year cycle, they had to leave more stocking than the original cuttings. So they went back and adjusted the curve and came up with a diameter distribution for a 10-year interval, having about 21m^2 per hectare and about 790 trees per hectare distributed amongst the size classes. The argument is if you cut to that diameter distribution you will balance the age classes, you will have structural stability and you will be able to come back at regular intervals and remove about the same amount of volume. It will give you sustained yield at the stand level.

How will this work? We had the case of an uneven-aged stand that was once an old farm woodlot but is now on public lands. We went out and used point sampling and enumerated the numbers of trees by diameter. The youngest trees in the stand that I could get an increment boreing were 20 years of age and the oldest were 150 years. So there was a good spread of ages. We wanted to cut it so we ended up with a balanced diameter distribution. We have to remember that a balanced diameter distribution represents the numbers of trees you need so that each age class occupies an equivalent amount of growing space. I superimposed the desired diameter distribution over the one that was existing and I saw that below 30cm I had some excesses in places, but in this case they tended to be adjacent to some deficiencies. Here is where the art comes in. The rationale says that if I leave those excesses, through differential growth rates it should fill in some of those deficiencies and the differences should attenuate through time. So we decided in this case we wouldn't be doing any cutting among trees less than 30cm, with this exception: if I found a high-risk tree, I may take it out to salvage the volume in it. If I found localized crowding, I may take out one or two trees to reduce that crowding. But my primary treatment in this case was among trees 30cm and larger.

A workable structure for 20-year cutting cycle ..

Dbh (cm)	BA (m²/ha)	NO/ha
5-12	0.7	375
13-24	1.7	59
25-32	3.9	54
38-50	5.0	30
51+	1.8	5
Total	12.8	527

I always begin my analysis with a graph of the diameter distribution. That helps me to visualize the conditions. But I cannot develop a prescription without creating a stand table. In the the left-hand column I list the range of diameters. In the next column are the original numbers per diameter class. In the middle column I can put my desired residual number. In this case, the Arbogast Guide goes from 118 two-inch trees down to one 24in tree. That maximum dbh number is adjustable; come up with your own figure that represents financial maturity for you. You are trying to create a balance. So, I make a subtraction between the numbers that are currently present and the numbers that I want. A positive sign means there is excess and a negative sign means I have a deficiency. By doing this grocery store arithmetic, it shows me that in my example, for trees up to 30cm, I had a combination of deficiencies and excesses and I could just mark "none" as the cut in those highest classes. Between 30 and 45cm I had seven excess trees out of the 33 that were present per acre. Seven divided by 33 is 21 percent, means cutting one in five.

By saying I have to get rid of one fifth of the trees, I'm defining an intensity for the size class. In the large saw timber it was 18 percent, or one in six. We simplify to these simple fractions, and that's what I take into the field. If you can't write them down on the four fingers of your hand, it's too complicated. You have to reduce it to maybe a few but not more than four simple commands, and you can give those to the feller/buncher operator once you've got that person trained to do the job.

So there is the reproduction method. In this situation it was taking all the trees larger than financial maturity, defined as 24in (70cm) in this case. The tending is marking throughout the immature size classes. When we do this marking, if we have a timber production goal, we are going to take out the poorer quality trees to favour growth of the better quality trees.

If we have wildlife concerns, there are some animals that absolutely depend on cavities. If that is our concern, then we are going to leave some of those cavity trees; you don't need very many. A couple per hectare would probably do it, perhaps three per hectare at the most. But we are going to adjust the marking to fit the broader objectives that some landowners have, and do this within the limits set by the marking guide. The cut represented above gave us approximately 40m^3 per hectare, which is about 4000 board feet to the acre. We didn't do anything in the lower diameter classes, so the diameter distribution we ended up with still had some irregularities in it. The message is: it may take two or three entries to really get the stand into balance. It takes patience. But you need to start with the first entry, and we found you would get to that balanced condition quite rapidly. I opened up a little space by taking out the mature trees. I knew the sunlight penetration would facilitate the growth and development of a new age class. I thinned out the intervening places so that light would now flood the foliage at all levels. The small, medium and large trees were getting illuminated and growing better.

How did it change through time? Fifteen years later we had a much more balanced condition. After 15 years we had excesses in the smaller diameter classes. We felt it was stable and we should be able to make a second entry into that stand, but with changes to the marking guide. We still had deficiencies in the less than 8in group and between 11 and 14in, but we also had an excess in the nine and 10in class. We still needed some cutting between 15 and 20in, and then a pretty heavy cut over 20in. So, at the end of the 15-year period, I could come back and re-structure the stand and come to something that is more balanced than when I started. And the yield here was a little bit less than with the first cut. In the first entry you are taking off a lot of stored timber. But we were finding this is going to come to a pretty consistent level of about 3500 to 4000 board feet (approximately 35 to 40m^3 per hectare), an operable cut.

The work that we and others have done has shown that this Arbogast diameter distribution does remain structurally stable. At the end of a cutting cycle you can go back in and recreate the diameter distribution, and you get even flow and sustained yield at the stand level. You get consistency of habitat conditions and of hydrologic conditions and visual qualities. You get consistency in all areas. We are preparing for a third entry into this stand and expect the same yield as the second cut. In three entries we've gotten to what we could consider almost a perfectly balanced situation. So if you start with the first entry and are loyal to your marking guide, you can balance a stand. You can get this consistency that I've talked about. And you can extrapolate this yield data to non-market values as well.

What would it look like if we wanted to apply this in a single-tree selection system, given a fairly uniform spatial intermixing of the trees of different ages? Throughout we would have big trees that are financially mature. Where there is some crowding of trees of intermedaite size, we would need to reduce the crowding within those immature age classes, as well as remove the financially mature trees. Removing the financially mature trees is the reproduction

method. The tending of the immature trees would focus the growth potential onto the trees that are suited to the site. I also maintain a stocking that is fully intercepting incoming solar energy and converting it to biomass at the maximum possible for the site.

In some stands, trees may occur in clusters. If stands have been given unregulated cuts in the past, sometimes a patchiness can result. Diameter limit cutting does that. In this situation you may want to practice what's called a "Group Selection" system. There will be groups that are mature, and some groups that are immature. I want to take out the clusters of three or four mature trees as the reproduction method, and then thin the immature clusters. as illustrated to the right. The problem with this is trees don't occur in triangular arrangements, and when you remove those kinds of groups you don't necessarily open up a uniform circular area. Only if you open circular area will you illuminate the center to the point where you can get the shaded intermediate species to grow. In single-tree selection, you shift the composition toward the shade-tolerant species. Some people like group selection because it gives you the opportunity to include a representation of the mid-tolerant species within the new age class, but it works only if the mature trees occur in circular groupings. Also, to maintain a balance of the age classes you can only open about three of these groups per hectare. Further, widths of the openings should be about one times the height of adjacent trees to be effective.

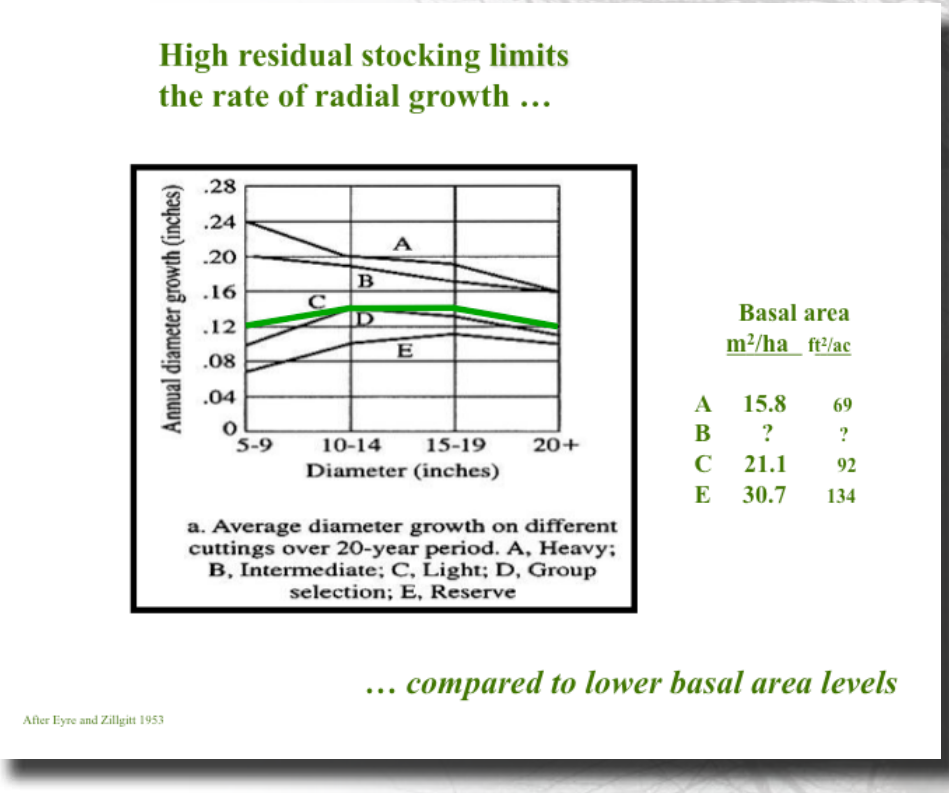
Bill Leak and Stanley Filip came up with an idea after observing some responses in circular openings that David Marquis had created. The width of these openings was about one times tree height. Marquis regenerated and sustained the development of yellow birch inside those circular openings. Filip and Leak said, suppose we combine that idea of cutting engineered patches on some of the area with single-tree selection on the rest of the area–would we be able to sustain some of the less shade-tolerant species? I call this "Patch-Selection" system. It is much more effective, in my judgment, than group selection. Part of the adaptation is that you may have to sacrifice a few trees that are not quite mature to get this engineered style patch. To compensate, you may have to leave a tree in another area a little bit longer than you normally would to limit the amount of area regenerated. So it's a hybrid method, where I'm combining this patch cutting with single-tree selection. But I'm not doing much more than two to three patches per hectare. You have to control the cutting of large trees and not let it get out of hand. I think this is an interesting idea and I have tried it. We do get better light in the middle, and I've been able to get some white ash established inside those patches, if there is a seed source. If there's no seed source, no matter what you do you are not going to get it. If there are interfering plants, you are not going to get tree regeneration. But given a seed source and no interfering plants, it's worth trying.

Now there is additional flexibility we have and it has to do with adjusting the cutting interval and coming up with a blend between cutting interval and residual density. In the 80s, Gerald Hanson came to Syracuse and we worked to build a selection system stand simulator where we could run some experiments and see what would happen to a stand through time. We recently modified it to upgrade the growth functions. But also, we are forecasting change in wildlife habitat conditions. But Hanson's work led to this idea, that if we wanted to operate on a 15-year cycle, we would leave about 19.4m^2 per hectare. For 25 years we'd drop it down to just under 15m^2 per hectare. But each of those

has a diameter distribution that is basically the same shape as the old Eyre and Zillgitt structure. Remember, their original experiment was a stand cut to about 15m^2 with a 25-year cutting cycle. And after all our efforts with these simulation experiments, we ended up with that same Eyre and Zillgitt structure. Through our simulations, we really have verified the idea that there is a particular kind of shape to that diameter distribution. If you maintain that proportion of trees across the size classes you can raise the curve representing the graphic stand table, lower the curve, shorten the curve, change the cutting interval, and still maintain balance in the diameter distribution.

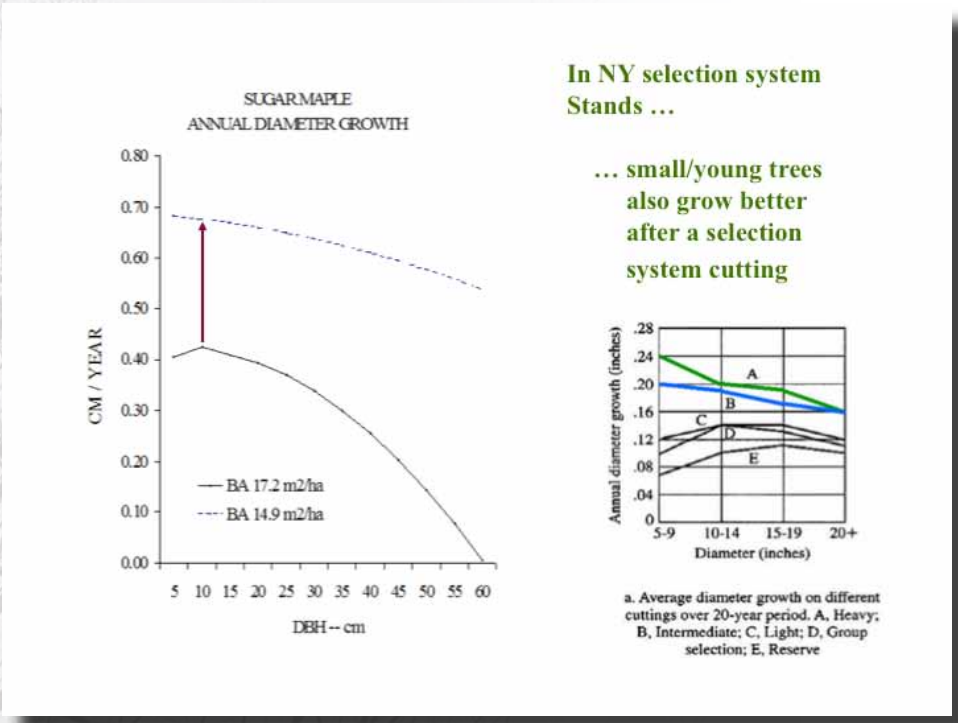
In looking at some of the Hanson simulations, one suggests leaving about a 21m^2 per hectare residual associated with a 10-year cycle. In another example, we would have a 16 m^2 per hectare residual associated with a 30-year cutting cycle. We noticed that in both cases, the production was about 3.2m^2 per hectare. So if you balance the cutting interval with the residual density using longer intervals for lower residual density, you can maintain a similar level of production per hectare, per year. In another example of a stand cut to 15 m^2 per hectare associated with about a 25-year cutting cycle, we notice there is an interspersion of different sizes and ages. We also observed a uniform distribution of the trees. At that level we are getting sufficient illumination on the ground that trees of mid-shade tolerance were regenerated. Yet another example we have is of 19m^2 per hectare associated with a 15-year cutting interval. It is a much higher density, shaded environment, so primarily it was shade tolerant species in the regeneration.

In comparing these last two examples, with the first we have high density understorey. The new cohort, occupies about 25 percent of the space, and it has in it Sugar Maple, White Ash and Yellow Birch. The second example has only Sugar Maple as the regeneration, but at a much much lower stem density. So, if I had a wildlife habitat concern where high understory stem densities were critical as some people have argued are necessary for the neo-tropical migrant songbirds, I could go with the 15 m^2 residual and get these high understorey stem densities and it would last for 25 years or so. So you can use selection systems not only to get consistent yields, but to make a profound change in the habitat condition, or to make a change in the visual qualities through time.



Cutting across the size classes is key to getting good diameter growth. In looking at the original Eyre and Zillgitt diameter growth functions, the bottom line, "E", is the uncut reserve. And then as you go up to higher and higher curves, "D", "C", "B", "A", those are stands cut to lower and lower residual densities. "C" is about where the 10-year interval would be. The vertical axis is diameter growth, and the horizontal axis is tree diameter. So at these lower densities, the trees less than 20 or 25cm grew at a profoundly greater rate.

The key there is that they cut across the diameter distribution, regulated crowding and illuminated the crowns even more. So it's that effect you can have on the smaller diameter trees by cutting across the diameter distribution, and by regulating density to get those growing faster so they can become bigger sooner. The fewer trees you have at the lower density, growing at a more rapid rate, compensate for the production you would see with more trees at higher densities. And that is what evens out the production if you match the cutting interval to the residual density.



The diagram to the right illustrates some new growth functions we have developed, showing an example of 17m per hectare and another at 15m per hectare. The trees grew much better at lower density. It is the same kind of pattern we saw for Eyre and Zillgitt's work. That's selection system.

Now what does it give us for Ecologic values? Let's consider a list of things that wildlife proponents say are important for habitat and focus on that. One of the first priorities is large, downed, coarse, woody debris. With selection system, every time we enter the stand we are putting coarse, woody debris on the ground, particularly if you are extracting only the saw timber portion of trees. Through time it will decay, and then you will put more on the ground, and it will decay and you put more on the ground. So you get some fluctuation through time. We find with a cutting interval of about 15 years, we are putting 10 to 15 coarse, woody pieces on the ground per acre, about 30 to 40 per hectare. That's a lot of coarse, woody material we are putting on the ground. And we are finding these coarse, woody pieces last for about 30 years. At the end of one cutting interval, we've got some partly decayed and we are adding fresh pieces. So I think we can maintain a fairly consistent level of coarse, woody material through time. If you have a pulp wood economy and this is important, you may have to reduce the degree of utilization and to leave a certain minimum number of coarse, woody pieces in the woods.

How about seed and fruit production? With selection system you always have large trees. By the time a tree is 25 or 30cm, it is producing seed. The bigger the tree, the more seeds produced. So we reduce the big trees and down goes seed production a little bit. But the residual sawtimber trees still maintain high levels of seed production through time, and always there is that seed production as a component of habitat.

Tall tree cover is considered important for some creatures like the big birds. Well, we never really get rid of all the big trees. We get rid of the biggest, but not all the big trees. So the pattern we will have is of big trees intermixed with the smaller ones, maintaining tall trees within the habitat.

For low cover and concealment, with traditional approaches using selection systems you don't have much. In the typical wave pattern, it will go up and then it will go down. But with traditional approaches to selection system, a 15-year cutting cycle, you will not have a very dense understorey, at least not by wildlife habitat standards. But if we went to lower densities and opened up the overstorey, we could actually increase the amount of understorey material if that was important. The use of low density/long cutting interval treatments could be a way to change that understorey habitat condition.

Plant species diversity will be low. Regeneration from traditional approaches will be shade tolerant, not only in the trees but also in the herbaceous community. If you go to low-density residuals, you could push diversity up a bit but you will never see the plant species diversity you get from the even-aged reproduction methods.

What about cavities? If we follow traditional methods they are gone. If maintaining cavity dependant species is important to you and the landowner, that is an adaptation you would have to make. Pick out some of the cavity trees, maybe a couple per hectare is enough, and work at keeping them healthy. Manage around them so they remain strong and robust into the future. That is not a big sacrifice. If that is what you want, you need to build that into your silviculture.

The traditional way would be to sanitize the forest. Perhaps the diversified way would be to leave some cavity trees, create or maintain some snags, create some irregular distribution of the overstorey canopy to build up the understorey. Creative thinking will tell you what to do.

So the argument here is that if we are going to move toward ecosystem management, we have to move away from traditional volume production thinking. Not sacrificing that, but recognizing there are other elements that have to be incorporated within our forests, to understand what they are, and to plan them out and to deliberately work towards them.

One of the characteristics of using uneven-aged silviculture at the forest level is that, as you move from stand to stand, you won't see a lot of diversity. One stand will look like the next. So if edge is important for habitat, you won't have edge. But you will have a high level of vertical structure diversity which means that in every stand you will have foliage from ground level to the tops of the tallest trees, with little difference from one stand to the next. But you will get consistency of those characteristics through time. Consistency is what characterizes the uneven-aged forest comprised of uneven-aged stands. We could take measures to diversify, perhaps using high density/shorter cutting interval stands intermixed with low density/long cutting interval stands to create some habitat diversity at larger spatial scales.

QUESTION PERIOD

Albert Marshall, *UINR*

Q: It would make sense to me that larger trees mean better seed production, also better quality of seeds. By removing the larger trees are we affecting the biodiversity of the forest?

A: When we are talking about removing larger trees we are talking about perhaps 60 to 70cm in diameter and bigger. So we are still leaving lots of large trees. As an example, Sugar Maples have good seed volume by 30 cm. It is also understood that the quality of the seed is genetic. I am not aware that it improves with age. So we focus on the trees we like, and we perpetuate good genotypes. And we need to use our judgement to decide how many big trees we need to leave in a stand to reach our goals.

Q: How do you maintain the age class when clear cutting?

A: Again, you need to program your treatments to meet your goals. We have to remember that if you clear cut, you are creating a one-aged stand. We maintain the old trees across a forest by having stands of different ages, with a spread of young to old.

Martin Béland, *University of Moncton*

Q: Above what diameter of growth is no more value added to the tree?

A: You have to start by considering what satisfies your objective. You might put less importance on financial value in an effort to reach other goals. Then you can come up with a viable selection system.

Mark MacPhail, *Director of Forestry, UINR*

Dr. Ralph Nyland, *SUNY-ESF*

Ed Swift, *CWFC*

First Nations' Perspective on Forest Management

Albert Marshall, *Unama'ki Institute of Natural Resources*

The task of presenting the First Nations' perspective to such a group of scholars is an honour, but a difficult one. It is comparable to coming upon an army camp. The generals are lined up and they have prepared their men for battle. All their resources and military hardware are ready for action. The soldiers are anxious to get into the battle. The situation is similar to our forests and the way they are currently being used. We are trying desperately to convince everyone how expedient it could be to balance economics with conservation and the environment. The only thing we can do is to try and continuously provide another perspective, and that other perspective will hopefully lead us into a state of appreciation, a state of consciousness.

We no longer have the luxury of continuing the pace we have had up to this point. We now have to expend our energies to ensure that no matter what we do from here on in to meet our needs, we will also do everything humanly possible to ensure that we are not going to compromise the ecological integrity of the area or the ability of future generations to sustain themselves, or even just to appreciate the beauty that the creator has given us.

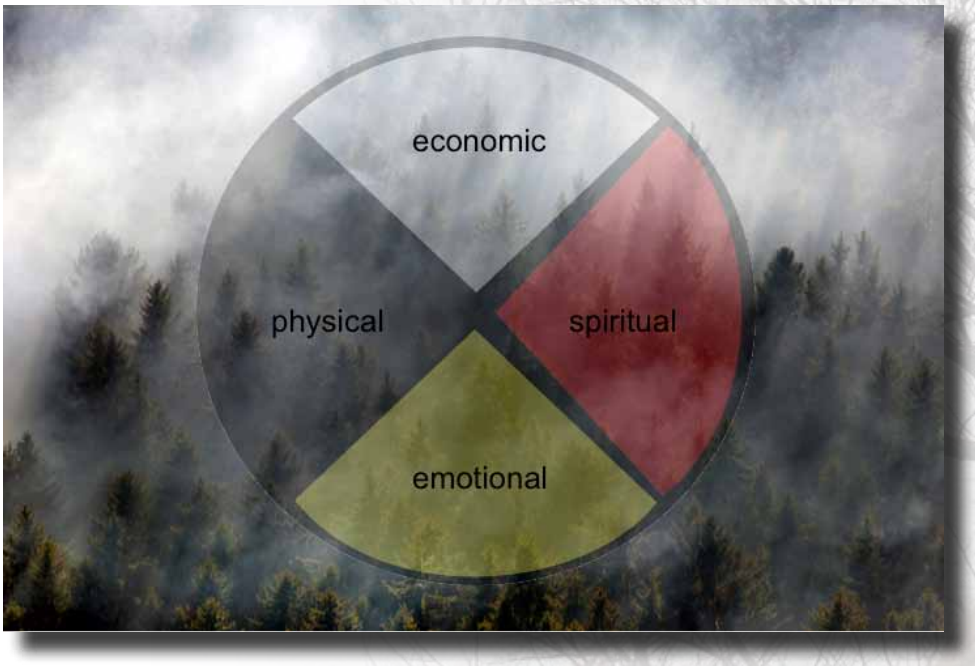
Your forefathers happened to land on our shores because, apparently, the lifestyle was no longer suitable wherever they came from. So there was a need for them to seek out new lands so that they could sustain themselves the way they knew how.

We are creatures of the forest. We are inseparable from it. It gives birth to us as a species and sustains us. It gives us our climate, our food and water. It gives us medicines. It gives us energy, heat. It also gives us tools and the ability to better sustain ourselves. It also gives us our clothing. It also gives us a means of transportation and gives us an opportunity to trade goods with one another. It gives us shelter and even our public buildings. It also gives us a means of education and gives us the opportunity for contact with other beings. Most importantly, it gives us spiritual substance.

The forest, from the First Nations perspective, is a total environment, not a separate resource to be exploited indiscriminately. We are inseparable from the forest. Everything we do to our forest we do to ourselves. Unfortunately, the current government policy is based on the notion that the forest is an external resource that can be mined by private interests. The forests are treated as separate from the human communities that are sustained by

it. The current government policies favour large-scale exploitation by private interests which are structured to maximize profits to shareholders in return for local jobs, and an income tax revenue generated by those jobs. Most of the profits are exported, but the long term environmental, economic and cultural costs remain local.

Through mechanization and the wage competition, it is an increasingly economically depressed environment. Companies can harvest the forest very quickly, leaving very little behind in terms of economic activity or natural habitat. They remove the primary source material as quickly as possible, adding little value to it locally before being shipped out as raw material to other places for processing. The current policy is also a single-use policy, usually pulp and, in the future, probably wood chips marketed together with carbon points as a sustainable energy source. It creates an economy and a "mono-culture" natural environment which deteriorates progressively with each round of exploitation.



The way First Nations' people understand it, there are consequences of strip foresting. We recognize that there will be a loss of habitat diversity. The export of profits will lead to economic dependency. It will lead to adverse effects on lakes and streams. It will also lead to deterioration of genetic stocks of trees, and loss of species diversity. It will lead us to a loss of habitat for fish, mammals and other species.

What do we hope to accomplish with gatherings of these types? We should work together with various perspectives and stake holders so that we will not be compromising the future generations of their abilities to sustain themselves or to just enjoy the beauty that the creator has given us. Forest management is the interest of those who live in the forest with long- term vested interest. We need to maximize the value of any resource as close to the source as possible for the long-term benefit of local communities. For us to be able to understand, and to be able to reconnect, and to regain the intimate knowledge that we once had to our natural world, we have to be given the opportunity and the resources to do what we would like to call an "Ecological Audit" to establish reference points and measure effects of management practices.

The First Nations people are also very concerned about how we, together, can protect our sacred sites. We are also putting out the challenge of how we can, together, try to maintain the species diversity and habitat, and most importantly, maintain the genetic quality of forests. We also believe there should be Mi'kmaq involvement in all matters of forestry management, including representation on all regulatory bodies involved in the policy making, lease signing, agreements, ecological audits, and planning approaches related to crown lands.

The forest not only sustains us but we also have to meet our dwelling needs, our spiritual needs, our physical needs and our intellectual needs. Unfortunately, at this point in time, we have been disconnected and deprived of using the gift that not only sustains us today but also sustained our forefathers. The methodologies that our forefathers used was to try and use the forest in a way that doesn't compromise the ecological integrity of the area. We try to leave good stock to continually produce the quality of seeds that are needed.

The other interest we are trying to promote and try to encourage some support for is: how can we restore the original intent of the treaties related to forest resources. Cape Breton Island is one fifth the size of the province of Nova Scotia. It was perhaps in 1744 that Cape Breton Island was designated to provide the quantity of wood that was needed for the British Navy and, ironically, it was something like 22 years later that the First Nations' people signed the peace and friendship treaties with the British Crown. It has taken all this time and has involved much litigation for us to be able to invoke our rights and our concerns and our interests in all aspects of the natural world.

First Nations' perspectives must be put forward.

From a First Nations' perspective, a forest and everything on it is, and will be, a source of life for all humanity. We wonder why more people can't look at it from that perspective. They would rather look at it as: how can we fine tune our skills to maximize our profits. When we have a healthy forest, it manages to balance itself. Flooding, air pollution, temperature; all those things, in our understanding, comes from the forest. In our understanding, there is no separation. We are not the superior beings or the masters and we do not own the natural world, we just work here.

There has been, up to this point, a high demand on conifers. As a result it seems that consciously we are aware that conifers are on their way out. So let's again refine our skills to converge on the last pieces. In our understanding, every living organism and entity is no different than the other. We are very concerned as we are converging on the last species still standing. We are going to create the same problems that we had with other species. Our simple understanding tells us that if you do not maintain the seed quality of any species, it not only deteriorates in numbers, but eventually it will cease to exist. We are trying desperately to create the perspective that there is a great need for us today to think beyond ourselves. Maybe we are somehow mistaken in buying into the idea that through science and technology we have managed to create a perfect human environment. We are beginning to find out now that this is not the case. From what we see and hear on a daily basis, Mother Earth is fighting back. She is suffering. She is telling us: "enough is enough." We should listen and we should try to learn the lessons that were put here before us, to live in a harmonious way with every living thing. What we do to the forest, we are doing to ourselves.

The challenges that we have before us are great. We have to somehow continuously explore new economic opportunities for the people that depend on this resource. But at the same time we have to reflect a little more deeply on the philosophy of the First Nations' perspective. There is a prophecy that applies here: "When the last tree is cut down, when the last fish has been caught, and when the last river has been poisoned, only then will we realize that money cannot be eaten." The environment will always balance itself, with or without humans, so essentially sustainability is a human rights issue.

Question Period

Ed Swift, *CWFC*

Q: How do we transfer these values to the next generation?

A: Education is the tool. We must be conscious of what we do. As we use resources to sustain ourselves, we cannot take away from future generations and their ability to do the same.

Q: If we did organize a program to teach these values, is this something First Nations would support?

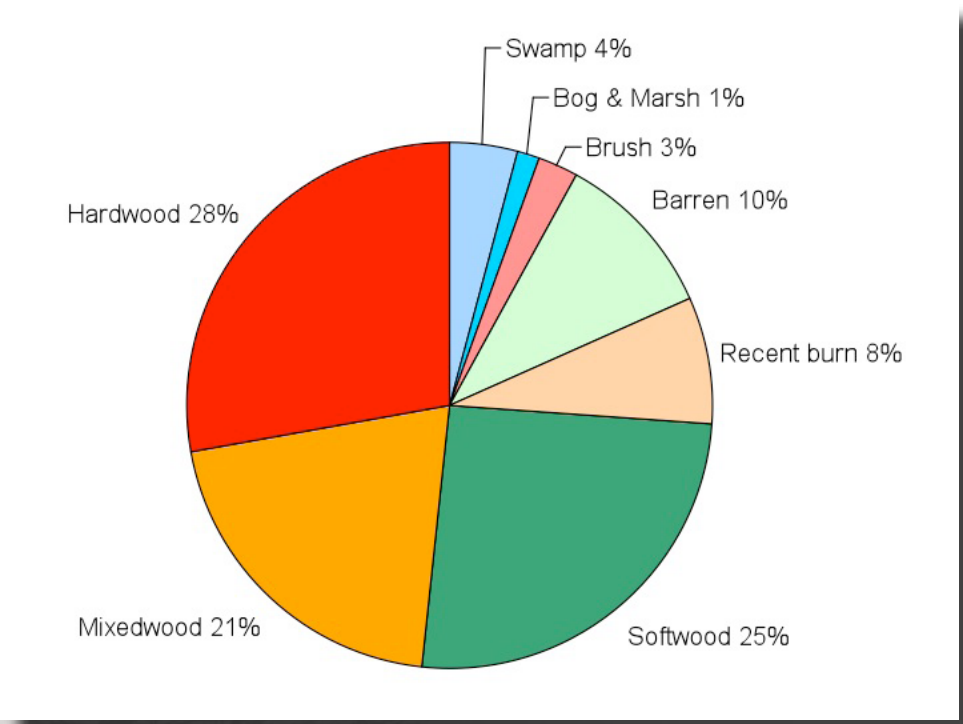
A: The analogy could be made to Colonel Sanders. He had to give his secret recipe in parts. We must go to the knowledge holders for these lessons.

Historical and Present Use of Hardwoods in Nova Scotia

Brendan Hemens, *Nova Scotia Department of Natural Resources*

Nova Scotian hardwoods and Keith Richards of the Rolling Stones have a few things in common: they've both been around a long time, they've both been used in ways they probably shouldn't, they've both been a little bit abused, they've both produced some good things but, after all that, they are in a bit of a state of disrepair. There is a really important difference between Keith Richards and Nova Scotian hardwoods. The hardwoods are recoverable and Keith Richards can't have more than five or six tours left in him.

The Forest Inventory section of Natural Resources has two primary activities as it pertains to inventory. The first is, we fly over the province capturing aerial photography and, from that forest inventory, we have interpreters who classify the forest types in the province. The second is, we have about 3500 permanent sample plots. We have more permanent sample plots per unit area than any other jurisdiction in Canada. These have been used to measure the forest continually since 1965. It is a tremendous resource. The oldest tree we've sampled in Nova Scotia is a Yellow Birch from 1855.



In 1801, Governor Wentworth, the Governor of Nova Scotia at the time, asked Titus Smith to journey forward and view the forests and discover what he could about them. Governor Wentworth's focus was hemp. He wanted to establish hemp in the province to produce rope for the British Navy. So Titus Smith set out to traverse the province, and he established lines and he trucked through the woods. You have to understand, while at the time the coast was pretty well known and discovered and even lumbered pretty heavily, the interior remained quite untouched. His focus wasn't really hemp. He is considered the Father of Forest Ecology in the province. He gave close attention to the wildlife and the flora and fauna that he saw.

There were some standout features from his survey at that time that really differ from the forest as we know it today, especially the hardwood forest. His take on it was that far and away, wherever he went, Beech was the predominant species in any hardwood stand.

Ralph Johnson, who wrote "Forests of Nova Scotia", took the information that Titus collected, using a well marked out map of where Titus's traverses had gone. He produced a rough approximation of the breakdown of the forest types in Nova Scotia at that time. By looking at that, we can see hardwood

makes up the largest single proportioned cover type. Now it's around twelve or thirteen percent by comparison. There are some obvious reasons for that. Hardwoods tend to be our higher quality sites. There was a big agricultural boom, especially through the nineteenth century. So here we see the first big change driving what the forests look like today, which is that a lot of them are under agricultural development. Granted, a lot of those forests that had been developed for agriculture have since been let go, but the recovery tends to be White Spruce, not tolerant hardwoods.

He also noticed a few other things that would look really out of place to us in Nova Scotia today. He saw lots of passenger pigeons. There were wolves. He observed that there were more caribou than there were moose in Nova Scotia at the time.

So the question is, if that's what he observed, then what kind of activities have taken place to produce the forests that we see today? Really, most of the trees we see today originated in this century. Only maybe three percent occurred in the nineteenth century. A lot of the activity in the 19th century still produced the forest, or the lack thereof, as we see it today.

When Titus Smith made his journey through the province, there were about 100 active saw mills, and while they were important to the economy of the time considering Nova Scotia wasn't very populated yet, they really weren't that important overall. Mostly they were exporting to the West Indies and just providing for local use. And they were operating pit saws. A big change took place, and it first started actually in 1751. Governor Cornwallis issued a bounty. He said: for every ton of ships built here, he was going to dish out ten shillings or 10 pounds or some amount of money. And that is certainly not the last time that policy originating in Halifax had an effect on the forests in Nova Scotia. It didn't really hit the ground until about 1802 or so, when there was war in Europe and Britain's traditional supply of hardwood couldn't be provided from the Baltic States, so they turned to the colonies. They gave very favourable duties. In fact, Nova Scotia paid no duty while everyone else paid 200 to 300 percent more than they used to. Not only did we have to ship wood, and the focus at the time was on pine, but they needed ships to do it in. So they built the ships here, and then they sailed the ship and the pine over and they sold them both.

Working in the 19th century, it's hard to get really good stats. But there was a rapid increase in just how many ships we were producing. These ships that they were producing had a tremendous impact on the wood supply in this sense: to build a 300-ton ship, you need 150,000 board feet of lumber. That's just not to build the ship itself, but also the staging. And you also needed hardwood, or fuelwood, to create the fires to steam the timbers. All together, we are talking a fairly significant impact.

By 1870, we produced 3000 ships in a single year. At the time of Confederation, Nova Scotia had the third largest Merchant Marine in the world, consisting of ships built here. Even in the 1840s, a place like Hantsport–which if you've been there, is currently kind of small–was the fifth-largest shipbuilding place in the world. Granted, the types of saw mills they were using at that point were no longer pit saws. The technology changed and they were able to produce wood more rapidly. But this was a very wealthy place. There were about 3000 people employed in about 1400 saw mills in 1861. Currently, there about 250 saw mills.

Not unexpectedly, they are harvesting three times as much wood. On the other hand, they employee three times as many people. So there has been a change in the shape of the industry, but maybe the employment rates haven't changed as much as some people suggest.

So, the Yellow Birch from 1855 is a lucky tree to have made it past 1861. The other thing to note is that the reason shipbuilding at the time had such an impact on our hardwoods is that Yellow Birch does very well underwater. It resists decay very well. Certainly, they used a lot of Oak in the Province, but Yellow Birch was always the source for keel wood and also for most of the hull timbers.

Another industry that has been considerably important in Nova Scotia over that time period is the production of barrels and staves and headings. The staves are the part that make up the side of the barrel and the headings are the top wood. In the 1930s alone, Nova Scotia produced 1,500,000 barrels and over 100,000,000 board feet of staves and headings on top of that. In fact, if you see the strapping around the sides, the hoops, back then it was mostly made from Gray Birch. They were taking those trees and splitting them in half. So a tree that, today, has essentially no value was actually quite useful at that time.

There was another important use of hardwood in the 19th century. If you wanted to load up fuel on a ship, and this is before the coal mines had been opened up and that became the fuel of choice, loading up a lot of hardwood on your ship was a very heavy choice of cargo. So what they did instead is they made huge piles of it, buried it over with a layer of soil and grass and then lit it on fire underneath. They would carefully manage it so that it was a slow burn and all the water would evaporate and a lot of the unnecessary parts of the wood would go away and you would end up with charcoal, which had essentially the same fuel value but was a quarter the weight. A lot of wood got used up in that way. We also had a pretty substantial furniture building industry. Hardwood flooring was also used ubiquitously in our homes at the time for its practicality, if not its beauty, and now we've come to value it much more.

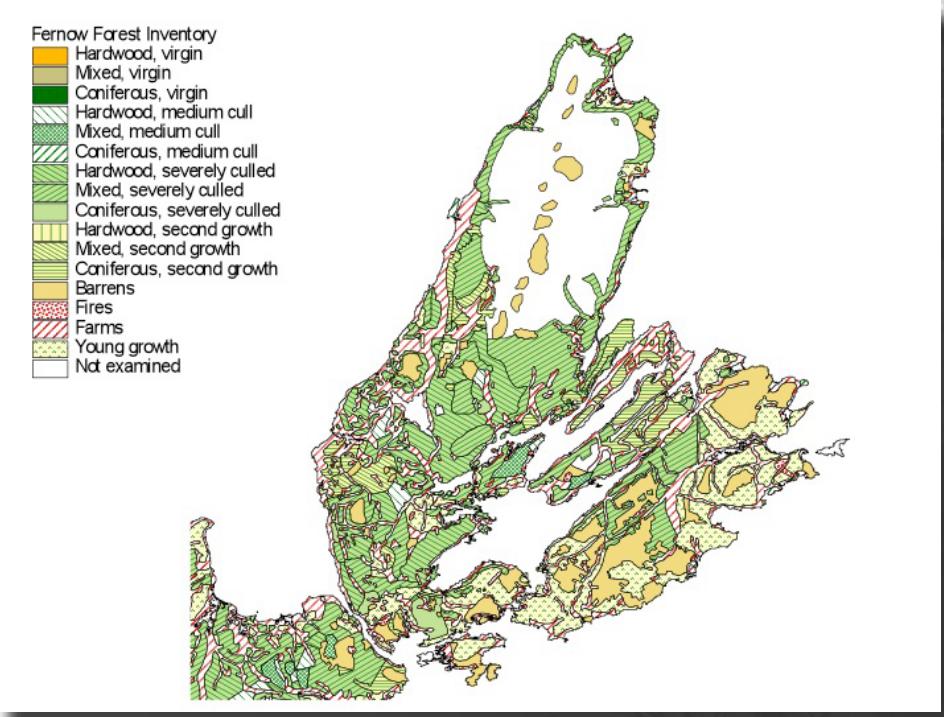
There are other things that were having an impact on Nova Scotia's forests through that time. James Sacksby got to be famous because he correctly predicted a huge hurricane in 1873 a year in advance. He wrote a letter to the London Times and said, "I predict that there is going to be a massive storm coming through Northeastern North America next year." And he was right. That knocked down a lot of forests in Northern Nova Scotia and there was a subsequent gale about five years later that also affected large areas of Cape Breton. We are talking a lot of downed wood.

In 1910, E. Furnow did a survey of the province and assembled a forest inventory that exceeded Titus Smith's in accuracy. It is certainly not as good as what we have today, but it does give us a sense of what was there at the time. There were some areas of fire barrens. And there were areas he coloured white on his map that he didn't explore. At that time he didn't find any virgin timber in Cape Breton Island. Most of it at that time he felt was severely culled. It had already been picked over and harvested a lot. So clearly, we had a large impact on this Island by what was there by 1910.

And then there were other things that came into play after that period that have also been knocking out our hardwoods. The European Winter Moth, a foreign introduction, was first discovered in Nova Scotia in the 1930s and now has spread to other parts of North America. It caused a lot of damage to our hardwood trees. Dutch Elm disease would be another one. When Titus Smith went through in 1801, he saw lots of American Elm, lots of Beech. But now, obviously, we are not going to see so much. Yellow Birch Die Back disease had a huge impact that finally came to a slow in the 40s and 50s, also Beech Tree disease.

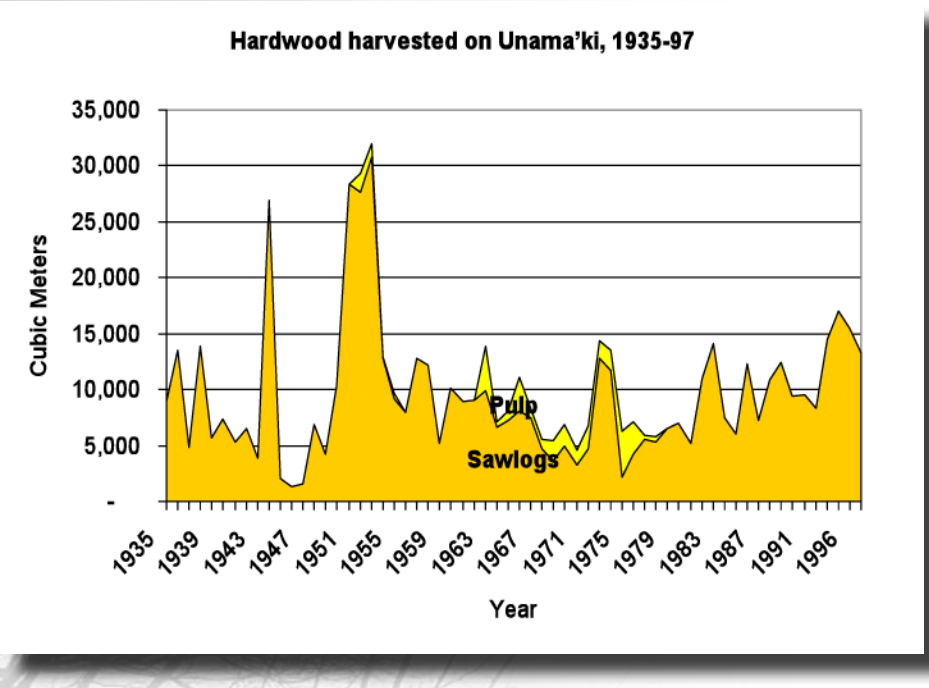
Veneer production and logging for veneer production did increase through that time. The Mosquito Bomber used in World War II was made almost entirely of plywood, and Yellow Birch was the species source for that. So that saw a huge increase in production for hardwoods at that time. The other thing that we really haven't done a good job of quantifying is fuelwood. Fuelwood has been tremendously important to Nova Scotians and continues to be, even increasingly so, throughout all that time. And yet the Department is really only starting to measure that in recent years, and we are only looking at the big producers. We haven't really got a good sense of how much hardwood went to that use for that period.

We have been tracking hardwood production to some degree in the province since 1927, but the figures don't really get useful until about 1935. Looking at the situation in Cape Breton, we can see in the 50s a large increase in production and this, again, can be credited to plywood and veneer production. Around 1997 or 1998, we started tracking hardwood production a little bit differently. We noted what was used inside Nova Scotia and what was exported out of the province. Production on Cape Breton Island has increased through most of the last century. But hardwood content has really declined compared to what Titus might have found a long time ago. In Cape Breton Island, we've got about 129,000 hectares of hardwood, 61 percent of that being a tolerant hardwood of some kind. In the mixed wood areas, it's about 22 percent. We've got about 70,000 hectares on the Island that's 15m or higher.



Recognizing that there is a need for better information on the hardwood resource that people might avail themselves of for more applied uses, the Department developed its own tree grading guide based almost entirely on the USDA grading guide. We implemented that in around 2000. Based on the information we've collected, using that guide from our permanent sample plots, we are able to make some estimate as to what the quality of the wood

currently out there is. You might wonder how that grading system relates to how the wood comes out in the mill. A study was completed on that, where they actually graded the wood in the forest using this grading guide and then took it to the mill. And what they found was that there was a strong correlation. If you are looking at G1 wood, you are going to get a higher proportion of veneer and better grade saw logs. If you were to look at that permanent sample plot database, what you are going to find are very carefully measured tree diameters. Since we are measuring those plots every five years, there is a lot of information in there. So if someone here, inspired by Dr. Nyland's talks, decides that they want to tackle something more rigorous, that database is available to work with. Otherwise, the other thing that we do is we collect photography for the province. Over the next two years, we will complete Cape Breton Island. The other thing that we've done that is a little bit different is, we started scanning our imagery last year and creating ortho-photos from that. If you go to our web page, essentially all the photography we collected last year, which is Pictou, part of Guysborough and Antigonish Counties, we have it up there. And you can take it down to a 1:500 scale and the detail is amazing. We are still working out with the Nova Scotia Geomatics how we are going to distribute that. For those of you that are trying to find that hardwood resource or might look at things that maybe our interpreters are not, we are hoping that will prove to be a valuable resource for you.



Question Period

Martin Béland, *University of Moncton*

Q: Do you have data from your plots on quality?

A: Only on one collection.

Tim McGrath, *DNR*

Q: Are the digital photos that you have collected available to the public?

A: My goal is that I want as many people as possible to see them.

Albert Marshall, *UINR*

Q: You say hardwood is a renewable resource, but how do we know how long we can keep up this rate of consuming the resource?

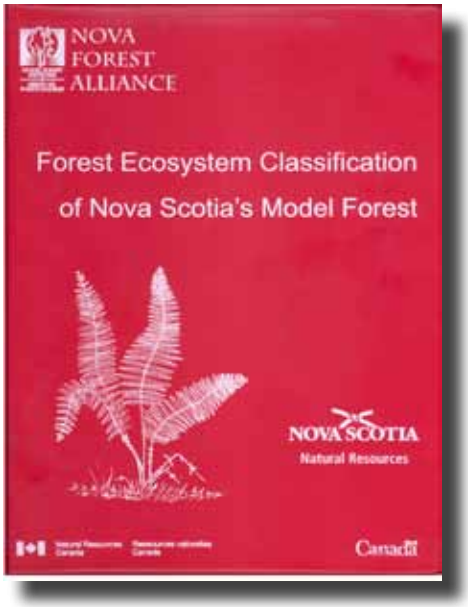
A: This is something Tim is going to talk about later. It involves wood supply analysis. We can only make predictions, and these predictions are only accurate if we use the resource as predicted.

Hardwood Management Tools for Nova Scotia

Tim McGrath, *Nova Scotia Department of Natural Resources*

The new Hardwood Keys and our Hardwood Growth and Yield Model are both tools developed by the Department to help people make the correct prescription in hardwood management. There is not enough time to go into each of these tools in detail, but we will give an overview of these tools.

We have recently published our Tolerant Hardwood Management Guide, and like everything else we produce, it is on the web in document form. The impetus for developing this tool was: we had very good even-aged management recommendations in our Forestry Field Guide, but the one thing that was lacking was recommendations for uneven-aged management and crop tree release. That was one of the major reasons for us developing this tool.



http://www.modelforest.net/cmfn/en/forests/nova/publications_record.aspx?title_id=3610

Another exciting thing happening in Nova Scotia is now we have our own Forest Ecosystem Classification System, an ELC, produced by the Ecosystem Management Group headed by Peter Neely in Truro. This has given us a template to name soils, vegetation types, etc. Now we can give specific recommendations for particular sites and stands in a standard way. This tool is available on the Nova Forest Alliance website. The manual produced was the first prototype developed and it is applicable just to the central region, but Peter Neely's group is producing a provincial guide as well, and right now they have interim guides for the northeast and the western part of the province.

www.gov.ns.ca/natr/forestry/reports/REPORT84.pdf

We will also briefly look at our Hardwood Growth and Yield Model. Previously in the Department others established a detailed set of permanent sample plots in hardwood management areas in 1978. We've been tracking these ever since and monitoring growth and development. Based on the results of the latest measurements, we have revised and updated the Growth and Yield Model to include hardwood growth and yield. It should be noted that this is based on even-aged management, but a lot of the concepts apply to all hardwood management. We also have efforts under way to develop single tree models that can develop more accurately uneven-aged management growth.

http://www.gov.ns.ca/natr/forestry/gny2004/growthandyield.htm

The Tolerant Hardwood Management Guide helps people look at a stand and the site that it is growing on, and based on the conditions, will recommend certain treatments. Of course, the treatments that are included in the recommendations are selection harvesting and there is a separate key for that, stand tending and for regeneration.

It consists of a pre-cruise method so that you can have a standard way to collect information that is required to go into these keys and to follow through and end up with a prescription. We have a bunch of tally sheets to make it easier for people to use the keys. Then we have the keys themselves, and they are basically flow diagrams consisting of gray diamonds which are questions that you have to answer based on the stand and the site that you are looking at. Eventually, after you answer these questions, you end up with a green box which is a prescription of a silviculture treatment or system, or a reference to another key, which is a yellow box, or a red key which means it's not ready to treat right now.

The overall goal is to move toward a system where we are prescribing treatments that are specific to particular ecosystems, particular stand types, particular soils, rather than a "one size fits all" type of treatment. Of course, since a treatment prescription is only as good as its implementation, we also have a recommended tally sheet for post cruise assessment, to make sure the quality of the job is up to standard.

The Guide really consists of four keys. The main key is the one you start on, and in most cases it recommends a different key. There is a separate key for Selection Harvesting. It could give you a prescription for single tree selection system or group selection system, depending on the condition of the stand. Then there is also a tending key, which could end up prescribing a crop tree release or a commercial thinning or pre-commercial thinning. The last key is a regeneration key, which could recommend a shelter wood or an overstorey removal, or an overstorey removal and plant.

Just to illustrate how the keys are used and some of the things considered in the key, we can look at the conditions where an uneven-aged management system would be recommended. As an example, consider we are trying to produce a stand with at least three age classes with a constant mature cover of wood. In this type of system, we need to pay attention to the regeneration of the stand, the tending of the stand and the harvest of the stand. That's a key component to this system. Most people focus on the harvesting part of it but, in our harvesting efforts, we should also be taking care of the tending, or making the trees grow and improving the quality as well as producing the conditions that are going to give us regeneration that we desire. Of course, we've divided the selection system into two major groups: group selection, such as we did in a trial in Upper Bass River with Tim O'Brien's group, and also single tree selection, such as was done at a trial in Woodfield in cooperation with New Page.

So what do we need to get into these keys? We need to know what the species content is. We need to know how many trees are there and what the growing stock is. We need to know the types of trees that are growing there. Do we have enough trees to produce seed, to produce the regeneration we want? Do we have acceptable growing stock? Do we have younger trees that have the potential to produce quality saw logs in the future? These are key things that need to be considered before we consider doing a selection harvest. We also need to consider windfall hazard. Hardwoods are more deep rooted and more resistant to windfall, but they still can succumb to wind if the exposure is extreme. And we need to look at the patchiness of the stand. This would help us to decide what type of selection system to use whether it be group tree selection or individual tree selection.

What are we looking for in terms of species? We are looking for long lived, shade tolerant trees that are suitable, that can be regenerated under shade, and are suitable for saw logs like Sugar Maple, Yellow Birch and White Ash.

A lot of the information in the keys originated from work that was done in Ontario and New England and Upper State New York, and this was really the start of developing the keys. We started there, developed a number of trials and selection harvesting and other hardwood techniques, and then have refined those recommendations based on Nova Scotia conditions. Anderson and Rice from Ontario created a very nice document with pictures that show different species and how to tell the quality trees that are growing. In each species you can see the bark characteristics and the indicators of quality.

Now that we have the Forest Ecosystem Classification System, we can also talk about stand types that are suited for selection harvesting and hardwoods. Suitable vegetation is referred to by numbers and people are starting to use the numbers instead of the actual names. For instance, VT21 refers to a Sugar Maple/White Ash/ Christmas Fern site, which is probably one of our richer hardwood tolerant sites and well suited to a selection harvesting system. Another example is a VT22, not as rich but, again, suited for selection harvest with Sugar Maple/ Yellow Birch/Hay Scented Fern.

We have to look at the growing stock. Do we have some mature saw logs to produce the economic benefit to be able to tend and regenerate the stand? That's a key ingredient to knowing whether a stand is suitable for selection harvesting. We also need to know that there's a good seed source. Sugar Maple is a tree that seeds at an older age, so we need to have some larger, relatively older trees in order to regenerate Sugar Maple. If we have some mature saw logs but not many younger trees of acceptable quality and potential for the future, then maybe it isn't the proper stand for selection harvesting.

In terms of windfall hazard, we should be increasingly looking at the soils in our sites as well. Very shallow soils, of course, will be ones that are more prone to blow down. So we should be examining the soils and making sure we prescribe these treatments in the right types of conditions. If it's a very shallow soil, maybe it is not the right place to do selection harvesting. Soil types are identified in the FEC guide. By looking down approximately 30cm into the soil, putting your shovel in and examining the rooting depth and the texture, we can usually tell pretty quickly that, yes, that's a good rich soil that's suitable for selection harvesting and might not be prone to blow down. We are leaving mature trees and we want them to stand on the site to provide a future crop, shade and seed for the next crop. And of course, consider the exposure of the site. If we are on a ridge top or right next to the ocean, it's going to be more prone to blow down.

We should identify the patchiness of the stand. Sometimes it is quite common in hardwoods that there are portions of the stand that are mature. There is no acceptable growing stock of younger trees within a certain piece of ground and they really need to be regenerated or opened up. Also, there might be other areas that are smaller, not many mature trees, but there is a lot of acceptable growing stock of smaller trees and they really need to be kept for the future crop. So in that case, maybe a group selection is more appropriate than a uniform selection or an individual tree selection, where the trees might be more uniformly mixed between mature and younger acceptable growing stock.

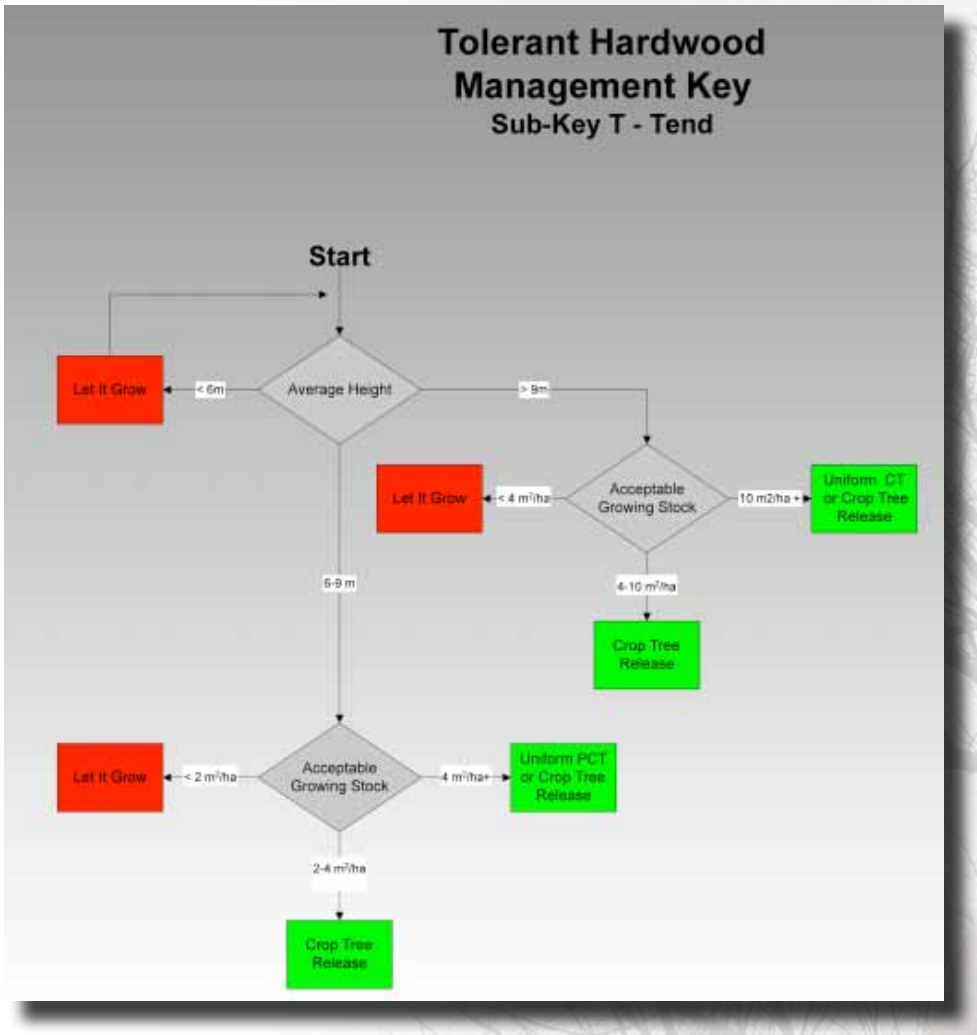
We have to focus on how we implement these treatments. The best prescription in the world doesn't ensure that we will end up with a good tree growing. If we end up harvesting these stands and damaging the trunks, destroying the future saw log potential of the trees, then we probably shouldn't do the treatment. So we recommend certain quality control specifications for people to try to aim for, to reduce the damage and improve the quality of treatments.

To illustrate the results of some of these treatments in our trials, we can look at examples such as a trial implemented in Delaney Settlement. It was an individual tree selection system. We have at this site, abundant, good quality Sugar Maple regeneration that is growing quite well after 10 years. On the downside, it's also encouraging Beech. But we found in most of the trials that single tree selection is the best technique to regenerate Sugar Maple.

Another example is the result of a group selection system that was tried in Upper Bass River and again, we are examining the results approximately 10 years after the cut. In this case we used the recommendations from New England. One of the recommendations was to utilize a half-acre patch for your groups. In this case we got fantastic Yellow Birch regeneration. It's a Yellow Birch thicket. We did get Sugar Maple but it is very small and suppressed

underneath this canopy of Yellow Birch. Initially, it looked like it was going to be a blackberry/raspberry patch. But after 10 years, the Yellow Birch regeneration was abundant, luxurious and overtopping the blackberry and raspberry. That's part of the changes that were made in the keys before they were published. If you're really trying to regenerate Sugar Maple, we recommended smaller than half-acre patches.

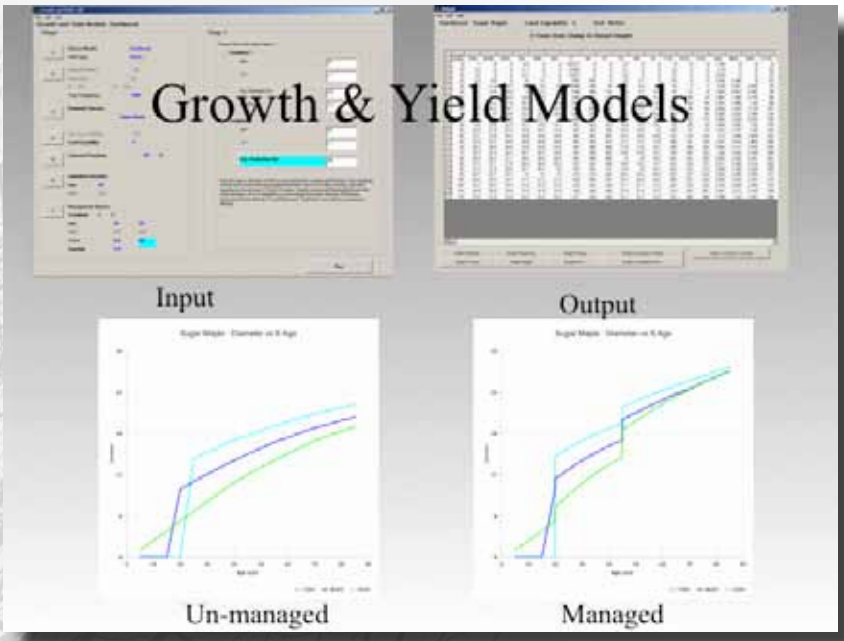
There is also a tending key. Again, that is not a harvesting system, but a system that recommends either a pre-commercial thinning or a crop tree release or a commercial thinning. It is really meant to produce the conditions so that, down the road, we can produce saw logs when there is no high-end saw logs in the stand at present. The results of our trials after five years mimic what was said in New England quite well, that if we release a vigorous Sugar Maple with a good crown, then we can produce an inch of growth in four years, as opposed to a control where we produced an inch of growth in diameter in nine years. So that is working quite well. Except that if you try to release trees that have small crowns that are suppressed, or intermediates, or if they have some damage or stress to begin with, they will not release. We have actually had some cases where the exposure was too great and the tops died back. The trees should be vigorous, trees with good crowns, before they are released. Then there is a regeneration key.



Next we will talk about Nova Scotia's Growth and Yield Model. It's a stand level model. We have recently updated it to incorporate the latest results from our hardwood trials.

Why do we do it? The attempt with the Growth and Yield Model is to define how much wood you can get at a particular time with various treatments, how long will it take to get that wood, and to do it in a quantitative way, in a numbers way. We have been tracking trees for 30 years now in these trials, and we have been measuring growth rates. We can incorporate that into a model that people can use to compare the results of treated versus non-treated conditions. The only thing to be said before considering the Growth and Yield Model, especially with hardwoods, is that the quality is just as important, if not more important, than the quantity. So if we do anything in our treatments to destroy the quality of the stand to produce high value, then we are really defeating the purpose of the treatment.

Just to illustrate this, and these numbers are not really up to date–they are more illustrative than "take home as Bible"–for the same amount of wood you could produce roughly $22 for a stick of pulp. If it was a high-end veneer, that same stick would be worth 20 times as much. If we have a few of those big stems that are of high-quality and we do something to destroy the quality of it, we can reduce the value of it quite a bit and we are really not achieving the aim of economic stability.



The computer model itself is a user-friendly computer model. It is available on the web. When you run it, you get an input screen that asks you approximately seven questions: what species you are interested in, what the site capability is, what type of treatment you want to do and when you want to do it. So you fill those items in, click a button, and then it will give you a prediction of quantitative estimates of what the growth would be in that particular stand. It gives you a table which you can use to produce graphs. Then again, you can just click a button and it will show, for example, the growth rate in diameter over time for three different components of the stand–all the trees in the stand, only merchantable trees and only the saw log size trees.

Of course, one of the major things you might want to do with this is: what effect are we having on our forests by treating it and doing silviculture? This illustrates how you can affect diameter growth by managing the stand versus not managing. So you can do "what if?" scenarios. Instead of waiting 60 years to see your result, you can see it represented on the computer.

One of the applications you might use this computer program for is to design silviculture programs. You might use it to answer such questions as: When to thin? What treatments to use? Should you use six-foot spacing or eight-foot? And you can also use it to predict various yields and various components, such as merchantable volume, total volume, saw log volume, and piece sizes to predict what the cost of harvesting will be.

These forecasts are used on a forest level. Basically, with this model, we can predict on a stand how a stand is going to grow. Of course, wood supply modeling is just an incorporation of a prediction of how stands grow in a whole forest. In this way we can estimate what the sustainable wood supply would be given different silviculture scenarios.

As an example, in a more detailed analysis that might be completed considering commercial thinning on a Sugar Maple stand at 57 and 87 years of age on an average site with 80 percent stocking, this can be compared to not thinning. The computer results show a red line indicating an increase in yield that you will get over time with the commercial thinning versus not thinning at all. A dotted line shows the increase in saw log volume.

Most of our information is on our website, and all are encouraged to view it and take advantage of it.

QUESTION PERIOD

Albert Marshall, *UINR*

Q: What percentage of the forest is used for the maple sugar industry? Can we use the Sugar Maple industry to enhance the seed source? Does your system take into consideration the loss of wildlife habitat and plants?

A: In this model I don't look at the impacts on wildlife, I guess I focus on timber management. But I can say that in our wood supply modeling we are looking at the whole forest. We are trying to look at the effects of forest cover on wildlife, etc., so we can take those things into account. As far as percentages of Sugar Maple production, I don't know. Hopefully, in the Sugar Maple industry they are selecting trees of good form and this will benefit their genetic stock. In our partial harvests, we should be ever vigilant to try and improve the forests.

Ed Swift, *CWFC*

A: Generally in the maple sugar industry, you try to keep the stands in the most vigorous state to get more syrup. The challenge is deer and moose prefer planted hardwood seedlings for food over everything. The challenge in northern New Brunswick right now is, when they go on top of the ridges which tend to be stands of Sugar Maple, they want a guarantee that those areas will be used for nothing but windmills. So there is a new conflict now with alternative energy.

Martin Béland, *University of Moncton*

Q: Can your model differentiate based on the distribution of trees?

A: No. My models are stand models. I am estimating the average tree in a stand. But we are moving towards another technique to help us more accurately estimate single tree treatments and crop tree release. We have the data to develop that but it is relatively new to us.

Tim O'Brien, *DNR*

Q: Can you comment on how you think herbicides can be used to promote hardwood regeneration?

A: It's something we are trying. Sometimes manipulating the overstorey and natural regeneration just doesn't happen, and we might need a little help to get the desired species established. If herbicide is a useful tool to make it happen I am for that, but only when it's really necessary and appropriate. Hopefully with proper regeneration techniques we can avoid major uses of herbicide in the future.

Jean-Martin Lussier, *CWFC*

Q: Your key devises a treatment based on stand structure. Do you take into account any objectives of the land owner?

A: I haven't put specific objectives in there, but that is really the important point. The hidden objective is we are recommending uneven-aged management wherever conditions allow for it.

Q: So there are no conversion treatments included?

A: No.

Gary Schneider, *MacPhail Woods Ecological Forestry Project*

Q: Are you doing any restoration or enrichment plantings?

A: No, but I think we should. Given the time available, I wanted to focus on certain things first.

Bob Bancroft, *Biologist*

Q: Is anybody looking at the land base and trying to convert it back? Usually where hardwoods grow naturally is where they grow best. Mr. Marshall is the only one to put together forests and water. We have to get this together on a broader scale. We are not taking the "big picture" steps.

A: My work just focuses on a particular objective. There are efforts on ecosystem management in the province on a larger scale. We are moving in the right direction.

Shyla O'Donnell, *DNR*

Q: A question about your ecosystem classification–how did you classify those sites?

A: They tried to look for stands that were mature and unaffected by management so they could identify the natural ecosystems.

Q: Could that be used as part of the Hardwood Management key?

A: Yes, that is the goal. But I took a broad brush approach for now.

Ed Swift, *CWFC*

A: These things take time. We are on a different time scale with the forest.

Q: How does climate change affect your keys?

A: It is something we should really keep in mind, but I don't think we should make drastic changes in our silviculture based on that. I think maybe a more prudent approach would be to plant a mixture of species.

Q: Will you refine your keys? Are they static or dynamic as more information becomes available?

A: These keys are not fixed and they will never be totally completed.

Growing High Value Trees: Uneven-aged Management Outreach Project

Patricia Amero, *Picea Forestry Consulting and Woodlot Services*

This presentation focuses on the Uneven-aged Management Outreach Project that Picea Forestry Consulting is currently involved with, and how we promote the growth of high-quality hardwood and softwood products to private woodlot owners throughout Nova Scotia. Our on-the-ground experiences over the last eight years with our consulting company, working with registered buyers or mills who demand high-quality logs, and delivering silviculture programs that aim for quality development, as well as developing management plans for woodlot owners throughout Nova Scotia based on multiple values and use, led us to this Uneven-aged Management Outreach Project.

There is certainly a wide range of private woodlot owners and woodlot conditions in Nova Scotia. The private woodlot sector makes up the majority of our province's forest, since approximately 70 percent of Nova Scotia's land tenure is private land. Over 50 percent of this land is the small private woodlots. The private land in Nova Scotia is the most accessible and productive land in our province.

While working with a range of these private woodlot owners and contractors, and being familiar with all forest types as outlined in the province's interim version of the Forest Ecosystem Classification manual, we have found there are many areas suitable to practice uneven-aged management and to grow high-quality products. With proper planning and silviculture, the focus is on quality. We are not pursuing this outreach project alone. We teamed up with the Nova Scotia Woodlot Owners and Operators Association, since they also promote uneven-aged management and value-added high-quality products, and have a great deal of experience working with and putting on field days for private woodlot owners. We joined forces to submit a proposal to the Association for Sustainable Forestry to deliver outreach and education services that promote uneven-aged management and quality improvement silviculture to small private woodlot owners and contractors throughout Nova Scotia. In December of 2007, we were awarded the contract from the Association for Sustainable Forestry. The duration of the project is for one year.

What is the Uneven-aged Management Outreach Project? The main focus of the Outreach Project is to promote uneven-aged management on appropriate sites, and educate private woodlot owners and contractors interested in growing tolerant, long-lived species and high-quality forest products. The outreach project is one part of the Category Seven Quality Improvement Silviculture Program, which is a new two-year program administered by the Association for Sustainable Forestry and funded by the Nova Scotia Department of Natural Resources (DNR). The other component of this Category Seven program is the Silviculture Funding Program. Over the next two years, $443,000 is invested in the Category Seven Quality Improvement Silviculture Treatments which include crop tree release, crop tree pruning and selection management. This funding program is directly administered by Rebecca Aggus, the Association for Sustainable Forestry's coordinator, and aims to help private woodlot owners and contractors offset the cost of improvement work that encourages high-quality products.

So what is Category Seven? Category Seven Quality Improvement Silviculture is one of seven silviculture categories available for financial assistance as per the Forest Sustainability regulations. Category Seven treatments focus on quality development of tolerant long-lived species such as Sugar Maple, Yellow Birch, White Ash, Red Oak, Red Spruce, Eastern Hemlock and Red and White Pine. The crop tree release and pruning treatments can be applied to both uneven and even-aged forest conditions, where selection management is suitable for uneven-aged forest stands.

The Forest Sustainability Regulations were put into legislation in April of 2000 and finalized at the end of 2001. Under these regulations, users or registered buyers of primary forest products from private and/or industrial lands in Nova Scotia are required to complete silviculture work and the Wood Acquisition Plan program, or pay money directly into the Sustainable Forestry Fund. The amount of silviculture work or money put into the fund is based on the volume of primary forest products registered buyers acquire from private and/or industrial lands in one calendar year. As part of the Wood Acquisition Plan program, registered buyers must either complete a silviculture program to obtain the silviculture credit requirements and/or pay directly into the Sustainable Forestry Fund. For more information about the Sustainability regulations or the registered buyers, please visit the Nova Scotia Government website.

The Association for Sustainable Forestry (ASF) was formed in November of 2000 to administer the Sustainable Forestry Fund on small private woodlots, in agreement with the Nova Scotia Department of Natural Resources. The Association for Sustainable Forestry is an independent organization with a Board of Directors that includes representation from the private woodlot owner, forest industry sectors and the Nova Scotia Department of Natural Resources.

In August 2007, the ASF signed an agreement with DNR to deliver a program aimed at increasing the number of small private woodlot owners who use uneven-aged management techniques on appropriate sites. Thus the Category Seven Quality Improvement Silviculture Program was created and is being administered by the ASF.

Why has the Outreach Project come about? The main reasoning behind this program is: since the ASF began in 2000 there has been modest funding spent on the Category Seven silviculture treatments. There are many factors thought to have influenced this. It is believed to be, in part, due to the lack of awareness, since there are some woodlot owners and contractors in various areas of Nova Scotia conducting some version or combination of these Category Seven treatments, but they are not aware that this funding is available. It is also due in part to meeting technical standards as set by DNR, since each silviculture treatment must meet specific criteria to receive funding, and not all site and soil conditions are suitable for these types of treatments that specifically focus on quality. Funding for uneven-aged management treatments has been limited in Nova Scotia until 2000, once the Forest Sustainability Regulations were legislated. There has also been minimal outreach and education available to woodlot owners and contractors regarding uneven-aged management and quality improvement silviculture.

In addition to promoting uneven-aged management techniques and encouraging program participation, ASF and DNR wants the Outreach Project to determine the extent of interest in uneven-aged management and quality improvement silviculture among both woodlot owners and contractors, the extent that these Category Seven treatments or some version of them are being completed, identify woodlot owners with suitable woodlots and identify challenges and costs woodlot owners and contractors face when conducting these treatments.

What does this Outreach Project entail? The proposal we submitted to the ASF is our delivery plan, our blueprint, of how this project is to proceed to promote uneven-aged management, educate woodlot owners and contractors how to apply the Category Seven treatments on appropriate sites, gain interest, encourage program participation, and to gather the information we need. The series of events include presentations at conferences such as this one, to present at annual general meetings, and this is to introduce the Project and concepts of uneven-aged management and silviculture treatments aimed to grow high-quality trees in both softwood and hardwood. It is also our goal to inform woodlot owners and contractors of the benefits of this type of management.

Five education workshops were held from early May to mid-June throughout Nova Scotia. They ranged from Richfield, Digby County, down in the west, to Middle River, Victoria County, in Cape Breton. These were all-day sessions, half indoor and half outdoor. The main focus of these workshops was to educate and show woodlot owners and contractors how to recognize potential and suitable sites for these treatments, how to properly apply these treatments to ensure success, and how to receive this funding.

Other events of this project include: 20 half-day, one-on-one site visits with interested woodlot owners and contractors. The candidates for these site visits will be chosen from our previous interaction with them, particularly from the education workshops because attending these workshops certainly showed that they had an interest in learning more. With these site visits, we will tour their woodlot with them and have a one-on-one discussion about the factors discussed during the education workshops, but more detailed and tailored to meet their own situation and needs and forest condition.

The final step of the project, as required under contract, is to produce a report for ASF and DNR by the end of October of this year. The results of engagement and site visits will allow us to inform ASF and DNR about the extent of interest, the extent that these treatments or some version of them are being completed, and the challenges and costs that woodlot owners and contractors face conducting these treatments. This information will be the underlying basis for us to develop appropriate recommendations and possible next steps to improve the program for woodlot owners and contractors.

Why is the Outreach Project proving to be a success? These project events were designed to take our experiences and what we have learned about uneven-aged management and how to apply the Category Seven treatments, and relate them to woodlot owners and contractors. Our on-the-ground experiences of dealing with a range of woodlot owners and contractors in a variety of forest conditions has given us the ability to relate to them and where to focus education and demonstration efforts. We find there are many woodlot owners in Nova Scotia that wish to manage for and optimize multiple values of their 100 and 200-acre pieces of forest. When you take time to talk to woodlot owners, it becomes very apparent how much these people are attached to their land. This is particularly evident when the woodlot has been passed down through generations since the original land grants. There are a portion of woodlot owners in Nova Scotia that are fourth, or even seventh, generation of woodlot ownership.

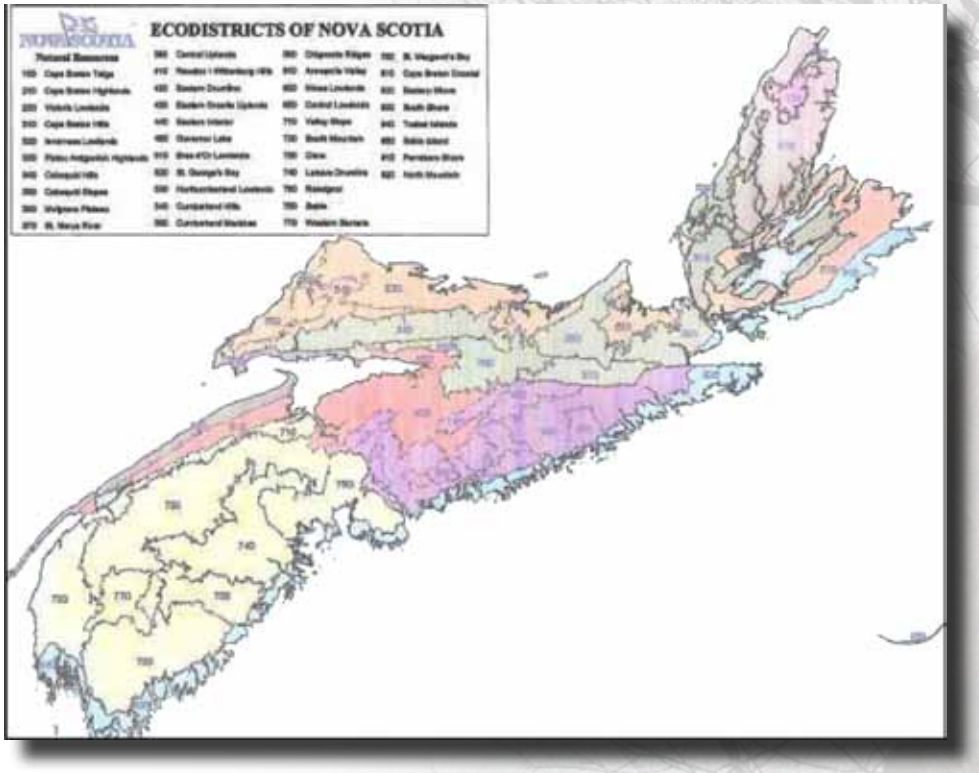
Uneven-aged management assists the woodlot owners to maintain multiple values and uses of their forest including growing high value trees. When they realize how uneven-aged management can be applied to help reach their woodlot objectives, we have found they become very interested and they want to find out more. We have also come across woodlot owners who have been implementing selection harvesting activities for many years and aim to promote growth and quality development of their trees. When in the woods, it becomes apparent that they don't realize that they are actually applying uneven-aged management as we know it, and some version of the quality improvement treatments.

The interest and demand to learn more about uneven-aged management and how to grow high-value trees through implementing quality improvement silviculture, is certainly shown by the full attendance at all five of our education workshops. Space was limited to 50 to attend these sessions and they filled up very quickly. Everyone was very attentive and they asked lots of questions, providing us with good comments and feedback. Also, the $443,000, as part of the funding program, was allocated within four months of the project starting. During project events, particularly the education workshops and one-on-one

site visits, we emphasized to woodlot owners and contractors the potential for growth and quality that is out there if we just take the time to look. Once we know what to look for, identifying potential for growth and quality becomes more evident the more time you spend in the forest. We must look at individual trees, not just stands. The forest stand may appear degraded as a whole but, sometimes when you look more closely, you may very well find 35 to 40 year-old Yellow Birch or White Ash that are 16m tall, straight, branch-free with a diameter at breast height of 15cm or more. Trees of this magnitude certainly illustrate high productive capabilities and potential for quality development of high value products. If released and tended, these trees in 20 to 30 years time will reach saw log status, as well as provide seed to the area for future crops. If similar hardwoods or softwoods are located every 40 to 50ft in your stand and tended, the return on such high-quality trees could be quite large.

The best hardwood growth capabilities and potential for quality in Nova Scotia we've seen, tend to be on the mid to lower slope positions in valleys that are sheltered. We have found examples of trees such as Sugar Maple with excellent height, diameter and straightness in locations such as New Annon, Colchester County on the lower slopes of the Cobequid Hills, and also the mid-slope position near Lake O'Law, Victoria County, in Cape Breton.

The Ecological Land Classification for Nova Scotia is a map that can be found on the government website, and it shows the various eco-regions and associated eco-districts present in Nova Scotia. The most notable areas for potential growth and quality of hardwoods include the areas along the highland and upland slopes that carries from the Cobequid Hills up to the Pictou/Antigonish highlands and up through to Cape Breton's Hills and the slopes of the Highlands in Mabou and the Middle River area. In the western part of the province, the area would be from North and South Mountain, as well as the Drumlands in Lunenburg County and down in Yarmouth County, as well as Queens County. The valleys and lowlands also support this potential for growth, particularly the Annapolis Valley, the Northumberland lowlands, the St. Mary's River Valley, the Margaree Valley and also the Inverness lowlands. These valleys are rich and tend to be more mixed wood, with varying components of Red Spruce, Hemlock and White Pine. These high productive areas are due in part to their sheltered micro climate, the parent materials is a glacial till and alluvium deposits, and seepages of moisture and nutrients from high elevations to lower elevations in terms of enrichment. Suitable site and soil conditions to grow high-quality trees are common in Nova Scotia. What is quite interesting is that four out of five of the demonstration sites for our education workshops were Sugar Maple, Yellow Birch and White Ash, with similar soil types of the soil type "eight". These were spread all over the province.



Nova Scotia Ecological Land Classification
www.gov.ns.ca/natr/forestry/ecosystem/elcpg1.htm

However, we do stress to woodlot owners and contractors that not all site and soil conditions are suitable for uneven-aged management and applying the Category Seven quality improvement treatments. Inappropriate sites include east facing slopes, since most of our damaging winds do come from the east, and fully exposed slopes and high elevated areas. We have noticed at elevations above 250m above sea level, that hardwoods commonly experience crown damage from ice and heavy snow, no matter what direction they are facing. On average, hardwoods can be 5m shorter than hardwoods at lower elevations. Areas at these elevations are certainly not appropriate for treatments that focus on quality. Further, shallow and wet soils increase windfall risk, and these may not be appropriate for these types of treatments.

Appropriate sites to grow high-quality trees are in deep, moderately to well drained soil, slopes that are sheltered and high productive areas. These sites are ideal for the tolerant, long-lived species such as Sugar Maple, Yellow Birch and White Ash.

In order to know if Category Seven treatments can be applied to a particular woodlot or site, it comes down to the forest inventory. The forest inventory is very important in order to know what you have and where it is located– not only for species composition, ages, height, wood product volumes, water courses and access–but particularly, the amount of acceptable growing stock versus unacceptable growing stock and terrain and soil characteristics. Acceptable growing stock are trees in your forest of desired species with good form and vigour. Unacceptable growing stock are trees in your forest that are not desired species or consist of poor form and/or vigour. The aim is to increase the amount of acceptable growing stock and reduce unacceptable growing stock with your management activities. Silviculture treatments need to be site specific in order to truly maximize quality in stocking of acceptable growing stock. The amount of acceptable growing stock versus unacceptable stock will dictate the proper prescription that is needed to either tend existing crop trees in the case where the levels of AGS are high, or begin regenerating the stand in the cases where acceptable growing stock is low. This is where the Tolerant Hardwood Management Keys certainly help derive a proper prescription that will meet management objectives and help with management and operational planning. Using the keys also adds credibility to decisions made by the Forest Manager. All unacceptable growing stock should not be removed in one entry. Trees should be harvested in stages to release crop trees and create openings gradually, not to open crop tree crowns up too soon. This will limit weather related damages and provide suitable conditions for shade tolerant species to germinate.

If you can increase the acceptable growing stock in your stand by 20 percent in the first entry while maintaining stand structure–that is, partial canopy– and limiting weather related damage, this would be considered a successful treatment since you have more acceptable growing stock than when you started and, most importantly, multiple forest values are being maintained.

Terrain and soil characteristics, especially on sloped positions, elevation, soil depth and soil drainage will reveal hazards that dictate how the operation should be conducted in terms of when and how much crop trees should be released.

Now we will describe the three separate treatments under the Category Seven program that are available for financial assistance to help woodlot owners and contractors to grow high-quality trees. These treatments are: crop tree release, crop tree pruning and selection management.

Crop tree release is a tending, thinning activity to crowns of chosen crop trees by removing less desirable trees. The objective of the treatment is to promote growth and quality development of your best trees to obtain high-quality log status. To meet funding criteria for the crop tree release, the crop trees need to be identified and marked. Diameter of crop trees must average 15cm, with none less than 10cm. Crop tree crowns must be released on at least three sides. Basal area post-treatment must be a minimum of $15m^2$. There is no maximum basal area requirement for this treatment. A crop tree release treatment differs from a commercial thinning in the sense that not all trees have to be merchantable and the entire stand or area does not have to be worked to receive the funding. The low-value material that is not economically feasible to come out, can stay in the woods which then serves a purpose of nutrient cycling and wildlife habitat. The entire stand can be worked if the land owner wishes, however, he must remember that the $15m^2$ basal area must be maintained when complete in order to be eligible for funding. After 10 years of growth, crop trees can be released more and claimed again for funding. The rate is $3 per tree to a maximum of 125 trees per hectare and a minimum of 100 trees per hectare.

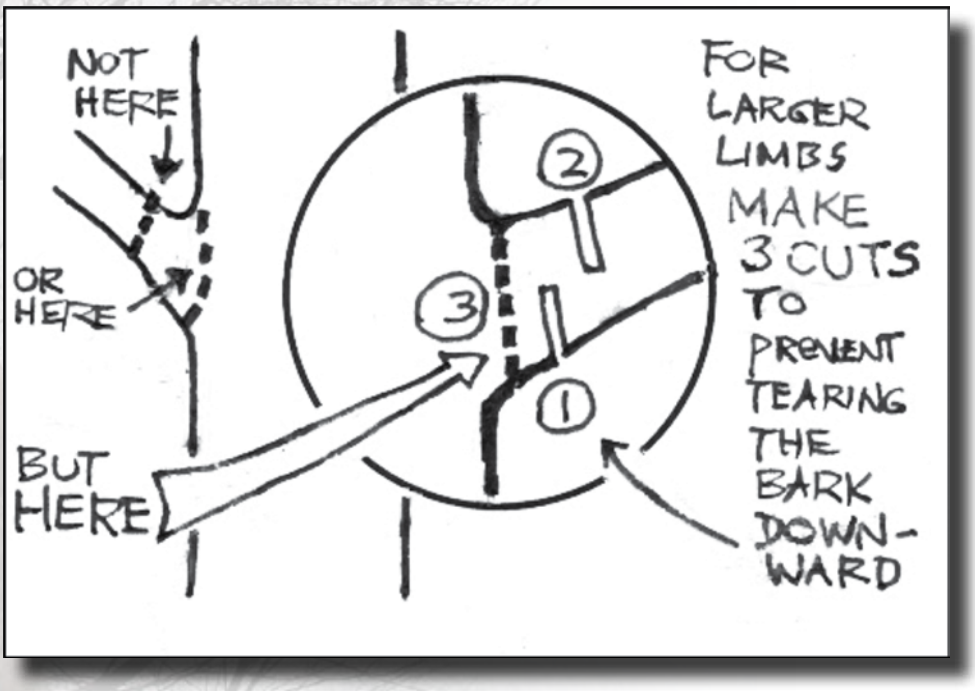
In an example of an in-progress crop tree release in a 40 year-old mixed wood stand, located on the lower side of the Drumland in Lunenburg County, the crop trees are premarked. The site has vigorous White Ash. The trees are 15m tall, vigorous, and will certainly respond to release. There are still some trees to come out for this first entry. The crop tree crowns will be opened up just enough to give it a jump in growth, but kept tight to limit possibilities of damage. This land owner in particular is cautious about taking out too much at once. He realizes he can re-enter when appropriate and re-claim in 10 years time. This is certainly an appropriate site to promote high-quality logs of both hardwood and softwood.

Another example of a crop tree release is in a 55-year old Sugar Maple Stand on North Mountain in Kings County. The Sugar Maple crop trees are identified with flagging. There were 150 crop trees per hectare released in this stand. Some high-quality hardwood logs were harvested from the west section to provide growing space for the young vigorous Sugar Maple. The management objective for this area is to produce high-quality hardwood products for the next generation.

Selection management is an activity which involves the pre-selection of trees for harvest due to poor form, quality and vigour, either individually or in small patches or groups, or a mixture of both depending on the distribution of your unacceptable growing stock. Each product harvest encourages the reproduction of new trees and enhances the growth of older trees providing a steady yield of forest products. Selection management is sometimes referred to as "harvesting the interest" because, if it is practiced properly on suitable sites, the return on investing quality development on trees will exponentially increase over time. This type of management can be quite profitable but requires a long-term outlook, dedication and patience. Selection management is specific to uneven-aged stands and requires a minimum of three height or age classes in order to

meet funding criteria. It is, essentially, crop tree release of various size and age trees. The other funding criteria for selection management includes a minimum of 80 percent stocking, post basal area must range from 16 to 30m^2, and pre-commercial thinning at 1.5m spacing is required of the young hardwood growth between 6 and 9m, and for softwood between 2 and 7m. After 10 years of growth, additional improvement work is completed and funding can be claimed again. The rate for selection management is $450/hectare for the first entry, the main reasons being the amount of low value material and planning, layout and trail placement needed. After the initial entry and claim, the rate for subsequent entries is then $300 per hectare, since much of the ground work is complete and the value of the wood extracted will increase with each entry.

An example of a hardwood selection area that has been worked for over 25 years, is a stand located on the southwest facing slope in Middle River, Victoria County, Cape Breton. The goal has been to reduce unacceptable growing stock and to increase acceptable growing stock, which is certainly being achieved. All the young Yellow Birch at the site have been tended, spaced and pruned. The overstorey trees help shelter these young Yellow Birch from the wet, heavy snow and ice. Once these stems are strong enough to handle the weight of snow, they can be fully released. The Sugar Maple on the site was selected for harvest, to begin releasing the young stems. Once this woodlot owner realized he qualified for funding, he was quite pleased due to the time and effort put into the stand over the years to increase quality.



Source: Gary Saunders, 2004

The final treatment of Category Seven is crop tree pruning. Crop tree pruning can be used with crop tree release for selection management treatments, and is used to create quality and value. The purpose is to promote clear wood by removing dead and live branches from the first 5m of the tree bowl. Pruning is a natural process, but takes many years and does not produce as much clear wood as the pruned trees. The younger the pruning is completed, the sooner the tree will produce knot-free wood and the greater the end benefit will be. It is also important that you use proper technique. Trees must be pruned where the branch meets the branch collar. It is important not to damage the branch collar or the tree bowl itself. This could cause defect on the tree and potentially introduce rot, negatively affecting the tree. When dealing with large branches it is a good idea to make three cuts. This basically releases tension of the branch when it falls from the tree to limit tearing of the bark, because if the bark is ripped the trees may not be able to seal off the wound. The best tool to use is a pruning blade put on an extended pole. The pole needs to reach up 16ft to promote that 16ft clear butt log. With a 6ft man or woman, a 10 or 12ft pole should be long enough.

To meet funding criteria for crop tree pruning, the trees must be at least 8m tall with 5m pruned of all dead and live branches. The rate for pruning is $300 per hectare and the minimum number of crop trees pruned is 100 per hectare to a maximum of 125 per hectare. That is all you get paid for; you can do more if you wish.

As examples of good pruning jobs on hardwoods, we have two specimens to consider. One is a 45-year old Yellow Birch. The branch collar is growing nicely around a prune cut at the collar. The other is a 35-year old White Ash. This Ash is extremely vigorous as shown by how well the branch collar has sealed off the prune cut just three years after the pruning.

With all that mentioned, how do we implement these treatments successfully on the ground? The key to success of these treatments boils down to three main things:

1. Pre-assessment and planning
2. Adequate layout
3. Trained and experienced workers

The pre-assessment and planning pertains to the forest inventory and permits proper silviculture prescriptions to be made that are site specific that aim to increase acceptable growing stock, and identifies hazards to be addressed during operation to ensure success of the treatment and, most importantly, that long-term site productivity is maintained.

Adequate layout of the treatments are also needed. Once you know the prescription and hazards, you might want to start with laying out boundaries of the work area. Watercourses, seepages and any other environmentally sensitive areas should be identified and marked. This should involve tree marking which is a helpful tool for implementing selection harvest, especially when high value products are involved. Now this tree marking is a separate action from actual operation. It concentrates on marking either the trees to cut or to leave, and identifies possibilities for main trails. Once the contractor knows what trees to harvest, he can effectively plan felling and placing of trails for extraction. This can make operations more efficient for the contractor to implement these treatments and perhaps more appealing to do, since much of the thought and groundwork is done. The contractor just has to concentrate on cutting the wood and extracting it to roadside.

The third thing to ensure successful treatments is trained and experienced workers. Selection harvest activities can be done with any type of equipment from horses to large machinery like feller bunchers. The limitations in Nova Scotia are the training and experience of the contractor and his workers doing these treatments. An experienced contractor knows what his operation can do, as well as what products are in the stand and, most importantly, how to optimize value when felling and bucking. So good planning and layout will make the contractor's job much easier and certainly improve the outcome of the treatments to reach the objective of growing high-quality trees.

Through our experience, both through regular business and through this outreach project, one of the main challenges woodlot owners face is locating trained, experienced and willing contractors to do these treatments. Contractors are facing increasing harvest costs while market conditions are not the greatest. The contractor needs to ensure a harvesting job is profitable,

not just a "break-even" venture. Woodlot owners pursuing these treatments themselves can usually absorb a "break-even" venture since it is seen as an investment, but a contractor cannot. So most, but not all, contractors seem leary to implement these activities because of the costs involved and perhaps the lack of training and experience. Tending and selection harvest treatments are more costly to do than total harvest, due to the pre-assessment, planning and layout involved to ensure the success of the treatments. Trails needed for access, equipment used, and the amount of low-value material that is present also dictate the cost of the treatments. It's important for private woodlot owners to realize that one cannot receive similar stumpage payment for these types of treatments versus total harvest situations. Quality improvement silviculture must be considered a long-term investment. It means greater returns in 40 to 50 years as a result of the high-value volume of wood products present, and as demand for high-quality forest products increases over time, since it is a renewable resource.

Question Period

Martin Béland, *University of Moncton*

Q: In reference to crop tree release guidelines for funding, I am surprised to see the narrow range of number of crop trees funded being only 100 to 125. How was that determined? Are there guidelines for spacing of these crop trees?

A: The main thing is that they are released on three sides. There is really no defined spacing. As far as the rate structure, it's three dollars per tree to a maximum of 125 trees.

Albert Marshall, *UINR*

Q: We are well informed on how to maximize profits. Ultimately, we must sustain ourselves. Can we not establish a certification system, that includes all areas of the ecosystem? We need to foster a cooperative spirit. The UINR emblem alludes to a metaphor we see in nature. When you observe trees in nature, if you look underneath, they are all "holding hands". We should do the same.

Jean-Martin Lussier, *CWFC*

Q: How many competing trees are removed around the crop tree on the first entry?

A: That depends on the conditions where the crop tree is growing. The prescription is to remove all interfering trees on at least three sides of that crown.

Q: What do you expect to be the return on investment on the three dollars per tree?

A: We don't really know. In 10-years' time, we hope to have more data to work from.

Even-aged Management

Dr. Ralph Nyland, *SUNY-ESF*

Even-aged Management seems like a simple idea: all the trees are the same age. They are not necessarily the same size, but all the same age. That is going to drive our decisions. In fact, some trees grow more slowly than others, perhaps because of a genetic linkage. We have to recognize that the small trees are not young. That is a key point. The small trees are the runts of the litter. And the saying goes: "Once a runt, always a runt."

When we are thinking about even-aged, we need to think about a long period of time. We call that the "rotation". The rotation begins with and ends with the reproduction method but, in between, we have the tending operations giving us a chance to regulate the degree of site occupancy, to stimulate tree diameter growth, to focus that growth potential on the trees that best satisfy the interests of the landowner. We enter this cycle at one point and we tend to think about the moment and forget what is coming in the future. The things we do at the moment influence the future. We need to take that holistic perspective and look at the whole system.

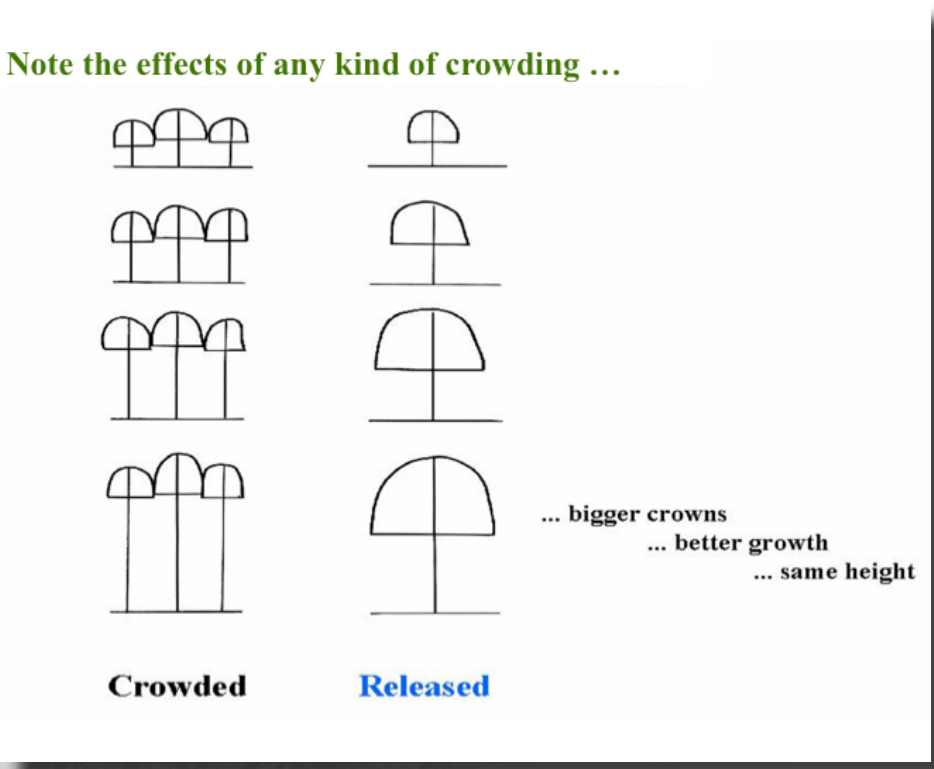
We talked previously about the silvicultural system and the three components: regeneration and tending being the two functions of silviculture with harvesting being the mechanism, the means to an end. Harvesting is the way we apply the tending and regeneration. The key feature with even-aged systems is that you never do those two things at the same time. The community is either immature or mature, and when it's immature we do the tending. When it reaches the stage of maturity based on financial or other criteria, then we regenerate the whole thing. So we need to think about the development, the financial aspects of the whole thing in the case of even-aged systems. At the point where the trees reach maturity by whatever criteria used, we will remove the entire community for the purpose of creating a new even-aged one and, as that develops, we will tend it to enhance the growth and development.

When we talk about tending, we normally think about thinning. There are other types of tending operations. We could do cleaning early on, during the sapling stage. But let's focus on thinning because that's the one where we can usually move enough product to pay the cost of the operation and at least make the treatment cost-neutral. This means the revenues will pay the cost of the operation, thus we have no investment to carry into the future.

The question is: how do we get a stand, for example, that is 60 to 70 years old to about 100 years old, with an increase in tree quality and good rates of diameter growth? Thinning stimulates the diameter growth of the residual trees. In a crowded environment, we find with even-aged stands that the trees stratify into height classes as we discussed previously, but the live crown ratios

of even the best trees in the stand will probably not be much more than 25 to 30 percent. That is fairly characteristic of even-aged stands. You go down from the dominants to the co-dominants–it may be 20 to 25 percent, the intermediates may be 15 percent and the overtopped trees maybe five percent. If we thin, essentially we reduce crowding around the crown and promote its development.

The thinning has three effects. First, it keeps the lower branches alive so as the tree gets taller, the length of the crown increases by virtue of having fixed the lower level of the base of the crown. By reducing crowding around the trees, that facilitates lateral branch expansion. So the crowns get wider. At least in hardwoods, and particularly the tolerant hardwoods, usually by reducing the crowding around the crown and illuminating the foliage in the lower portions of the crown, we also get a thickening of the foliar mass. So we get a three-way improvement: crowns that are wider, longer and denser. That results in more photosynthetic output which is translated into improved diameter growth.



To what end? If we have an upper canopy tree in an unmanaged stand, we'll find that it grows very well at first. But as that tree grows and develops, the new wood amount of photosynthate that the new wood must be laid down over a larger and larger frame, so that amount of photosynthate increases through time, the new layer of wood gets thinner and thinner. In that case we would see radial increment decreasing. If we thin around a tree and increase that foliar mass in the three ways mentioned earlier, we can increase the amount of wood produced each year, which means we can increase the thickness of the sheath of wood that's laid over the whole frame of the tree and at least maintain the radial increment of the tree. That is our goal, to stimulate diameter growth to get bigger trees faster. And if we focus that on the better trees, we get bigger, better trees faster.

The key factors that affects radial response, according to Assmann (who did growth and yield in European forests. Those who are looking for a classic book to read about growth and yield, then Assmann book is the famous one):

1. Climate–we can't do anything about that. We live within the climate that is here. We can, though, make sure that the species growing in our region are suited to that climate.

2. Soil–We really can't do anything about that. Yes, we can throw fertilizer on the site, but the studies really show that fertilization doesn't have much of an effect. We can do more by thinning than we can by fertilization, except on impoverished soils.

3. Position–This refers to the position of the tree within the canopy, that is, whether it's in the upper canopy or not.

Notice what Assmann links at the center of all this: the genetic make up of the tree. His argument would say that the trees which grow fastest are growing fast for a reason. It is because they are genetically suited to that particular combination of environmental conditions. If you move that tree to some other combination of environmental conditions it may not grow as well. But at that site, the environmental conditions linked to the genotype influence the rate that the trees grow and the quality. So there is a genetic linkage to the tree growth rates, and we are seeing more and more evidence to demonstrate this genetic linkage.

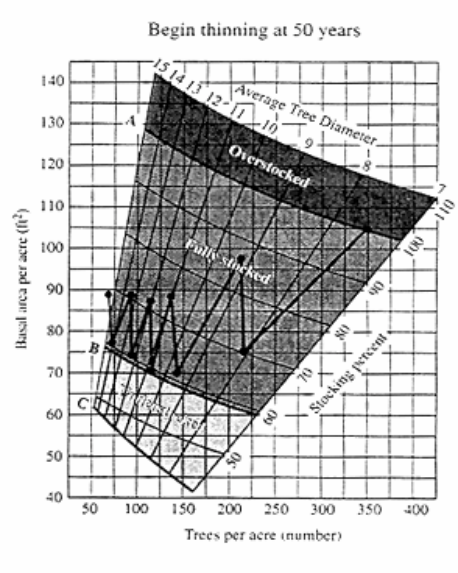
So trees grow in height and diameter. The effect of thinning is on diameter growth. It does not affect the height growth of main canopy trees. When we do thinnings, we get the three-dimensional change in the crowns and we are affecting radial increment. By choosing to favour the upper canopy trees we have trees with height that are the tallest possible at a site.

So we have recognized the dominants, co-dominants, the intermediates, the overtopped trees. The dominants and the co-dominants are the trees best suited to that environment, that are growing best, that have grown best in the past and will grow best in the future. Those are the trees we want to favour during our intermediate treatments, our silvicultural efforts. This is one of the key things to remember in any tending operations we do in even-aged stands.

The trees in subordinate canopy positions grew poorly. They will grow better after thinning, but not very well. If you take out the big trees and leave the small trees, guess what you get? Slow rates of growth as well as poor quality. So the trees we want to favour by our thinning operations are the best, and the best are in the upper canopy positions. When Lareau did regressions of growth and dbh he found that once he had accounted for tree diameter within an even-aged stand it was redundant to also plug in canopy position. It is the big trees for dominants and co-dominants and small trees for intermediates and overtopped. By taking account of diameter, by keeping the bigger trees you get optimal growth rates, development and product quality.

So we want to leave the bigger trees to get the growth response we are after, but how many trees? What do we need for full site utilization? This has been an important focus of research in the U.S., by the work that Roach and Gingrich started, and later continued by Benjamin, Roach, or Leak, Solomon, and Filip, and later still, by Marquis, Ernst, and Stout. It is a major breakthrough in how to manage even-aged stands.

If we look at the progression of trees, starting with young trees and moving to older age trees, as trees age they get bigger. That is not revolutionary. The work that Roach and Gingrich began to articulate was that, although it is hard to age hardwood trees, there is a pattern of development that is fairly predictable. As a stand gets older, there is a predictable rate of mortality. Roach and Gingrich argued that we could use number of trees per hectare as a surrogate for stand age. They developed the chart hown below. On the horizontal axis, they put numbers of trees declining from the right at young ages to relatively few on the left at old ages. That becomes a measure of age of stand, by using number of trees per hectare. On the vertical axis they used basal area. That is easy to measure with a prism. They found that for a forest community type there is a



predictable pattern of growth, what they call a "stand development trajectory", and that as stands mature, the stocking and basal area builds up in that predictable pattern. This happens across site index classes, but the poorer sites develop more slowly than the better sites. However, they all tend to follow that same predictable pattern. That simplifies our assessment.

In the original work, Roach and Gingrich published what we called at the time a "Stocking Guide" (it is now called a "Relative Density Guide"), and there were two key lines on this. The upper line, which was called the "A" line is one hundred percent relative density. It is the maximum that you can expect to have at a site for stands of different ages. Then they put on a lower line, called a "B" line, and that was the minimum judged necessary for full site utilization. So at "B" level relative density, you've got full site utilization. You're fully fixing incoming solar energy on the biomass and, at the same time, by reducing crowding, you're stimulating individual tree diameter growth. So there is the model for management. You reduce the stand to the "B" level, you let it grow up, you reduce it to the "B" level, etc., through time.

Besides volume production, we can use these lines for something else. Once you get below full site utilization you begin to see profound understorey responses. For example, for wildlife habitat management, if we wanted to increase understorey levels than we have to drop the stand below "B" level relative density.

How did they get the "B" line? This goes back to the work that Mar Muller did in Europe where he reviewed the results of thinning studies primarily from Denmark. He compared annual volume growth to the level of stocking in stand. His model included stocking levels from none (after clear cutting) to100 percent (uncut, with stands at all levels between these extremes. Mar: Moller argued that if you add a little stocking above the clear cut, you get better growth. You go up to 20 percent, to 30, you keep increasing the annual growth until you get to about 60 percent stocking. From about 60 to 100 percent, gross growth was fairly equivalent. There is a plateau there. If, in fact, I can get full production at 60 percent and, by reducing stocking, I can also stimulate tree diameter growth, why would I have stands at higher levels of stocking?

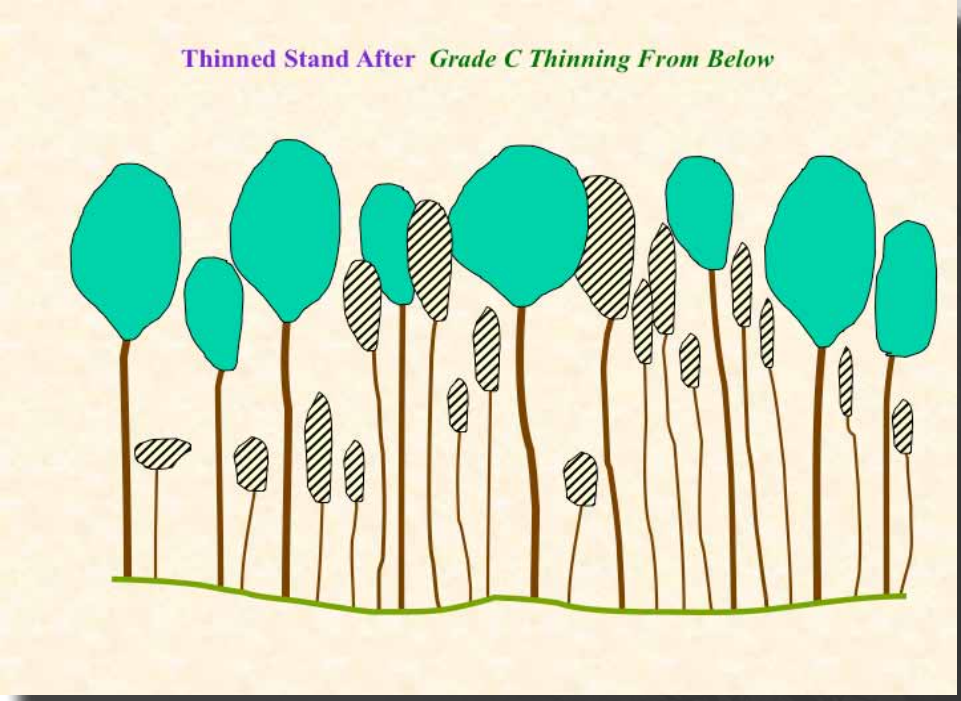
When Martin Dale and some others began looking at net growth, accounting for mortality, they found that as stands got above 60 percent and particularly when they rose above 80 percent, then we begin to see measurable amounts of mortality. At 80 percent, we begin to see mortality in upper canopy trees. At 100 percent relative density, they measured mortality at about 45 percent of gross growth. So if we cut stands to 60 and let them grow to 80, we have pretty well controlled mortality losses. We can take those excess trees and put them in the marketplace to generate revenues. In the process, we are stimulating individual tree growth to the maximum possible without reducing production per acre per year.

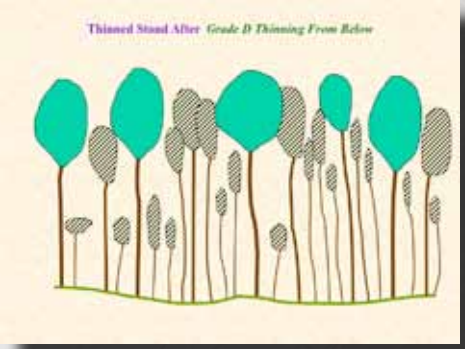
So we have ended up, as a result, with the work that started with Roach and Gingrich and was followed by several other people, identifying a "zone for rational action", a level of optimal stocking. We cut the stand to 60 percent relative density, favouring upper canopy trees, let it regrow to 80 percent. If we let it grow longer we begin to see increased mortality, so we cut it back to 60. And it happens that in hardwoods if you cut from 80 to 60 you get an operable cut. That has been true in Oak community types as well as northern hardwoods.

So let's take that idea and put it to work for thinning. So far we've said trees grow better in diameter when you thin. Upper canopy trees will grow best when you thin, and if you regulate the stocking to 60 percent relative density you can get full net production per acre per year. Now let's look at the methods for thinning, the approaches we could take for cutting it back to those levels of stocking.

First, we can look at thinning from below. It is essentially what it says, removing the smallest trees. If we look at a graph of the diameter distribution, with the vertical axis being the number of trees per hectare and the horizontal being tree diameter, then a thinning from below simply takes out the small trees. This had its development in European forestry, where there was a lot of opportunity for using small trees for cooking, for various kinds of uses. We let it drop out of the picture because we haven't had much use for those small trees, but now, as people are talking about biomass production, you could cut those small trees and put them into fuel, couldn't you? In fact, we've had an example in Upper New York where a couple of consulting foresters thinned 9000 acres from below because they had a fuel market. They got 50 tons to the acre, which supported a commercial operation. They were 70-year old stands. So, maybe thinning from below still has a role for us.

Let's look at only the "C" and "D" grade thinnings from below. In a "C" grade thinning, you cut all the overtopped trees, all the intermediates and some of the co-dominants. With a "B" or "A" grade you don't intrude into the main crown canopy. That's why I don't think we need to consider them very seriously. With "C" grade, you begin reducing the crowding in the main crown canopy. It's a moderate level thinning. We can create a diagram as a model for what our stand might look like. If we were doing a "C" grade thinning from below, we would take out all the overtopped trees, all the intermediates, and we would intrude into the main crown canopy by taking out some of the co-dominants. We can picture that, if we had a market for biomass, those small trees would be chipped and put into that marketplace. Think about the wildlife habitat though. Essentially, we've removed the shorter trees that are important to the songbirds that operate close to the ground. So there would be, in that sense, a negative effect on the songbird habitat by using a thinning from below. It is worth thinking about.

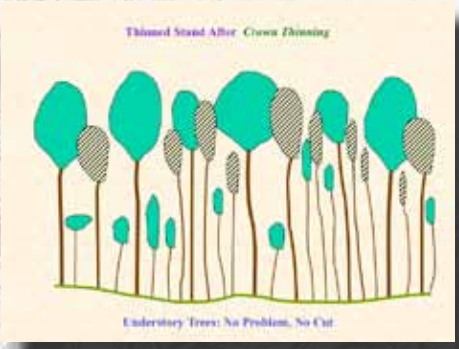




Let us consider a "D" grade thinning. This would be a little more intensive thinning. I think this would get us below 60 percent relative density in most cases. Using the same model stand, we take more trees out of the upper canopy. More of the co-dominants are coming out. If you had one opportunity to thin the stand, and you had a fibre market, this would be a heavy thinning that you would do once and then walk away for long periods of time until you apply a

reproduction method. With this thinning, though, you are probably going to stimulate an understorey response. From a wildlife habitat perspective, if you wanted vegetation close to the ground, this might be a way that you could do that. You've taken out the low cover for the songbirds, but you would stimulate browse material, for example, close to the ground.

Thinning from below reduces the spread of diameters in the stand and leaves a very open understorey. This might be useful in an area with high recreational values, where you might see the small trees as either obscuring views or perhaps being some obstruction to recreational activity.



Now let us consider "crown thinning". Crown thinning is different in that we are striving to reduce canopy crowding within the main canopy. That is our primary goal, to work within the main crown canopy. If we look at the diameter distribution, we are going to take out trees from the middle part of that distribution. The rule of thumb is this: you take out about two thirds of your cut from below the mean diameter and about one third from above, favouring the best upper canopy trees. We are looking to keep those upper canopy trees that have the best diameter growth. They have the best quality potential. In our model stand, we can forget the understorey trees. They are not affecting the growth and development of the trees in the upper canopy. One exception would be if you have an extremely dry site, like Ponderosa Pine or maybe some of the really dry Oak sites, they might affect the upper canopy. But those sites are probably not commercially interesting anyway. They are just poor sites. We really don't have any evidence to support the notion that taking out those small trees benefits in any way the growth of the upper canopy trees, so we are going to leave them there.

Notice that in crown thinning, we are going to look at whatever are the best trees we have at some sort of spacing we would like to have, and we are going to stimulate the growth of all those trees. Some of them are not ideal trees, but they are the best we have, and we are going to try and foster their growth and development so they get bigger faster. Perhaps in the next entry we take them out as part of the intermediate treatment, but we will try to favour all of the best trees we have in the upper canopy.

The third one we are going to look at is called "free thinning". This is a difficult one to describe. It favours ideal crop trees. It releases those trees and it skips areas that don't have ideal trees. I call this "crop tree release", and I think it's pretty consistent with the way we've heard that term used here. The way you go about this is you have to start by defining what is an optimal crop tree. You would use whatever criteria are good for you. An artist might find every crooked tree of upper canopy position and want those released. But a saw mill operator would get rid of those trees in favour of those, as Highberg used to say, that have a square profile, which would be ideal for saw timber production. You define first what is your ideal crop tree. Then you go out to the stand and you are going to try and look at those things. Then we must decide what we are going to do to release those crop trees. A common approach that Smith and Lamson proposed in West Virginia, was to do what they called a "crown touching" method. Any tree whose crown touches the crop tree, remove it. Whatever seems best for you, you do. But you come up with a strategy and the purpose is to reduce the crowding around those crop trees.

There will be areas where there is no thinning. These are areas that had no ideal crop trees, so we are not going to waste any time there. In a crown thinning, we would have thinned there, but in a crop tree release we are going to ignore that.

What if you had an owner who wanted to do extensive kinds of silviculture, who might say, "I'm only going to grow 100 crop trees per hectare." You'd figure out whatever that spacing would be, you'd do a crown touching method around the selected trees, and then just leave the rest of the stand alone. Or if you have someone who is interested in a more intensive treatment who might say, "I want 200 crop trees per hectare." If you could find them, you do it at that level. There are a range of ways you can use this to fit the management objectives and long-term goals of the landowner.

What is the purpose of all this? To get that crop tree growing at good rates and more importantly to keep it growing at constant rates because if we grow the tree at constant rates we get better wood quality, we have less twisting and warping and cupping. In hardwoods, the evidence says if we stimulate the diameter growth we are getting more summerwood production. The summerwood is more dense, hence we will get better quality wood for most of the hardwood uses we have. There isn't any evidence that we can grow hardwoods too fast, at least not the fine hardwoods. Possibly with a species like Aspen or something like that, you could. The neat part of all this is that we can take those excess trees when we remove them, and we can put them on the marketplace and we can generate intermediate revenues for the landowner, if we have the markets.

Ideally, you would have close to uniform spacing. That ensures that you have good light around the crowns of all trees. Uniform spacing with a wood production goal is really a key. That is the difference between an amateur and an experienced person in marking, the uniformity of the stand that they leave behind.

Basically, in thinning we reduce the crowding so that we get lateral branch expansion. We fix the lower branches. As we get tree height growth the length of the crown increases and we get an increase in the density of foliar mass, and that translates into improved diameter growth. That is our goal.

So we are getting bigger trees sooner. In a non-market environment, if a person wants to have a mature looking forest, what can we do with thinning? We can speed diameter growth, and we can get the illusion of stands looking older sooner.

At some point, though, these trees become mature, by whatever standard we use. Then it becomes time to apply a reproduction method. What are the options we have? The key in hardwoods, and I think it applies to spruce/fir as well and many other forest community types, is this: if you want to reduce the risks, if you want to ensure the presence of shade-tolerant trees within the main canopy of the next age class, you better have it there as advance regeneration. If you do not have advance regeneration, you need to build it up before you take off the old-age class. Otherwise, you run a high risk of not getting the shade-tolerant trees within the upper canopy positions. The rule of thumb: if you have abundant, well developed advance regeneration, then you can take the overstorey off in a single cut.

How many? If you have 2500 per hectare that are at least knee-high, you have probably got enough because, if you've got 2500 of that size, you've probably got another 50 or 60,000 somewhat smaller than that. It doesn't take expensive inventories. If you walk through a stand and you are aware of the abundant knee high advance regeneration, you've probably got enough. If you don't see it, it's not there.

If we have advance regeneration we can take the overstorey off in a single operation. We call that clear cutting. I'm not worried about the purists who say if there is advance regeneration, then it's not clear cutting. Let's call it, "one-step overstorey removal" if we have the advance regeneration present.

What that does is trigger a developmental pattern. At year one the development started, we increase light levels, we increase all moisture, etc. That triggers the development of this advance regeneration. It provides the environment where seeds of the less shade-tolerant trees will germinate and grow. By the third year, we've got a sea of raspberries out there. But there are seedlings beneath the raspberries. And somewhere around the fifth year, things like Yellow Birch, White Ash and Black Cherry begin to emerge from the raspberries and, as they do, they cast shade on the raspberries and the shade-intolerant raspberries begin to decline in density. Then the Sugar Maple comes up through it, given that it is there as well-developed advance regeneration. By the fifth or seventh year, we have the emerging stand. Probably by the 10th year, we find canopy closure, and certainly by the 15th year.

We must remember to tell people that this is a reproduction method that starts a pattern of stand development. It is not a harvesting method. We have killed ourselves because of that. We get obsessed with the idea that we are doing a harvesting method; we are not. We are tending and regenerating. This is a reproduction method that starts a period of long-term stand development that gets us back to tending and eventually gets us back to another reproduction method.

There are reasons we may not want to clear cut large areas at one time. If we are depending on seed dispersal, most seed doesn't go much more than one times the height of the tree it comes from. Yellow Birch and Paper Birch are the exceptions. There are some times when, because of environmental considerations or visual qualities, we may want to do progressive removals. This is where progressive strip and patch clear cutting have an advantage. There is some argument about when does it become strip shelterwood versus strip clear cutting. We won't argue that today. Let's say once you get widths of about one and a half times tree height, it is probably strip clear cutting.

Applying that to our model stand, we have areas of strip clear cuts. We bent them for only one reason: to reduce the line of sight. So we affected visual qualities. We also have patch clear cuts. These are one times tree height, about 30m across. We entered in and did one third of the stand with the idea that, once the advance regeneration gets up to an acceptable level, perhaps out of the raspberries, then we would go in and remove the next series of strips or patches. That would illuminate the initial regeneration and stimulate its growth. In two to three entries we would have the whole area cleared. Now, the neat part for non-industrial owners, it takes the reproduction method revenues and spreads it out over two or three entries. For them, it extends the cash flow associated with the reproduction method. In an industrial setting there is

probably no advantage to this, unless there is some environmental or habitat or other kind of gain that would come from it.

The key in applying one-step overstorey removal is to have that abundant, well-developed advance regeneration. If you lack it, then you need to do something else. That's where the "shelterwood method" comes in, in the case where the regeneration is not adequately developed. There may be other reasons but that is the technical one that is of importance. It may be that you have tree seedlings present but they are only small. The reason is the evidence suggests that if you don't have that well-developed advance regeneration, you may not get the shade-tolerant species into the main canopy positions. They will be overwhelmed by the Yellow Birch and the White Ash and the Black Cherry.

With the shelterwood method, when you choose trees to leave they are the phenotypically elite. They are the best you have. You are going to reduce the stocking to at least 50 percent relative density and perhaps down as low as 35 percent relative density. What you are doing with that is creating an ecologic void and the void will get filled. We are depending upon those elite trees left behind to provide a source of seed, to mitigate the change in environmental conditions such that we get better survival and development of the new cohort. We are trying to space those out uniformly so that this effect of seed dispersal and environmental mitigation occurs throughout the stand. Now, there are some philosophies about clumping these trees. If that serves your purpose, fine. But the historic approach, and the safest one, if you need to modify environmental conditions, strive for uniform spacing. And to ensure good genetic quality, we leave the best phenotypes as your seed trees.

In an example of shelterwood method, once that new age class gets up with maybe 6, or 7000 per hectare, free to grow up out of the raspberry bushes, then you can take the overstorey off. We have found that occurs somewhere about the sixth or seventh year. By the 10th year, we have trees that are three centimeters and bigger at breast height. We have found that if you wait beyond that point to do the overstorey removal, as you do logging you either hit those trees and uproot them or break them off about chin high. Then you have really lost them. If you take off the overstorey before the largest trees of the cohort get to be about three centimeters, they are still pliable and flexible. You bend them over, you may get stump sprouts out of them or they will spring back to an upright position. We have a window of opportunity to talk about from about the fifth or sixth year up to about the 10th year. Then we take the overstorey off and we have a new age stand. By about the 20th year, you will not be able to tell whether you are in a stand regenerated by shelterwood method or clearcutting method. They will all look the same. It is a developmental process. We are starting a process by having small trees early and a lot of them. Then, through time, we use our tending operations to reduce the crowding, to stimulate growth until we get the trees to a mature condition by whatever criteria you define. Then we will apply another reproduction method cutting. We will move through this cycle at perhaps century-long periods of time. If you do early tending you might be able to get them through an 80-year cycle, depending on what size tree you want to grow.

There is another alternative we can use here and that is "shelterwood with reserves". Some people call this "irregular shelterwood". I tend to call it "reserve shelterwood system". That's the historic thing. Some people today are distorting the language by calling this clear cutting with variable degree

retention or something similar. But let us go back to the technical language and call it reserve shelterwood method. The notion here is that you need to reduce the stocking of those seed trees down to a very low level, maybe 30 or 35 percent relative density. When the time comes that the new age class is free to grow, you just leave those overstorey trees in place. So you get a two-aged stand. You get these reserve trees growing into the future at very high rates because they are fully exposed around the crown and you get the new age class developing under them. To pull this off, you must keep upper canopy trees of high vigour and sound characteristics. You could leave cavity trees there and that is one of the ways we can make some modification. If they are vigorous and sturdy trees, we can leave ones with cavities that will provide us with a source for those species that depend upon those cavities. It gives an interesting two-layered effect. The thing we have noticed, for example, is that those big trees have the structural characteristics where the Goshawks can build their nests. For the first 25 years, the understorey is so dense those animals cannot fly through the forest. By about 25 or 30 years, stem density is reduced so they can maneuver and that understorey is no longer a haven for small mammals. So there are the Goshawks perched up there having a good sleep at night, zooming down and filling their bellies during the day. It is interesting what we can do with this technique that is designed for regenerating trees for timber production to also address some habitat conditions that are quite important with these large, avian predators.

We can use this technique to alter the visual qualities. My cohort, Robin Huffmann who is a landscape architect, has pointed out that trees look big because they are standing next to small ones. If you put even a moderate size tree next to a small one, it looks huge to most people. So one of the things she sees in this is the illusion of bigness. That stimulates positive responses in people.

At some point, those big trees have reached maturity by your definition and then we have to intervene in the stand. We have to remove the old trees. We have to reduce the understorey to a very low density to stimulate a new class. Now we are into two-aged silviculture. We need to think carefully about whether this is really going to work. If you are doing this at half rotation age, you are doing it at 50 years of age and, unless you have a fibre market, there is no way you can reduce that in a commercial operation. The other factor is, as you drop those big trees, you are going to smash up a lot of the understorey. So perhaps you need to wait until the younger age class is, in height, up to the level of the main crown canopy, and then you can drop them through the canopy of the small trees. That is probably not at 50 years, it's probably more like 70 years which means you are into a 140-year rotation. So before you get too excited about this, think it through. It's been praised, but no one has done it and no one has really figured out what is going to happen in those circumstances. But you do get this effect and it does help visual qualities. It profoundly changes the habitat conditions. If we can pull this off, there are some ways this is going to be very useful.

What about the ecologic effects of even-aged silviculture? Let us look at some of the important changes that are heavily geared towards the wildlife habitat. When you do a reproduction method cutting in even-aged, you are putting tons of that coarse, woody material on the ground, presuming a saw log market. If you are doing whole tree harvesting, it will be zero. But here is the transformation we have seen in our stands where there is a saw log market: at

20 or 30 years we still have a lot of this coarse, woody material on the ground but by 60 years, it is essentially gone. The input of coarse, woody debris is heavy at first but then it decreases. It probably won't start buildiing up again until nearly a century. Remember, for wildlife you need to have sizeable pieces of coarse, woody debris. Little sticks don't do much for us.

If we look at seed and fruit production, during this time when we have raspberries and a tremendous amount of herbaceous material, maybe some shrubs, we get tons and tons of seed and fruit production. There are many animals that benefit from that. But, once we get canopy closure, that is all gone. Then we go through decades without any seed production. Probably around 50 or 60 years we begin seeing some. Then it builds up through time. Remember, there are minimum ages when trees begin to flower and bear fruit. The more shade tolerant, it seems to take longer.

For large tree cover during that time when we have the reserve trees in place with shelterwood, method we still have a high degree of large tree cover. Once they are gone it is all down to zero and then it takes decades to build up that large tree cover, the type that is suitable for the Goshawk nests, for example. It takes 80 or so years to get those trees to a suitable structure where those creatures will build their nests in it. So we have to remember this pattern of development, and when we use the even-aged reproduction, it is a long time before we get mature looking forests.

For low cover and concealment, it is huge, really huge, at first. The deer people love this because there is a variety of browsable material close to the ground. The folks who are interested in the song birds that depend upon brushy conditions, and the small mammals that benefit from brushy conditions, the first decade is hog heaven. But once you get canopy closure, that all crashes. Then you have these long periods of time with nothing close to the ground. Until you get into the eighth and ninth decade when, in an unmanaged stand some upper canopy trees begin dying, little spotlights build up of understorey. In plant species diversity, in that first decade, you have zillions of plants out there. You have extremely high levels of plant species diversity because of the herbaceous diversity. But then it will level down, but compared to uneven-aged system it is pretty high. We have, in the first three or four decades, as many as seven and nine tree species out in some of our even-aged stands. The additions are the less shade tolerant things that are relatively short lived, like Aspen and Paper Birch. There will not be a useful cavity in the stand for eight or nine decades unless you leave them there. So this is one of the ways you might be able to use reserve shelterwood method, is to leave cavity trees that will also be perches or nesting spots for Goshawks. You can make those changes if you think about them and they are important to you. Don't forget the cavities. We will lose a lot of species without them.

There are ways to provide that habitat, such as naparean zones and set backs, but unless you have cavities, you will not have a whole host of species that depend upon them. So in these even-aged reproduction methods, we can create something like a traditional stand, or we can modify it by perhaps leaving some cavity trees, perhaps leaving some snags or leaving some residual trees with good characteristics. In some cases, in the Pacific Northwest, they climbed some of those Douglas Fir trees, strapped dynamite around a $3000 tree and blew the top out so there was a place for birds to perch. That seems extreme but if that is important to you, do it. Spend the money. We can diversify these things, it just takes some creative thinking.

What does it look like across the forest? If we were to take a walk through it, we would see a lot of edge. If we plan this right there are a lot of structural differences from one stand to another. By proper planning, we can compensate for the lack of low material close to the ground here by having it over there, or the lack of mature trees here by having it over there. We call this "horizontal structural diversity", the differences from one stand to the next. Edge is defined as being the interface between two stands that have distinctly different amounts or characteristics of vertical structure. This is really desired for many wildlife, like deer and elk

That is a quick overview of even-aged silviculture and management.

Question Period

Peter Christiano, *Fine Wood Flooring and Lumber*

Q: In considering releasing crop trees, how do you determine what the spacing should be? At what point is there too much spacing and you might have to start dealing with things like epicormic branching?

A: The best situation is to leave the high-vigour upper canopy trees if you want to avoid epicormics. In the "crown touching" method, you remove every tree that is touching the crown. The spacing should be based on your management objectives. Work for uniform spacing.

Martin Béland, *University of Moncton*

Q: I would like to hear you discuss crop tree release.

A: The earlier you intervene, the bigger the tree at any age. But there are problems with early intervention. The rule of thumb is, wait until you reach mean merchantable height, then release. Different owners have different objectives and you have to come up with a scheme to reach the objectives.

Brendan Hemens, *DNR*

Q: We have a lot of Red Maple as stump sprouts, so I expect a lot of these treatments would result in stump sprouts? Also, we have a lot of Beech as advanced regeneration down low.

A: We know with stump sprouts and clumps, they tend to self thin. Seems to me the best thing to do is just zap them. They can be removed by brush saw, chain saw or herbicide. If you use herbicide, you need to have people who know what they are doing, who know the rules and don't bend them. It has to be used at the recommended dosages and rates. With Beech, the only good Beech is a dead Beech. When we remove that understorey Beech, we stimulate other advance regeneration and create important habitat. Beech simplifies the ecosystem. By taking it out, we make the ecosystem more complex. Glyphosate is the best way to get rid of it. This is done by mist-blown or stem injection. You can remove it with brush saws but it is much more expensive. It must be cut low to the ground or you will get root suckers.

Jean-Martin Lussier, *CWFC*

Q: What is your opinion on the slow shelterwood approaches?

A: At the end of the cycle, we've got advanced regeneration. If there is some non-market reason that this process would satisfy the objectives, then do it.

Bob Bancroft, *Biologist*
You were talking about Red Maple. They may be useless from a forestry point of view, but it is a habitat for wildlife.

A: You know, the sad part of this world is we have very good wildlife biologists and very good silviculturalists, but we never talk. I think if we got together, we would realize that we can make decisions for habitat but that can also be commercially viable.

Unidentified
Q: Is there a season that's better to take the overstorey off?

A: In December, you can see and log more efficiently. The ground is frozen and you are protecting the site a lot. If it's not the winter, then the dry part of the summer.

Q: Is the Leaf Area Index still used?

A: That never impressed me because it is an extrapolation. I use the simple method.

Ed Swift, *CWFC*
We found we never got Yellow Birch back without scarification.

A: I'm not convinced of that. We found we got plenty of Yellow Birch without scarification. You might have to ask yourself how much Yellow Birch do I really need?

Rob Sharkey, *Trout River Environmental Committee*
Q: You mentioned that after 80 percent relative density, you are seeing a 40 percent mortality rate, and you wouldn't manage past that. It seems to me that is a lot of coarse, woody debris that is not making it to the ground for wildlife habitat?

A: To be useful for wildlife, the debris must be at least six inches by six feet. In a lot of cases, it is smaller trees that are dying so you are getting a lot of biomass, but it is not useful for wildlife. I was wondering, could you create a surrogate for useful coarse, woody debris by felling smaller trees and strapping them together?

Q: In regards to herbicide, is it something to use considering the future from a wildlife and habitat perspective?

A: It is not something we should approach lightly. The most common herbicide in use today is Glyphosate. Glyphosate breaks down quickly into common compounds. Once it's used, you can come back and you can't find it. Also, it only affects plant tissues, not animal tissues. I think the bigger issue to consider in using Glyphosate is, if we change the habitat characteristics, this can affect wildlife. At the same time, if a person doesn't want to use herbicides, there are alternatives. It might cost more, but do what you are comfortable with.

Mark MacPhail, *UINR*

Q: We know there is a correlation between density and age. How do you judge the age of a stand without using an increment bore?

A: We have stocking guides, but you would have to know what is the rate of development for your sites. You can come up with a pattern based on number of trees per acre.

Ed Swift, *CWFC*

Q: The thinning methods you talked about are difficult with the current mechanization, especially on first entry. The boom is just not long enough. Most thinning is done on the trails.

A: The concepts we talked about are really on the between-trail space. On the first entry, be careful and plan out your logging. If you've got a fibre market, do a thinning from below. Grab it all up. That is why we need people who are knowledgeable.

Disadvantages of Diameter Cutting

Dr. Ralph Nyland, *SUNY-ESF*

This is historically one of the most commonly used harvesting methods that we have. The question we need to ask is: where is our attention focused? Is it focused on instant and immediate cash, or is it focused on long-term management of systems and sustainable forestry? That, ultimately, is the question we are looking at.

Conservation. Traditionally, it is an economic term. It is a question of when we use resources and how much. Perhaps the important aspect of this is whether we use resources with an eye to the future or just to optimize current benefits. It is this seven generations thing. Is that important to us? Is sustainable forestry, a long-term perspective important or not? Contrasted to that is exploitation. That means using resources without any concern for the future, focusing on right now. It is like going to McDonald's and filling your belly with this gorgeous tasting thing and then, when you get older, you realize your arteries are just filled with this junk that is plugging them up. So you start spending a lot of money on pills to get rid of that junk. The solution is not to eat that stuff in the first place. That is what we are talking about: wise choices or exploitation.

Conservation and silviculture is what separates forestry from exploitation. If we are practicing silviculture we cannot be exploiting anything. We must be thinking into the future and for the present. We have to put the two together, that what we do now is setting up the future. That is why we must get the point that forestry focuses on either tending or regeneration. You are focusing on what you are leaving or creating. The products you get come from that, and they should be abundant and adequate and pay good returns if we practice our silviculture. Remember that a primary function of silviculture is control, control over stand development. And remember at the same time, that we need to be cognizant that whatever we do today has to be efficiently done, it has to be cost effective, it has to be meshed in with other uses that are going on. We must support the idea of protecting the site, protecting the trees, of salvaging when things get out of hand. More importantly, we must support the idea of properly managing density and condition of trees so we minimize mortality and instead, take those trees and put them into the market place where commodities are important. When we use a non-systems approach we are really relaxing control.

We are not exercising control, we are simply taking out. That means that the outcome is unpredictable. We have no way of knowing what will come from a diameter limit cut. We used to say: let us compare diameter limit cutting to silviculture. When we started studying that, we realized diameter limit cutting is not one thing. It is a whole range of unpredictable conditions left behind, depending on what you set as your limit and what is the nature of the stand you start working with.

To put it bluntly, what we are seeing is the "greed factor", the importance that people have attributed to what happens right now without a thought for the future. We must consider the idea of whether we are going to use things now with an eye to the future, or whether we are going to use things now for whatever purpose we have at the present time.

What are the consequences? Let us look first at even-aged stands, then we will go on to look at uneven-aged stands. We can just review a few key ideas with even-aged silviculture. Remember that with crown thinning, with free thinning and with thinning from below, we are putting the focus of the future on the trees of upper canopy position that have the large diameters; the trees that have grown well on that site in the past and where the evidence says they will grow well in the future. We are trying to favour the trees with those desirable characteristics. It is like putting them in the bank and letting them increase in value, knowing that at some point in the future they will be much more valuable because they are larger. The importance of "grade" has been mentioned at this conference. In hardwoods, something like 40cm is the minimum size for a grade one tree. If you cut a grade one tree, you get two thirds one common of better lumber. One common better lumber is where you make money. You lose money on two and three common lumber. If you cut a grade two tree, you get maybe 50 percent one common better, at best. The figures are more like 35 to 45 percent. You lose money. If you cut a grade three, you get perhaps 15 to 20 percent one common better. You lose a lot of money. So it just makes sense that if you want to maximize cash flow, you have got to have these big diameter trees.

15-year post-thinning diameter growth of sugar maple trees in different initial crown positions

	Crown position	15-year total	Annual
		cm	
Keep these	Dominant	7.57	0.51
	Codominant	4.96	0.33
	Intermediate	3.45	0.23
	Overtopped	1.75	0.12

Nyland et al. 1993

Consider the growth figures that have come out of our plots. These are 15-year diameter growth. The dominants are roughly 7.6cm in a 15-year period, the co-dominants about five centimeters. With the intermediates, we have about 3.5cm, and only 1.75cm for the overtopped trees. Size makes a difference in even-aged stands. Remember: once a runt, always a runt. The bigger trees are the ones that will grow well into the future, and if you take them out, you have left a stand where the trees do not grow well at all.

Marquis had similar results in northwestern Pennsylvania. He expressed growth as a percentage of what you could get on dominant trees. On a chart, he showed an upper line with the dominants being at 100 percent. At 10 to 20 years, you get about two thirds as much growth out of a co-dominant, about half as much for an intermediate and about two fifths for an overtopped. At 40 or 50 years, the intermediates are only one third of the growth rate of the dominants, and it is only 15 or 16 percent for the overtopped trees. If you take out the big trees, you are going to get about a third to 15 percent of the growth that you could have gotten by leaving the better ones. That is a key to the difference between silviculture and diameter limit cutting.

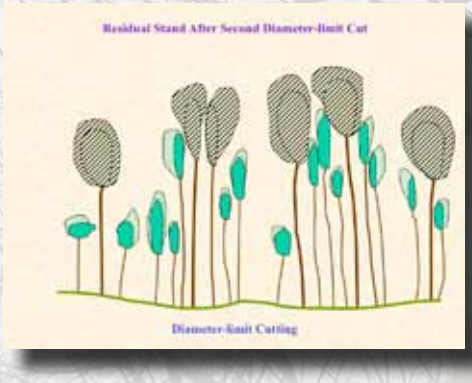
We have figures from the work in our group. We found that in the 70 to 75-year old stands, the overtopped trees were growing in diameter growth at about a quarter of the rate that the upper canopy ones were, and half for the intermediates.

We can see where this is heading. Chuck Maynard, a tree improvement guy, says that diameter limit cutting is like going to the horse races and shooting the winners and putting the losers out to stud. It is a profound statement. That is what we are doing with diameter limit cutting. That is what the numbers show. Removing the upper canopy trees reduces the production potential of a stand. With crown thinning, free thinning and thinning from below, you focus that growth on the trees that have potential for maximum growth and maximum quality. The trees in the inferior crown positions do not have very good quality. They do not heal over the branch stubs quickly enough. They often have poor form. That is what you are trying to grow if you use diameter limit cutting on even-aged stands: more pulpwood.

Diameter limit cutting removes the biggest trees and it releases the runts for future growth and development. The method is simplistic, easy and cheap. You don't even have to get off the feller buncher. Just say, "Cut the big trees."

We can do an imaginary diameter limit cutting on a model stand. We cash in the big trees. There is a notable patchiness in what is left behind. That characterizes stands that have been given diameter limit cutting. The big trees do not occur at uniform spacing. So you end up with this patchiness with some places being really exposed and other places the trees are very crowded. If they are crowded, of course, they are never going to grow as well as if you had uniformly thinned around them.

We do know that the remaining trees will get bigger although they will get bigger slowly. So eventually we want to come in and do a second diameter limit cut in this stand. We will find that with the first diameter limit cut we get high amount of revenues, you get good volumes. You come in for the second one and the volume isn't there. So what do we do? Well, we can lower the threshold cutting diameter. Now we have more uniform volume yields.



When you come in for the third time, it is hardly operable. An example was a 70 to 75-year old northern hardwood stand, Sugar Maple, White Ash and Black Cherry with some Red Maple. In a diameter limit cutting, they have taken the big trees out and left the little ones to grow. That is a common saying: "Cut the big trees and leave the little ones to grow". This is horse feathers. They don't grow. It is a common misconception with landowners. In this example stand, the Black Cherry and White Ash are gone. There is patchiness and small trees. The quality is degraded. There is no control over stocking and density. Comparing this to a stand that was given three thinnings from the age of 70 to 75 years, by age 100 there are trees up to 22in in diameter and a lot of veneer quality pieces.

How do they compare in yields? We can take real stand data and through simulation apply two scenarios to each stand. In one case we can simulate a crown thinning which starts at around age 63. We follow after 15 years with another crown thinning. At age 113, we regenerate the stand. In the other case, we do three diameter limit cuts at the same time periods. With the thinning, we are controlling conditions using the relative density guide; cutting it down to 60, back up to 80, cutting back to 60 up to 80, the sawtooth function portrayed on the stocking guide. With the diameter limit cutting, we are going to take out all trees 30cm and larger because when we see diameter limit cuts in these stands, they are taking out anything that makes a saw log. With ice and snow damage, the heights never get much above 12m, even for trees over 40cm. So we will

base volume estimates on those heights. Let us look at the effective yields from when we start thinning, or start diameter limit cutting at age 63 and then end the rotation at age 113. Remember, statistics lie and liars use statistics, so look for major differences and overall trends, not for specific details.

The test stands …

Stand	m^2/ha	#/ha[a]	DM[b]	Relative density
1	24.1	751	26.4	103%
2	27.7	1467	27.2	92%
3	24.3	1195	27.9	104%

[a] Trees ≥2.54 cm dbh.
[b] The diameter at the mid-point of the distribution of basal area, for trees ≥15 cm dbh.

After Nyland 2005

In sample stand number one, we are getting about 1.3 times more saw timber volume (this is only board foot volume) from the crown thinning. In addition, with the crown thinning, we have taken out about 21m^3 of pulp wood.

In stand number two, it is about 1.2 times more, with 6m^3 of pulpwood, with crown thinning over diameter limit cutting.

In stand number three, we see the same pattern; 1.25 times more volume with crown thinning versus diameter limit cutting.

With thinning, about 70 to 75 percent of the total volume came out in trees at least 41cm and larger. Given we have kept the best trees, that gives us the potential for high-grade material. That is what influences the values from a financial perspective. When looking at the diameter distributions, you can see you never get those big diameter trees with diameter limit cutting. The first ones that you cut are the largest you will ever get. Any grade recovery you get comes from taking out Black Cherry, White Ash and the larger Sugar Maple on the first entry. They are only still grade two trees at best.

Now, let's go to dollars. We will base our figures on 2003 market conditions and make a couple of assumptions, firstly, that the tree would be the highest possible grade for its diameter. That is optimistic with diameter limit cutting since we take out the best and the understorey trees never do become grade one. The stumpage prices are based on tree grade and another assumption is that we are only dealing with Sugar Maple. This is a simple assessment. We also assume that the landowner will hold the land and that he will pay mortgage and maintenance costs. We are only looking at the change associated with the growing of that timber. It is not an analysis of whether this is a good investment in forestry. Rather, it asks: What is the difference in value growth from stands under these two scenarios? It is a very simple kind of financial assessment.
In stand one, the thinning gave us 200 percent more value over diameter limit cutting. All of these figures show that for the rotation long period of time, we get a positive present net worth value for five or six percent. Looking at the simulation, the stands with diameter limit cutting have the greatest current value. So you have to realize the assumption for this analysis is that when you take your revenues out you reinvest it in an alternate investment that pays you that much. If you take the money out and buy a car, the assumption is gone. If you take the money out and give it to stock holders, the assumption is wrong. The assumption also is that if you take the money out in the first cut, you are willing to work with the stand that pays you nominal amounts of cash flow into

the future and at the end of the period you have to make major investments to rehabilitate that stand and get another one going. You have to think about that when you look at the numbers. You want to look for the maximum value? Yes, you've taken all the value out at age 63, put it in the bank or stocks at eight percent. If you do that, if you are concerned about cash flow for a non-industrial owner, you do far better with the thinning and you end up with at least a six percent return on investment.

Initially, you will get four and a half to five times more volume with diameter limit cutting. You are cutting all the volume that is out there. So it has to be more. And you get four to five times more revenues with the first entry. Over the rotation, you will get only about 80 percent of the total volume yields. You will have only about 10 to 15 percent of the volume in high value saw logs and only about half of the revenue as cash flow. That is what you have to mesh with the return on investment figures.

VALUE OF SAWTIMBER YIELDS

STAND	D-LIMIT	THINNING	LONG-TERM THINNING GAIN
	---------- $ /ha ----------		
1	$ 10,836	$ 21,696	200%
2	15,645	28,477	179%
3	13,847	24,347	176%

There are some additional things. As an example, in a stand with White Ash and Black Cherry, those would be in upper canopy positions. You do a diameter limit cutting and they are gone in the first entry. So you have simplified the species composition. The only tree we have in our northern hardwoods in New York that produces hard mass is Black Cherry. If you are concerned about the habitat and hard-mass production, you get rid of the Cherry and you have destroyed that habitat component. And you have left a patchy stand, one with lower value in individual trees and lower growth rates of individual trees.

Some other factors are: you are not controlling tree quality. You get patchy distribution. Because of that, you get inefficient use of growing space. Now we have some information which shows that in stands given repeated diameter limit cuttings, there is a higher proportion of rare genes within the trees that are left, and they are associated with poor quality and poor growth. We have that data now from all this work with these models. It is dysgenic in even-aged stands. The trees you get at the end of the rotation are weak and poor, they are not good seed producers. Even the amount of seed production would be degraded by repeated diameter limit cutting. There are a whole bunch of opportunity costs associated with non-market values that you have lost by this. The summary is: little control, little consistency, little long-term benefit but a high amount of short-term immediate gain. That is the choice.
Now we can look at uneven-aged stands to see what happens with them. You know the story about uneven-aged silviculture. If we do balance the stand, we get consistency through time. You can go back into that stand at fairly regular intervals and get fairly regular amounts of volume and value from the stand.

In uneven-aged stands, essentially diameter limit cutting removes the older age classes, and that is important to remember. The genetic potential of the younger age classes is still there. You may be releasing trees which still have a good potential to grow. But you are not doing any tending in those young age classes,

so you will have these areas with a high degree of crowding. While there may be a growth potential there, because of the crowding you may not see that expressed in diameter growth of the trees that remain. You are not balancing the age classes. You bring this kind of transformation, taking out the big trees. But remember, those younger trees do have this potential to grow, and that is going to be a huge difference in the effect of diameter limit cutting in truly uneven-aged stands–not stands with uneven diameters, but truly uneven aged stands. The younger cohorts should have in them trees with potential for growth.

So you are not controlling age arrangement or the diameter distribution or the spacing between trees. You are not optimizing the growth of individual trees or upgrading the quality or the patterns of regeneration. There was an example of a nice uneven-aged stand that received a diameter limit cut. Twenty-five years later, what was dominating in the stand? Beech. Beech Bark disease went through. The stand was degraded. There is the change in character of the stand. Actually, diameter limit cutting in uneven-aged stands tends to give you something in the end that looks quite like an even-aged one. You have reduced the number of age classes and often you get poor regeneration because of interfering plants that form in the patchy areas. You end up narrowing the diameter distribution through time.

Let us look at the effect on yields. For this example, I used six different stands, and started to monitor them shortly after a cut. We started with the residual diameter distribution that was in those stands after the last entry. We are going to use that to simulate their growth through a series of entries, and and at the end of each cutting cycle used that same structure or cutting pattern that was originally used and repeat that. Based on having measured the stumps from the first cut, we know what they took out and what they left behind. We can evaluate multiple entries across the period of about a century to see what the effects are from repeating the same cutting strategy.

The patterns would be as follows: in one stand, they removed all the trees 36 cm and bigger. For the simulation, the cutting interval would be 20 years, at which time we can go back in and make another operable cut. An operable cut would be 2500 board feet to the acre. In the other two stands, all the trees 41cm and larger were taken and, by virtue of different structural characteristics, we were required to use a 25-year cutting cycle for one and 30 years for the other. Three of the stands were selection system stands which are structured using Arbogast diameter distribution. In each of those cases, we could use 15-year cutting intervals and still get more than an operable cut, so my projections there were for 90 years.

Looking at the results of the three diameter limit cut stands, we notice that the percentage in trees 41cm and bigger is quite variable from one stand to the next. That depends on the structural characteristics, primarily how many trees were present just below the threshold cutting diameter. In some cases there was a huge movement of trees from the smaller sizes into those classes, and the long cutting cycle with that resulted in improvement of the yield of 41cm and bigger trees.

In the selection system stands, we notice that the yields are generally higher and we are getting about 90 percent of the yield in trees 41cm and bigger. You can begin to anticipate what is coming with the financial assessment in these cases.

Now, because they are different intervals of time, it is better to annualize things so that by putting everything under a "per year" basis, then we can make a better comparison. The annualized production from diameter-limit cutting was about 2.5m^3 per hectare averaged over the three stands and about $306 per hectare. We can note a level of variability that is associated with that. When looking at the three selection system stands, they averaged 2.9m^3 per hectare per year. The variability is about half as much from one stand to the other. And now we have about $435 to $440 of revenue per hectare per year from the selection system stands.

Put it together and the difference per hectare per year is about six tenths of a cubic metre of wood and about $131 a hectare in the difference. $131 over a hundred hectares, that is a lot of money. If you own a million hectares, that is a ton of money. When we looked at the present net worth calculations, (the same basic assumptions as for even-aged stands), every stand gave us the eight percent and the selection system stands consistently come out high. In uneven-aged stands, the result is undisputable. You are doing better in present net worth and in cash flow by using selection system.

It is true that with diameter limit cutting in uneven-aged stands, you get greater saw timber removal with the first entry. You get higher immediate revenues. But you are leaving a low residual value. You are leaving very little standing value in the forest. That is what gives the century-long financial analysis a positive twist. You are not leaving any value to accrue in the forest. But over the century-long period of time, you get only about 80 percent of the volume through diameter limit cutting. You get one and a half to two times fewer of these high value logs, and 70 percent as much annualized value in cash flow as results from selection system silvicutlure.

So, if you are thinking about sustainable forestry, the data for uneven-aged stands shows that you gain by cutting across the diameter classes, establishing that balanced condition, and going to those circumstances that gives you sustainable production. Same as before, you get more regular, predictable, controlled conditions, better quality and better control over opportunity costs when you do silviculture as opposed to diameter limit cutting. So that is the difference.

How do they compare in general? With diameter-limit cutting you get less long-term volume. You get fewer large diameter trees. For money, you get more first-entry cash but lower long-term revenues from diameter limit cutting. That is true for both uneven and even-aged. You make the choice.

Question Period

Martin Béland, *University of Moncton*

Q: I was surprised to see that there was more difference between the diameter limit cutting and the uneven-aged selection cutting than with the thinning, because in uneven-aged management the small trees still have some potential to grow. So how do you explain that?

A: I think the difference is what you leave behind in residual value and that affects the outcome. I try to look at both cash flow and return on investment. What are the assumptions you make going into the analysis? Are you committing to long term or not? Are you taking the revenues and reinvesting it?

Bruce Chisholm, *New Page*

Q: I noticed in the past that a lot of companies in Maine were still doing diameter limit cutting. Is this still going on a lot in the Northeast?

A: The most prevalent thing you see in the woods is diameter limit cutting. It has been the saddest part of my career, to observe that forestry has mainly been about valuing and efficiently removing lumber.

Jean-Martin Lussier, *CWFC*

I think your analysis would be even more effective if you showed the fourth entry. There is the indication that you can keep carrying this over and over but it's not true. The costs of rehabbing these stands has to be taken into account.

A: I believe you cannot sustain diameter limit cutting. We haven't been through a full rotation so we can't say definitively that silviculture works, but I think the evidence is there to support it.

Q: In the field we don't see strictly diameter limit cutting. If there are ugly trees they are left behind.

A: That is one thing that has not been studied, these trees that are left behind and what that means for habitat. We know it is uncontrolled and unpredictable. So if you have specific goals, you can't predict what will happen.

Russ Waycott, *New Page*

Q: Many landowners find themselves in need of quick cash flow. In those situations would you recommend a clear cut or diameter limit cut?

A: I believe we have been remiss in not discussing things with land owners. Maybe we could recommend a shorter rotation, maybe a patch cut. We need to spend time on the job we are supposed to be doing: consulting. If in the end it is decided that the land owner needs to liquidate, then help him to do that with minimal impact on the environment. But offer alternatives.

Q: In the typical unmanaged stands that you run into, do you find more of them suitable for uneven-aged or even-aged management techniques?

A: The concern I have is that uneven diameters are considered uneven-aged. But you have the situation here where, at one time, a lot of the land was cleared for agriculture. Now the forests are back, so you have a high proportion of even-aged stands. If they are treated as uneven-aged stands, you will get poor results. We need to calibrate our eyeballs so we can identify what is even-aged and what is uneven-aged.

Martin Béland, University of Moncton

Q: In the silviculture literature in Quebec, we find the term "succession cuts". Do you make a relationship to diameter limit cutting?

A: Some people will say, if you have a two-aged stand and you cut off the older class, isn't that diameter limit cutting? In a sense it is, but on the other hand, your purpose is to establish a new age class. So the goal is different. It has been done after an evaluation. Forestry ought to be positive.

Ecosystem Hardwood Management in the Acadia Forest

Gary Schneider, *MacPhail Woods Forestry Project*

Prince Edward Island is a location where a change in forestry could really take place because we didn't have the resistance there that other areas have. We didn't have a bunch of big saw mills or big pulp companies who would resist change. It is a very different thing in agriculture. We have those "resistors". But in forestry, for the most part, we didn't have that kind of "push back" on things. So we have been making some progress on getting more biologically sound forestry practices to take place.

We will consider a history of what our project has done. We set up the MacPhail Woods Ecological Forestry Project in 1991. It is a project of the Environmental Coalition of PEI. At that time, we were seeing mostly clear cuts and plantations. There was a lot of brush burning, all monocultures. A huge amount of federal tax money was going into it. As a group we felt, if we could convince the Department of Forestry to change what they were thinking about, then we could get on with good forest practices. We realized that wasn't the way to do it because people who were trained in a certain style of forestry weren't going to roll over. So we set up MacPhail as a way to demonstrate what we considered sound biological forestry practices.

There is an excellent quote from Ken Lurtzman: "New forestry is an attempt to define forest management with timber production as a by-product of its primary function." Forests give us so much. If you think about timber as just something extra it produces, it gives you a whole different way of looking at it. We have taken the outlook of a naturalist into the forestry practices that we demonstrate there.

Most of the plantations were conifers. These were usually all one species and often very inappropriate species, we are finding out now, and certainly inappropriate places. We are dealing with woodlot owners who have a Red Pine plantation put in and will leave it for five, 10 or 15 years and finally get rid of it. Sometimes now we are getting paid to go in and manipulate 20-year old Red Pine plantations because the landowners don't want it to get any worse. Even at the best of times, if the plantations were actually successful, the most you can hope for is that it is great habitat for squirrels. There was a DNR forester from New Brunswick who came in and called them "Biological Deserts". When it comes to Red Pine, a lot of people think these stands are desirable. From a wildlife standpoint they are horrible, because they offer no cover for smaller animals.

Our bias is towards mixed forests, all the different plants that make up a forest. The expression "interfering plants" is odd in that sense because there are very few plants that we don't get excited about. People think there are no woods left on PEI, but there are some magnificent trees left there. It is just that so much of the land has been cleared for agriculture, and now there has been so much pressure over the last 30 or 40 years, that there is not much of size left. But there are still some wonderful areas of mixed forest. Our interest is always in the complexity of that forest, the species make-up. A lot of things that are rare on Prince Edward Island aren't rare in other places, but we don't have seed sources for a lot of things because a lot of land has been cleared for agriculture. So it is not just that it has been clear cut, it has been clear cut and then farmed for 150 years. That is a difficult transition, to get it back. We are working in a different system than most people here or in places like New York State in that they are highly degraded sites. We are down to the wildflowers. It is quite interesting that, when we first started, the big deal was to get non-commercial timber species in. Then we started thinking of shrubs for all the values that they had. Now we are starting to think about ferns and wildflowers and adding those into the forest.

Dr. Stephen Manley was in charge of the forestry program on PEI in the 70s and really wanted to restore the Acadian Forest. He was a great inspiration for a lot of the people there that are looking at values in the forest other than strictly timber production, although Stephen was very much into high-quality products. He had a different way of looking at things. After Stephen, they really mashed into a Red Pine/ Black Spruce/ White Spruce plantation mentality.

In 1991, we started the MacPhail Woods Project on the Sir Andrew MacPhail property in Orwell, PEI, which is between the ferry and Charlottetown. We set up a nursery, not because we wanted to run a nursery, but because we couldn't find the species that we wanted to use for the restoration that we wanted to carry out on the property and in other places. We are looking at a lot of very high value commercial species: Red Oak, Sugar Maple, White Ash, Yellow Birch, White Pine. We are also looking at some non-commercial species. We have Dogwood that we found only two samples of on the whole island. So we said, "What is missing from some of these properties, and if we are going to work on places, can we actually sneak in some rare plants to help reintroduce some of the diversity that should be there?" There are about 110 acres of woods on the property, and we started doing work on a lot of those stands just to show people that you can harvest wood. We are cutting wood. We are really interested in using wood. We just want to try to do it in a way that doesn't degrade the forest. So we are really encouraging people to burn wood sensibly, to use wood products. We wanted to show people that you can actually work in woods and make them better and still have products coming out.

We set up an arboretum. It is going to be 150 years before it really gets to the style that we want, but it is fantastic to show people the range of native plants, or most of the native plants, that we would find in a forest on one site. For most people on PEI, they've seen old field White Spruce stands and clear cut stands that have predominantly regenerated in Poplar and Maple and Pin Cherry, things like that. So that is their idea of what forests and forest plants look like. The nice thing about some of the work we have done is we have seen things that start to seed in very fast. We have Ironwood, that is an incredibly rare species on PEI, seeding in. We have White Ash that we are collecting seed from already. Some of these plants are quite rare.

That is a big deal of what we have learned about forests: we can't fix everything. If we are looking at degraded forest systems, we have to look at what can help us fix that. We can either get a whole bunch of people out to help us, or we can get seed sources in that will start to do that job over a long period of time. That is really the only way that we have found that makes any sense.

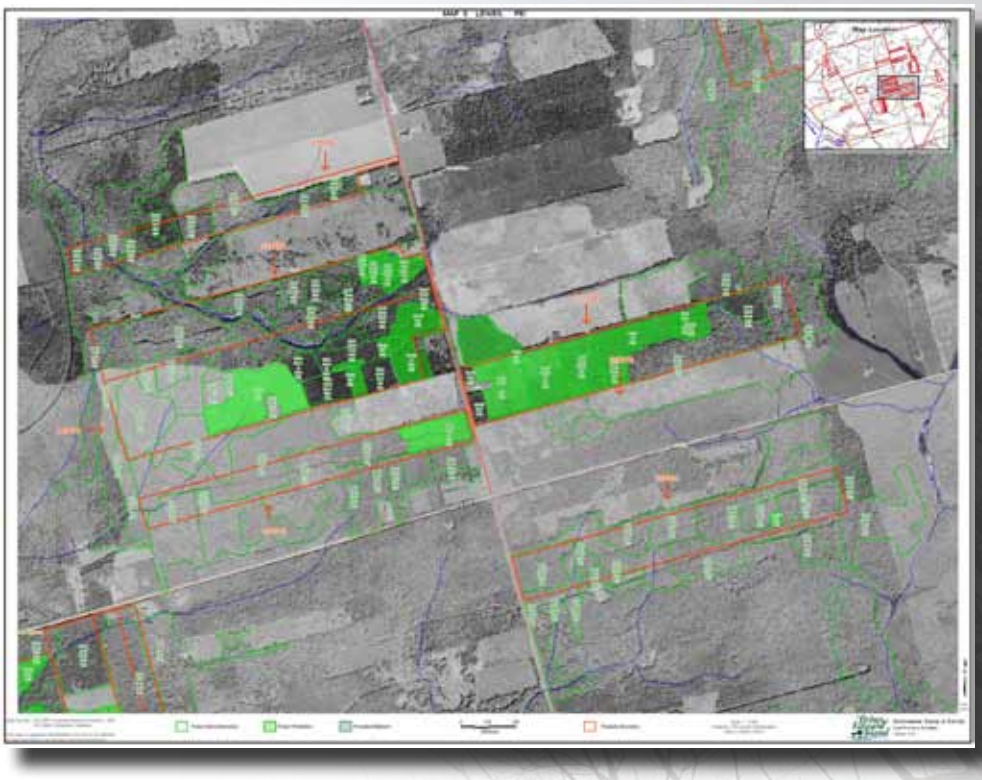
We do lots of school tours. We do more public education than anybody on PEI around forests. We have done school plantings at 15 or 16 schools across the Island. We do a summer program where the kids come out for a week at a time. There will be a group of 15 to 20 kids four times over the summer. It is an incredible learning experience and we have had good feedback from the public. A woman told us the other day that her son said that Christmas and MacPhail Woods were the two things he looked forward to in the year. It was a great compliment to us. We have fantastic people working there. It is amazing how doing something wonderful will attract really fantastic workers. We have a nature centre set up on the property, in the old barn on the property. It has turned into a teaching centre.

We have been really political. We feel we can't make MacPhail Woods beautiful and not try to change policy. Our whole thing was to change the way forestry was practiced in the province and we are aware that is an ambitious goal. We were very surprised when the Minister of Forestry came to us and said, "We are not making any money off the crown land management anyway. Do you want to look at what you can do to handle some of the crown land?" So after a year of negotiations, they turned over 2000 acres of public forest land (which to PEI is a huge chunk of the land base) that the Provincial Forestry Department manages. The really weird thing was to have the province handle it as a "feel good" story. They actually had a session in the house where they introduced this.

There is no 2000-acre block on PEI. It is 26 different properties. Seventeen of them are linked together in a kind of unit. So we are actually doing 17 different management plans all around the southeast part of the Island. For instance, we have six properties linked together that have old fields that were clear cut and turned into plantations. So we are not dealing with 2000 acres of high-quality woods. A lot of the plantations are Scotch Pine and a lot of Red Pine; things that we are going to have to deal with as a problem rather than as something that is really useful. But again, we saw it as a great opportunity. The Province turned over this land and the agreement is that, if we do the things we say we are going to do, then every 10 years it gets renewed. So it is actually in perpetuity. One of the things we said we were going to do was involve the public. So we would have some activities for the public to come to, whether that is seed collecting, or public events or workshops or something. Another thing was that we would actually grow more trees every year than have less trees on those properties. We also agreed that we would improve the quality of the sites, either through

planting or through pruning or other methods. And finally, that we would add a couple hundred rare species every year. So they are fairly simple things and they give us some leeway to do good work.

Fortunately, there are some beautiful areas left. Some of the properties, like most places on PEI that are close to the road, have been hacked to death or farmed. If the site is farther back, if there is a stream or it is a mile long to get to the back, you can find some lovely Hemlock, Yellow Birch, Sugar Maple and White Pine on the site.



We've also got the same problems that everybody on the Island faces. We have got a lot of old field White Spruce that has grown up, and what do you do with that? It was things we have already been doing on a small scale at MacPhail Woods, and it would seem that gave the Government confidence enough that they would turn this land over to us, and ourselves confidence enough that we can actually make the changes that we feel are necessary.

There are 10 principals that guide our work on the project that we can now discuss.

First of all, we believe that we should allow forests to age because we are really talking, in a lot of the plantations, about a 50-year rotation. The Red Pine stands seem to be standing up for about 45 to 55 years before they start to die. But in a lot of the young stands, people were talking about forests and they were literally 35 to 40 year-old regenerating clear cuts. They would go back in as soon as they had any value at all because they never thought that they paid tax money and had to look after this land for 40 years. They just looked at it and saw it had wood and said, "Well, wood has got value. Send a machine in to do something with it." So one of the first things we talk to woodlot owners about is that they should allow their woods to get older. We know trees start to gain a lot of high value volume once they reach a certain size, and that is what we are not seeing on PEI for the most part. We are seeing a lot of young stands being cut. A typical stand on PEI may have some later successional plants, but there are a lot of young trees with maybe one or two big trees. It is better than not having any big trees left, at least it is something to work with. But it is a long way from being ideal.

#1 Allow forests to age

To illustrate: we do "owl prowls" every year, where we bring people out to MacPhail, usually 100 people or more, and we teach them how to call for owls and identify them and go out with a group. Barred Owls are cavity nesters. They are big birds. They need to be in a cavity that is still in a tree that still has some residual strength so it is not just going to snap off. It is great for people who have only seen owls in Harry Potter. But when we see them live and close up, it is a special experience for people. So we can talk to people about the idea that,

if you decide that Barred Owls are a good thing, you have to decide that you are going to have big trees around because if you don't, you are not going to get them. If you don't have large trees, if you think you can cycle forests through a 40, 50 or 60-year rotation, you are really making a conscious decision that in that area there is going to be no nesting habitat for those Barred Owls.

#2 Plan for dead trees

We always plan for dead trees. Herb Hammond, who is a registered professional forester from BC and has written a very lovely book, *Seeing the Forest for the Trees–A Case for Holistic Forestry*, was down to MacPhail in the mid-90s. It was the first time many of us had actually heard someone talk about the idea that we have to plan for trees to get old and die. All the talk at that time, it seemed, was: we have to push these plantations through and eliminate them after 40 to 60 years. And Herb was saying that if we really care about forests, we actually have to plan for between 20 and 30 percent of the trees to get old and die. And that was such a different method or way of thinking. And yet, the more one learns about biology and about birds that nest in cavities and amphibians and things like that, the more we realize that we have not paid much attention at all to having trees fall down and die. We are in a culture, and especially in PEI, that says that leaving trees to die is a waste. We have woodlot owners come through after one of our tours and say, "So I don't have to clean up my woods? I don't have to cut down all the dead trees?"

Another interesting thing to consider is highlighted by some of the work that has been done on amphibians for the U.S. forest service, specifically looking at the amount of Red Backed Salamanders, something we don't eat or hunt so we don't think much about them. They found in the eastern U.S. that the biomass per acre was equal to moose and greater than migratory song birds. That is amazing, but we don't know much about them. They are a little smaller than your baby finger. Somehow we think it is okay that we have this really interesting being that is part of our world and we can, all of a sudden, change its habitat, that we can allow full sun into that stand and take away most of the biomass from that stand.

#3 Increase biodiversity using native species

We are always striving to increase biodiversity using appropriate native species. Appropriate is a key word. We have people coming to the nursery all the time and saying, "I want to put native Acadian species in. I'll take your Hemlock and stick them out in my field." And we have to say, "No, you can't just take our Hemlock and stick them in your field." It is not just a matter of only using native plants, but it is using them in appropriate places. The reason we decided to use native plants is, there is such a range of beautiful plants and high value plants that we can fit into our forests that we know are good, that should do quite well if there is a dramatic shift quickly through climate change. We use a lot of Red Oak, which is the Provincial tree of PEI.

We don't just look at the high value timber, although that is certainly the concentration. Wherever we do plantings, we certainly want value from them. But we are always adding other things. So Hobblebush isn't rare in Nova Scotia, but it is a plant that we can probably find on only a dozen properties on PEI. Witch Hazel we can find on maybe six to 10 properties. We have put thousands of witch-hazel out. It is quite interesting being in a small place; you can make changes very quickly.

When we are talking about biodiversity we are not just talking about the plants. When we are finding trees that have feeding holes from Pileated Woodpeckers, that is an important component of that forest. So we actually look at how, in the management plan, we can preserve those trees, and actually look at when those trees fall down because obviously they get weakened at the bottom, what other trees are coming up so that those Pileated Woodpeckers will have a whole continuum of trees that they can use, nest in, feed in.

We are always looking to enhance waterways. That is something that Herb Hammond talked a lot about, was how important those waterways are. Coming from Prince Edward Island where many of the farmers have actually decided that they can plow right through the streams, and all of a sudden you will see a stream that is just starting out of nowhere that constantly gets silted and pesticided, we sometimes feel like we are fighting a losing battle. But they are incredibly important for a wide range of wildlife. Those could be streams, they could be rivers, they could be ponds. We have really tried to work at using those places to enhance the value of those areas. Not that we want to cut along the rivers, but just to put seed sources in and rare plants in.

#4 Enhance waterways

Lots of times people who work in the woods think that they don't really have to pay attention to the wildlife in the woods. Sometimes in a small place, you can do an awful lot of damage with one action.

We are always looking to protect forest soils. Peter Solonius of Forestry Canada took Kate McQuarry, Director of Forestry Operations for PEI, and myself, outside of Fredericton to show us some of his plantings that he has done. He has done some really interesting work with small seedlings. But we were just astounded to observe large ruts in the soil created during forestry operations. I was really shocked that people would do something like this. I found it very difficult to look at this and think that those people who were extracting that wood actually cared about the forest soil. And if they didn't care about the forest soil, then why were people letting them in their woods? This is not unique to New Brunswick. It happens in PEI and NS as well. I remember Tommy Mahundropa from Forestry Canada in Fredericton talked about every time you expose large areas of soil to sunlight, you start degrading the soil. We are trying not to do that. We are trying to limit the size of the opening we create. If you can imagine the response that we get from some farmers on PEI when we talk about using nitrogen fixing plants like Alders to actually build up some of the soil. Most of the time we are not working with forest soils, we are actually working with soils that are degraded agriculture soils.

#5 Protect forest soils

We are trying to work with nature all the time. When we looked at some of the damage from the hurricane at MacPhail, our instinct was, "Oh my God, look at all the extra work we have to do now". There were all these trees down. When you start thinking about it, on some of the agriculture soils especially, it is the best thing that could happen to that soil. It diversifies that soil. It puts a huge amount of coarse, woody debris on the ground. It took some mineral soil up to the top. You are going to get some great hummocks and divets. It created some of these lovely vernal ponds in these areas that, because it had been farmed, had no water storage at all except in the soil. And we looked at those vernal ponds and said, "Well, what can we do? Can we do something within those ponds to actually enhance and maybe speed up the natural succession of those forest floors from an old field White Spruce area to a more mixed wood stand?"

#6 Work with nature

We are trying a lot of interventions, we can call them, that don't take a lot of money. The woodlot owners often can't afford to do a lot of work on their own on the property. And there are not many incentives for them. So we looked at things like: can you collect acorns and plant them? It is surprising the amount of success we have had with that. They often will take some pruning after they come up. But it is a very easy way to add a lot of Red Oak to a property. And just making sure that we are aware that the work that we do is not only the area that we are fixing, but what the seed sources are expanding into around that site.

#7 Make thoughtful interventions

Another thing we have been trying to learn more about is when to harvest trees. We are okay with thinnings and stuff, but questions arise when it comes to trees that have included bark or splits on them. When is the actual best time to cut that tree down? We have noticed in some of the old field White Spruce, you can actually see the moss breaking away from the base of the tree and if you are cognizant of that, it actually gives you a great time to know when the smaller feeder roots are starting to break down and that tree is going to come down in the next big storm. We are trying to leave those trees as long as we can and not lose too much value from them.

That fits in to making thoughtful interventions. The opposite of that is you are not being thoughtful, or you are thoughtless. It is different on PEI because lots of times here, if you are working in healthy forests, you don't need to plant trees. But for where we are, a lot of cases we just didn't have seed sources to come in. For some of the people they had never actually thought about that. You actually would know what you want to plant. Why would you care if you are a silviculture worker? If you actually understand the dynamics of the plants that you are going to put in, it makes it a lot easier to know what type of cut you are going to make in those forest stands. In some ways it is like the house construction people who only do electricity, or only do plumbing, or only do foundations. If you cheat on any one of those things then the next person down the road is going to pay. So if somebody frames your house and they are not at right angles, the person who comes in to do the gyproc is going to have a harder time. And the person who tapes that is going to have a harder time because somebody before them has cheated.

For the most part, we are doing a lot of work pushing the natural succession. We often say, if we left Prince Edward Island for 200 years, it would be fine. Nobody is really likely to agree to do that. So we are finding other ways to move that natural succession ahead, such as doing small cuts that we can add things to. We don't do a lot of eradication of invasive species. The Director of Forestry on PEI is probably the biggest Beech fan. In some areas there is too much Beech that has canker. We are looking at how we change that so we can get at least some value into those stands. They do make fantastic fuel wood. There are people making flooring out of them. They are fantastic for wildlife. I think we really need to look at the values in that other than just the wood.

We are trying to go into stands and do real silviculture, but there are so few left on PEI where you actually have a good species mix and good quality, at least something to work with. Sometimes you have one, and sometimes you have the other, but very rarely do you have both.

Being thoughtful means you also understand what else is living in the forest. We talk to people about not cutting in the prime breeding season. PEI actually has some regulations on public land, not on private land, about that. I have woodworkers say, "Well, I look and check and see if there are nests in the trees." That is impossible. You can't find all the nests. There is the example of the Red Eyed Vireo that lives in Brazil, most likely, and migrates up here to have babies, and then flies back. Its nest is about 6ft off the ground. It is very easy to disturb them. While we have a migratory bird protection act, it is never enforced, but someday it is going to be enforced. People are going to look at these and say, "This is a migratory bird. If we cut its nests down, it has absolutely no chance to rebuild the nest." We have a responsibility to things like this. That is why we must think about thoughtful interventions. We actually try to find other work to do during the prime breeding season.

Someone made the comment, "You are managing light." It sounded like such a strange thing to say, but it is a most interesting compliment. We are actually looking at managing the amount of light that is getting to the forest floor. Partly to keep the humidity levels high and to keep the forest floor as healthy as we can, and partly to start getting other species, later successional species, that we couldn't get into those stands if we opened them right up. Partly, managing the light is for quality. The Department of Forestry planted a Yellow Birch stand in 1980 on the MacPhail property. The stand is in a field. It is worth next to nothing. It is never going to be worth anything. On another part of the property, the exact same seed stock was planted at exactly the same time. We didn't get there until 1991, and we have done some pruning on this second stand. This latter stand has some veneer quality trees. So we are trying to manage the light and keep to the height of the tree.

#8 Manage the light

It is not just for hardwoods. We are working on a whole range of plants. The nice thing about being somewhere over a long period of time (for us since 1991), we have Hemlock that are 18ft high, we have Yellow Birch that are over 20ft and Red Oak. When we started we were looking at small plants, saying, "We are doing a patch cut, I'm going to plant these small seedlings. Trust me, I know what I'm doing." Now when people come and they see birds nesting or even feeding in some of those trees, it is a lot easier for them to accept that you can do something different. We are looking at managing the light not just in older stands of White Spruce or older stands of hardwood, but in young stands. We get calls from people all the time who have fields growing up and they don't know what to do with them. If they leave them, they know it is going to be predominantly White Spruce, and they want to intervene early so that we can put some other stuff in. So we are trying to manage the light. How early can you stick in Red Spruce and Hemlock and Sugar Maple? How much cover do you need? Those are some of the things we are working on, managing light. Jim Drescher, who is from Nova Scotia and is renowned as one of the Ford Stewardship Council Certified Woodlot Owners and does a lot of teaching and training, he always talks about keeping your trees tall. So we need to keep the tallest trees up there so that other trees are actually stretching up into that light. He says we really do need to raise the level again of the height of the forest. On PEI, we have shrunk the height of the trees. We have done so much cutting, we have changed things so dramatically, that the trees are actually a lot shorter. It doesn't mean that they are genetically predisposed to do that, it is just the conditions we have created for those trees.

#9 Maximize harvest value

#10 Help others learn to love forests

We are trying to maximize the harvest value. We are looking at what kinds of products we can get from the forest. We have no interest at all in a commodity market, but we are looking at what kind of stuff can we produce from that wood. We have some fantastic craftspeople on PEI and they are doing very interesting things with burls and twists and all kinds of forks, making products out of it, things that people might traditionally see as a waste. There is a turner just down the road from us who goes into places and gets forks and scrap Yellow Birch that is just being left because it is not log quality and he is making bowls that are worth $500–$1000.

We are trying to look at how you add value to things. Yellow Birch into furniture makes a lot of sense. We are looking at what other products can we get from the forest. There are some years that the chanterelles in the forest are worth way more than the amount of wood produced.

The biggest thing that we do at MacPhail is teaching other people to love forests. We have really looked at that and said, "How can we get people to actually love their forests?" Especially on PEI, forests are seen as "not farmland". So if you've got 2000 acres, your good land is your farmland. Your poor land is your bush. Everything would have been cleared for agriculture. The farmland is productive, bushland isn't productive. It is not valuing that forest at all, not valuing what that forest brings to you. It is easy to get people to love big trees if they have some big trees. We have found just going out and collecting seed from people's property, they started to value it more. We can get people to fall in love with wildflowers, if they have something special there. The problems are the other things. We don't see beauty very well as a culture. We see beauty if it is big and jumps in our face and somebody else has put a value on it. But it is very interesting to walk through with kids and show them different types of fungi growing, especially at the base of trees. They are absolutely works of art. If you ever start looking at lichens closely, if you can get a magnifying glass or put a doubler lens on your camera and start looking at lichens, you can actually see how beautiful they are.

One of the students helping out with our summer programs was so excited because he'd found this thing. It was a larvae of a Robin Moth. Their wing span is about 6in. They have cobalt blue on them and orange and yellow and white and green and these puckery little legs. They are quite wonderful. We just don't see them. We don't know what is going on, so we are kind of stumbling blindly through the woods sometimes. If you do that, if you are not looking at what is around you, then it is okay to dump your garbage. Perhaps it is the same kind of problems here, where if you've got a road into the woods, why wouldn't you dump your garbage there? You can only do that if you don't care about what is there. If you don't value that woods at all, if you don't value what it is doing for you, then of course, why wouldn't you dump garbage? On one piece of crown land, we found pesticide containers and all kinds of stuff, and it is not close to anything else. So someone actually had to drive there, when they could have dropped it off free at one of the dump sites. But instead, because there is no consequence and because there is no history of valuing that forestland, we think it is somehow okay to do that.

We do everything from preschool to elder hostels and literally everything in between. We do tons of talks at MacPhail. What we have tried to do is get people to see better. We can take them into the woods and show them things that they may not have seen before. They might have been walking by it. They

may not have known that that Ostrich Fern is such a beautiful plant, or that bird that migrates from Venezuela or something has this incredible call. But once they start to think of those things, it gives them a bigger range of values for their forest. So maybe they don't have to think that they absolutely have to maximize the amount of profit that they get from their woods so that we can have cheap paper to waste and we can have cheap wood so that we can build houses that are too big for us to heat anymore.

We have a website and it has a ton of information on it:
www.macphailwoods.org

Question Period

Martin Béland, *University of Moncton*

Q: I wondered if you had specific strategies for enrichment planting?

A: We try to do patch cuts and use the revenue to replace plants. We don't plant a lot of trees but we try and create seed sources.

Kermit Degoyer

Q: I'm intrigued by the arrangement you have with the Province to manage crown lands. Who is paying who?

A: There is no money being exchanged. I looked at it as an opportunity.

Q: Is there a formal way for citizens to have input on a management strategy?

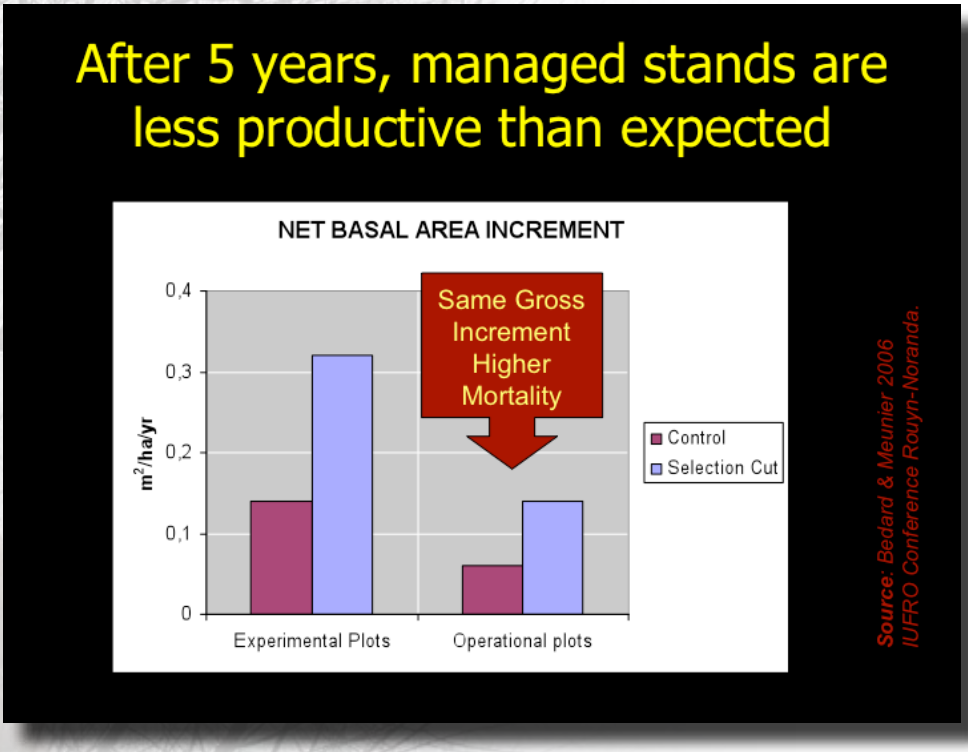
A: No. It is not a model for community-based forestry.

Optimizing Selection Harvesting Prescriptions with Economical Objectives

Jean-Martin Lussier, *CWFC*

The attempt is to improve tree marking rules by considering their economical value. Harvesting priorities have not created high value. Can we improve our prescriptions in order to increase value in the short term and the long term?

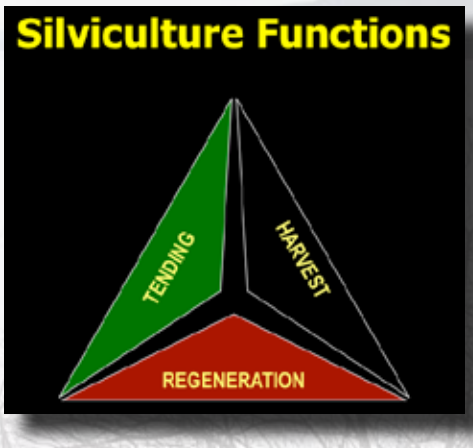
The following information is based on the work done out of our lab in Quebec. The hardwood forest we deal with is about 32,000km^2 of managed forest. Since the 90s, selection system is officially the only system which is allowed on public land in Quebec. It makes Eastern Canada home to one of the largest managed forest under selection system in the world. Currently, the rules are: you are allowed to take 35 percent of your harvest at each entry; entries are scheduled on a 15 to 20-year cycle; the priority is given to harvest the low grade and low vigour trees because for the first entries we are making sanitation cuts to increase the value for future harvests.



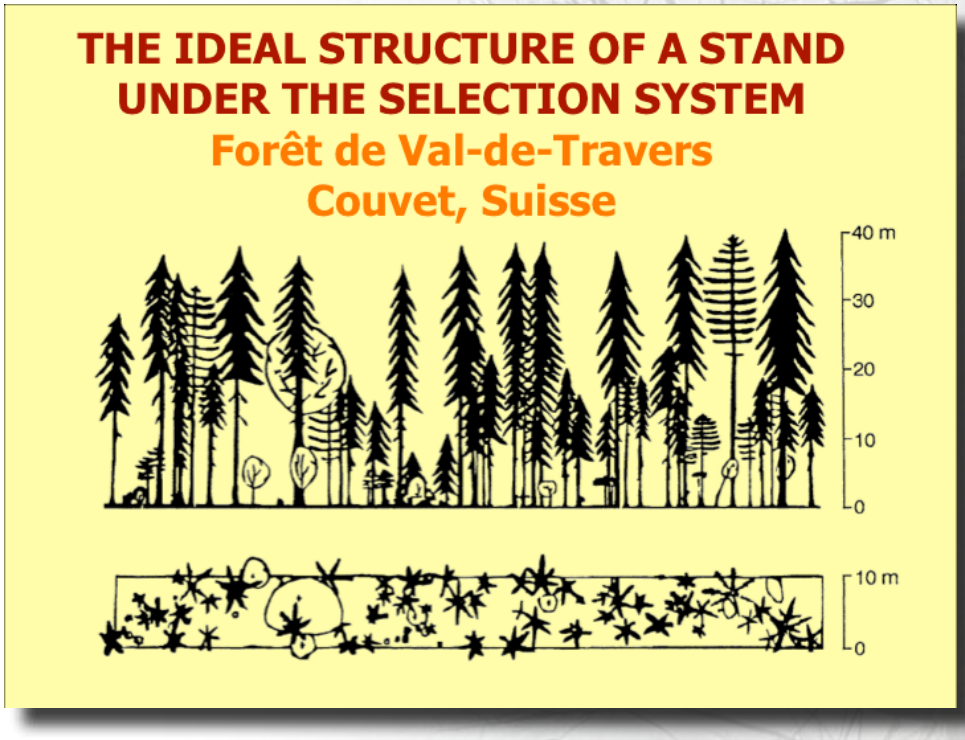
A colleague of mine, Steve Badile, made a study comparing permanent plots that were established in operational areas and compared the results from these plots to experimental units. They found large differences in net increments. The gross growth rates are the same but the differences are due to higher mortality. After analysis, it seems that even with the current rules, there was some high grading still occurring in the forest. So the Ministry decided to tighten the rules. The analysis: we have low-grade stands due to inadequate marking guides. So there was a new guide to grade the trees that was produced, and new rules to force the sanitation of stands, because we wanted to maximize the yield of high-quality lumber in the long term. But we are currently in a crisis. There are a lot of mills that are shut down because of poor markets. Those who were exporters were affected by the collapse of the US housing market. There is a globalized competition, mostly for flooring and furniture. Also, there is a scarcity of quality lumber resulting from the previous high grading. This is aggravated by the current sanitation policy that forces us to harvest low-grade lumber. There is also a problem of obsolete mills and maybe poor supply chain management. The consequence is that there is a lot of mills closed, either permanently or temporarily.

So how do we solve this? What are the basic objectives of a selection system? We want a continuous forest cover. That is the first objective. We want a sustained delivery of products. It can be wood products, it can be non-market products. But we want a sustained delivery of it on a short cycle. Contrary to even-aged systems, we are aiming at the same objectives with long cycles.

Selection system is a great thing. Basically, you are doing the three main services of silviculture at the same time. We are tending the forest, we are harvesting it and we are regenerating it at the same time. So it is the most complicated system you can imagine up until now in silviculture. The mecca of selection forests is the Couvet Forest in Switzerland. This is probably the first example of the long-term application of selection system. It is mainly in Norway Spruce. This area has been sustainable, managed under selection system for the last century and a half.



It is a system that has been developed for softwood at first, because they were in the Alps. Many farmers were managing it on a tree-per-tree basis. We were inspired by their work to develop a more "scientific" system. There is a way to perceive this dynamic of a stand under selection system. I borrowed this idea from a French colleague who presented a selection forest under three compartments. The first part is the roof frame, composed of the dominant trees, that is controlling the light. There is a waiting room of seedlings. And the big job of selection is to manage the light so that you have a continuous input of sprinters that go from the waiting room up to the roof frame. So the trick is to manage the light and have enough control on the roof cover. If your roof cover is too closed then you may still have a waiting room but no sprinters. We estimate that if you have over approximately 27m^2 of coverage per hectare, then you have too close of a roof frame. On the contrary, if your roof frame is too open then you will have a massive sprinter start, but you will interrupt your waiting room or your regeneration process for some time. You will end up with a two-stage stand for quite a while. You will interrupt the regeneration and promotion process over time. So going too far on the other side has a negative effect and typically it is around less than 16m^2 per hectare in both softwoods and hardwoods.



Usually, when you want to make a selection system, you choose a stand that already has a good structure and then you maintain it. So there is some idea of an ideal steady state here that is kept over time, but the biggest part of the work is to start from a stand that is not optimal and to steer it down to this optimal steady state and to keep it there. The steering treatments, or conducting the stands toward this ideal state, is most of the big deal of selection systems. Now this is done by a certain amount of entries, perhaps four or five, but it could be more, according to the cutting cycle.

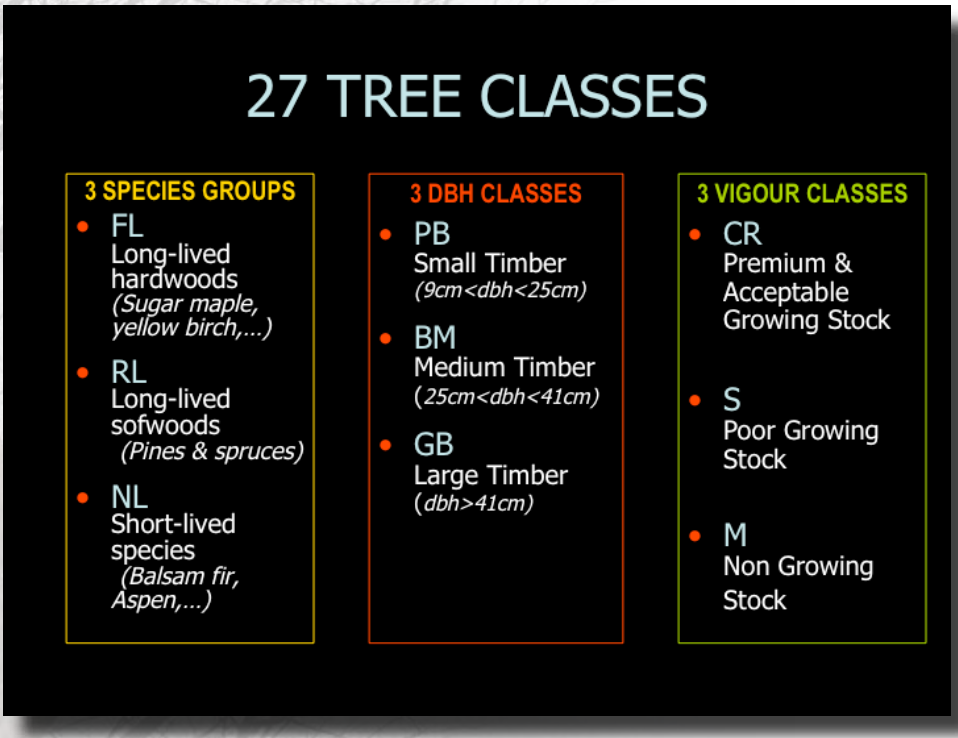
How do we choose the steady state structure? Well, there are many ways of doing that. The first one is trial and error, experimental stuff where we are trying things and making errors and making good things and learning about it. That is our first basis of knowledge. The second one, that is derived from the first, is using standards. We are talking about the Arbogast Curve or BDQ approach, that kind of stuff. That is derived from the trial and error. The third one is simulation modeling. Doing

the same thing that the trial and error would do but with a computer, making experiments, but virtual experiments. The last one is optimization modeling. That is the one I want to present to you. It is inspired by the simulation approach. But instead of trial and error, it is using a linear programming algorithm to try to figure out what is the best solution.

The BDQ approach is the one that was proposed by Zahn Mason who is the main researcher behind the selection system in Quebec. So it is exactly the same approach that is used in the U.S. You have a template and you are removing every tree that is exceeding the template.

I am proposing a model I named "Biolet". It is an optimization model which uses three entries: economical values, strategic and technical objectives that need to be defined prior to the exercise, and a matrix growth model to make the forest grow over time. It delivers two things: if you want to define the steady state first, then what is the optimal initial stand structure and the optimal number of trees to be removed in each class. From this you can derive the stand yields either in cubic metres or in dollars.

Who is Biolet? He was the first forester who proposed a scientific selection system in Switzerland about 150 years ago.

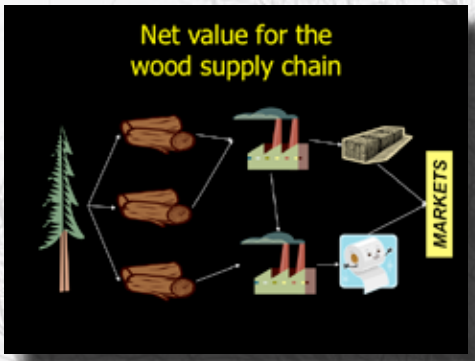


The model is quite simple. The forest is reduced into 27 tree classes, tree sizes, tree species groups, long lived hardwood, long lived softwoods and short lived species. You have three deep age classes: small, medium and large woods. And you have tree vigour classes: "C" and "R" which are the premium and acceptable growing stock; "S" for poor growing stock; "M" are mortality or non-growing stock. These are mostly based on disease criteria or pathology criteria. So what kind of fungus you have mostly determines in which class you are. In the matrix model, imagine you have the number of trees per class, and we want to predict what will be the number of trees in each class within a five-year period, for instance. You have, first of all, the initial number of trees per class, subtract the number of trees that will be cut, and then the difference is the residual. You multiply the residual with the matrix and it gives the final number. The matrix gives the number of trees or the percentage of trees from one class that will remain in the same class and the proportion of trees that will move toward the next class. This matrix has been calibrated with permanent plots.

So it is a very simple and crude growth model. The part that is lacking or missing here is the recruitment function. You need a recruitment equation that predicts the number of new trees that will step in the system periodically.

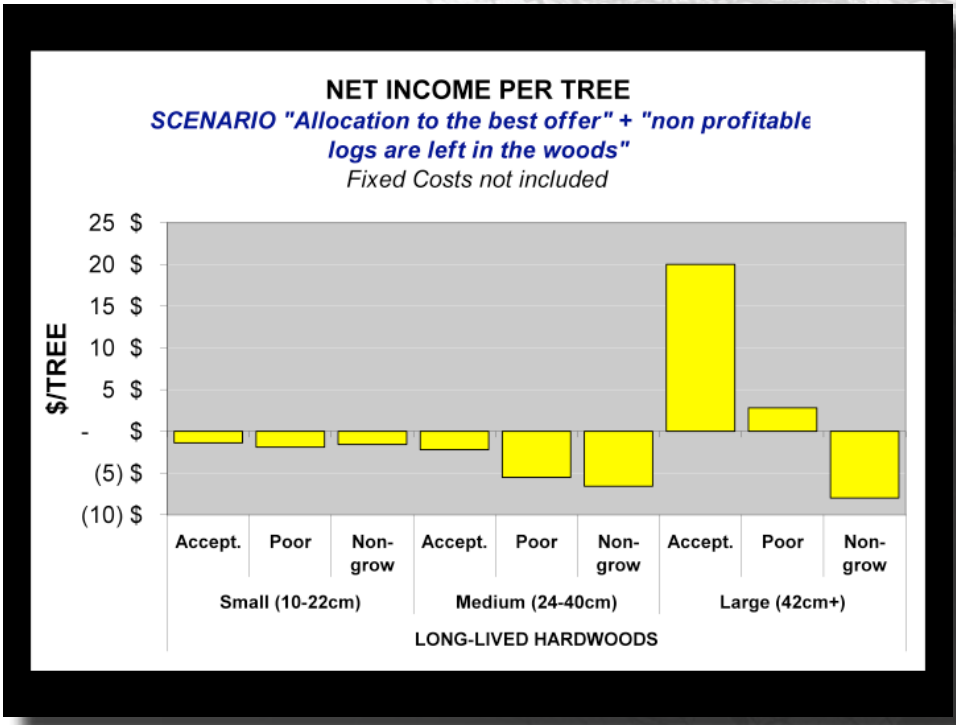
If we want to optimize the steady state, the problem to consider is: I don't know what is the initial stand condition, I don't know what is the optimal number of trees to be cut. So these are the two decision variables. The objective function is to maximize periodic net income from the whole value chain. The constraint we have is we want the initial structure at time zero to be equal to the structure at time 25, because we are dealing with a 25-year cutting cycle. So we want some stability over time in the structure. The basal area must be maintained at 16–27m^2 per hectare, for reasons explained previously. Of course, we are expecting the number of trees to be harvested is less than the number of initial trees.

What are the economical functions we are using? Instead of trying to figure out the value of trees in a transaction between the tree grower and the industry, I am trying to figure out what is the net profit for the whole value chain from the market up to the forest. Basically, we are estimating the market value of the products and then consider their transformation rates and costs and the recovery from the lumber and the harvest costs, transportation costs down to the markets or the mills and considering the fixed margin of profits through each step. The overall net benefit from this is considered as the net benefit for the value chain. What we are trying to do is maximize this revenue; maximize what we can do here to maximize the net value for the whole chain considering that producing wood is part of the chain. How this profit is shared is another issue. We are just trying to maximize our decision from here.



I was brought to this idea because my first attempt, just dealing with the round wood market was quite deceptive, knowing that most of the net income is down the chain, not from the wood.

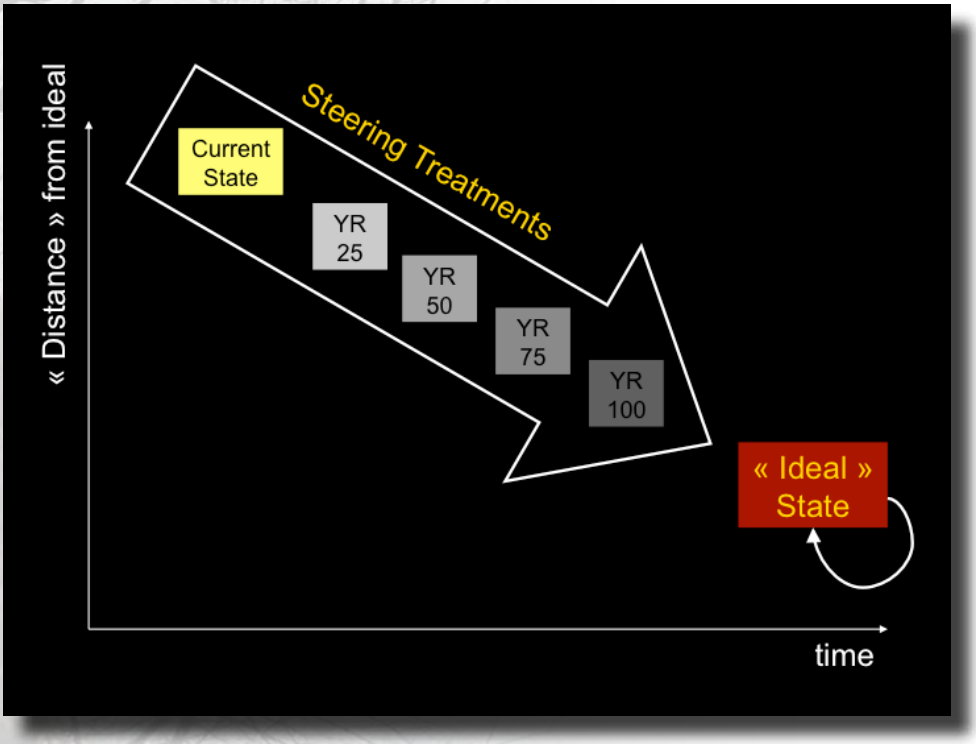
Which market price did we use, since we are in a very depressed situation? If I take the current prices, I will get some kind of figure and it won't hold more than six months. In order to have a little bit more stability in prices, we have taken the long-term trends of price and we remove the inflation effect. For each product, we have this equation and basically what we are using is the price predicted by the overall trend instead of using the raw data.



Put all this together and we get a net value per tree for the whole value chain. If you look at it this way, the only trees with value are the large ones. The best price you can get is for an acceptable stock large tree at $20 per tree. That is not a great amount of money. This is for a particular region so it is considering a particular design of value chain with distance and that kind of stuff. So it doesn't hold for all of Quebec or even for here. The next case with a positive value using this equation is the poor stock large trees and all the rest have negative values. If you look at the small trees and medium trees, the smaller the trees the less value they have.

The figure I just presented you excludes the fixed costs. The fixed costs are management, tree marking and roads, camps. Where we are on public land, the forest is quite far from the updated areas. So we are having, typically, $900 per hectare as a fixed cost. This is very heavy.

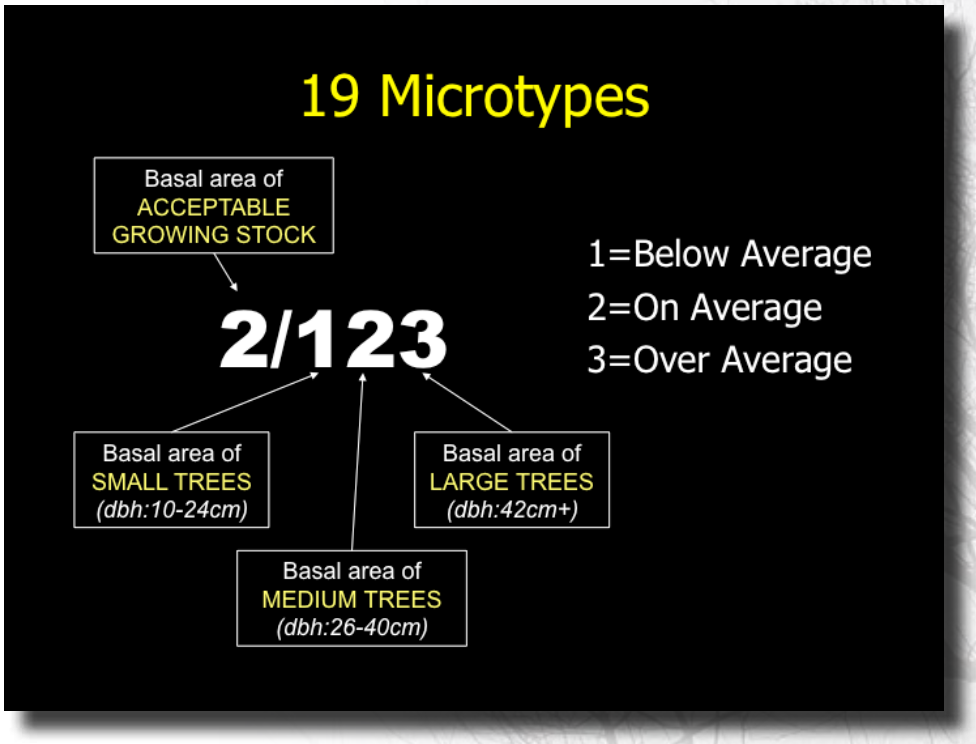
If I put that in the machine and ask what is the optimal structure of an ideal stand, it will give the initial stand structure with number of trees per class. It will colour code the results, with yellow as the residual and black for the harvested. The original basal area given is around 4m^2 per hectare for small trees, 14 for medium trees. This allows you to harvest all the large trees as long as you have this amount of trees and you must improve your small and medium trees by removing the poor and ungrowing stock. So basically, what it suggests here can be perceived as a diameter limit cut with improvement on small and medium-sized trees. This is very consistent with the previous figure, when we see that the only valuable trees are these. To sustainably produce the maximum amount of these on a 25-year cycle, this is the amount of small and medium trees we have to produce. If we put all the economical numbers together, the best value we have is -$400 per hectare. That is the best steady state situation we have with the numbers that we have. In this number there is $900 of fixed costs. First, we have to validate these numbers. When we actually sought validation with the practitioners in the field, the prospects were bleak. We have had problems for the last 5–10 years, and this is probably one of the reasons. We are just putting the numbers to the reality. We have problems to get a balanced budget. So it gives us an opportunity to see where we can gain dollars, where we can reduce costs, where we can increase value from.



This is only the first part, setting the idle state. But it doesn't tell us what to do with today's stands. So we went to the second phase, which is a steering treatment. Up to now we are talking about ideal stands that do not exist. At this point we are starting to talk about real stands. One of the problems that we had up to now in practice is most of the prescriptions were based on assumptions where we are sampling the stand, making a large average of it, and we are making the prescription on this one and we are assuming that if we have three different stands based on the average figure, this is the colour we have. But in reality what we have is a mixed situation. So the average prescription generally doesn't work anywhere because there is a lot of variation. The solution here is to have a multiple treatment approach, saying, "If we can recognize stand types within a stand and optimize a recipe for each stand type, then probably we are hoping to have a better solution or resolution at the end, instead of applying an average solution that fits nowhere exactly, but on average it is okay." The idea is: do the right treatment at the right place. So to get there, we developed a simple micro-topology based on the data we have from point sampling. The topology is

based on the level; one, two and three corresponds to the level of basal area. If you have a two, you are on average, one below average, three over average. The first digit is for the level of acceptable growing stock. After the tree digits, the digits represent the basal area part for the small trees, medium trees and large trees. With a small code number, we have a quick image of what is the structure of your plot. This gives you the frequency of these stand types in the event of entry. Fortunately, the 2222 is an average. It is the most prevailing one. This has been an experiment we have done on a 2.2 hectare forest, each square is 20m by 20m, and it tells me the diversity of the structure within the stand.

For the purpose of the linear programming we have 19 types. We are trying to optimize each one, a steering treatment for each of the types. We can look at the solutions for the average 2222 stand type.



So, we have an average and we know the number of trees by classes. It is highly dominated by long-lived hardwoods. There is a short-lived species component, mostly Balsam Fir. This is the resulting solution from the steering optimization process. We have this optimal target and we ask the system to take the stand to the current stage and cut them to move them as close as possible to the optimal stage within four entries, each at 25 years. This is one part of the objective. The other part of the objective is to maximize the profit during the process. So we have a long term target but on the short term we want to have the maximum profit possible to get there.

This is the solution. You have for the 2222, the number of trees that should be removed, considering the initial stage, over the next four entries. What is proposed for the first entry is to remove all the large trees and leave the "M" trees. There is no real problem because most of these, as per the model, are programmed to be dying within the next rotation. So there is no value to get there and there is no penalty to harvest them either. The other prescription is to tend your small trees. That is normal. What is surprising is: don't touch your medium-sized trees. My understanding is that on the long term, the system sees that it is more profitable to tend the small trees and have long-term benefit on quality instead of forcing the short-term improvement to your stand. You will have a very good improvement but it will cost you a lot of money because these medium size trees are the trees that have the lowest value. They have a negative value. To make a comparison, I've put what should be the tree selection rules according to the provincial current rules. The policy is to at first remove all the "M" trees, and then the "S" trees down to the target basal area. Basically, they are forcing you to remove a big deal of these and a lot of "M" in the medium size and this costs a lot with little revenue. So on the short term, there is a big contrast in the value of the harvest for the first entry.

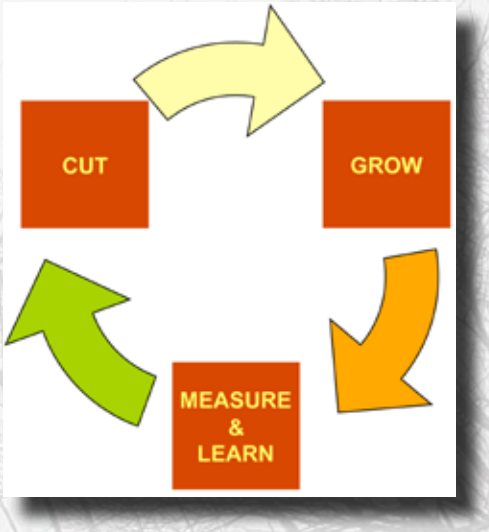
I have to translate this to an operator or tree marker. I would say, "Never get under 16m^2 per hectare." So you have to have your prism or have a basal sweep. At first, harvest all mature, short-lived species. After that, harvest all the "C", "R" and "S", the good looking large trees, all of them, if you have at least 4m^2 per hectare of good medium trees. It is not part of the solution from the machine, it is something we added just in case, to make sure we have got some insurance. It is okay to remove all your valuable trees as long as you have a reserve of trees that will replenish it for the next rotation. On average, we have them, but in the field we need some insurance to get them. We are proposing that, if you are looking back and you are having at least 4m^2 of trees that will likely be ready and merchantable at the next rotation, then you are allowed to clear what is valuable. If not, you must only harvest two thirds of your stock and reserve one third for your next entry. Don't touch the medium trees. It isn't worth it. And tend the small trees. This is the way we are going to guarantee an increase, over time, of the value of the stand.

If I apply this to the 2222 and I try to compare the structure, the actual structure to the structure of a century from now, on the medium-sized trees we are increasing our capital over time. The system is supposed to increase the capital over time. We are not exactly on target but we are moving to it. If we look at an overall picture of it, we will see that in comparison with the current situation, we are increasing a lot of the short-term value. But we are harvesting more value than what we should on the steady state. We haven't reached the steady state already, we are moving slowly to the solution. It is interesting to consider what is the net value of the stand at the end of the century. What will be the initial value of the stand? Basically, what I understand is that the current policy is we have to tighten our belts and invest a lot. We have to lose some money here but we will gain value in the future. There is a balance between the short term and long term, and the current rules are pushing more on the long term. So it is very costly for the current generation, it is a very costly situation. But three generations from now they will have a very good value forest at the end. This is in comparison to the optimal steady state. Why is it negative? Well, because the standing value of a stand is where you clear cut everything and you sell it. But remember, that in our stand there is a part that is a positive value and there is a part that has a negative value. When you sum it up, even if it is the best value, you end up with a negative standing value.

So linear programming here suggests that, if the land owner agrees with the economical objectives where we want a steady state stand over time that will maximize the profits, and where we want to tend the stands to reach this over time and we have to maximize the revenue during this process, we will end up with a better economical solution than the one he is currently applying with some concerns with economics but no explicit economic function.

There is a little parenthesis I want to make about models. There are a lot of questions about the reliability of models. How can we make sure these models are right or not? Well, all models are false. They are wrong from the very start. They are only a way to help us to think. The earlier silviculturalists with selection system were facing this problem also because selection system at the very start was accused of high grading the forest. Well, you are picking the good ones and you are leaving the rest, and this was done in the beginning when we were in the golden age of the even-aged system. The youngsters that proposed the uneven-aged system, they had no yield curves, no models. One forester, Adolph Greneau, who is a little bit older than Biolet, was quite

innovative. It was a long time before his ideas were recognized but he is the father of the check method, saying, "Well, I don't have to have any models, but I'll make a system where I can learn about my errors." So basically, what they are doing is: you start the system by measuring your forest, or your plot. You are making some assumptions on what should be cut and what should be left. You cut them and then let it grow and re-measure everything periodically. You are making errors and you are learning about it. The only thing about selection system applied in very productive forests is the entries are every 7–10 years so, if I have the chance of being the forester on that woodlot for all my career, I'll be able to see the result of my own work at least two or three times during my career. There is a lot of power in this stuff. The challenge is to try to apply the check method within a longer horizon. In the 21st century, this is adaptive management. This is probably the only tool we have to give some confidence or control on our management despite poor models and a lot of uncertainties.



So what have we learned? Selection system is more than just harvesting large trees. Selection system is not only selection cutting. It includes the tending of stands that do not have the optimal structure and steering them towards this ideal steady state that provides the maximum products we want on short cutting cycles. Maximizing lumber volume is not the same as maximizing value. Using explicit economical functions leads to different decisions. If I would do the same job trying to maximize volume, I would probably cut far more medium-sized trees over time than this solution. Mathematical optimization helps to find better solutions, it is just a way to think faster. Selection system requires highly skilled foresters and operators not only for planning but for delivering the stuff. Finally, the check method is our tool against uncertainty.

Question Period

Ed Swift, *CWFC*

Q: Is the model ready to start playing with?

A: It is programmed in Excel. It is based on a simple model.

Q: Could you send a copy to members of the audience?

A: It is a prototype now and needs validation. Over the next nine months we will be working with it, and as soon as it has some validation, it will be freely available.

Restoration Silviculture Practices

Dr. Ralph Nyland, *SUNY-ESF*

Let us discuss some concepts about what we might do when restoring our forests in an economically feasible manner, and then end up with one practical example.

I want to use as a basis for outlining the treatment alternatives, some data gathered in New York State back in the 1990s. The New York Society of American Foresters decided to see what was the nature of the timber harvesting operations across the State. So we chose, at random, 63 topographic maps and then found the nearest cutting operation to the center of each sheets. So these are randomly selected stands. In each one of them, we evaluated a series of criteria. We considered residual stocking and we looked at not only what was standing but also the stumps so we could recreate what was there before, and thus we could look at not only the basal area that was there but also how much was taken away. We looked at the variability in stocking from place to place within the stand. We also considered whether the species left behind were desirable or not. There could have been more valuable species taken out but if what was left behind was desirable, that was okay. We looked at the change in the average stand diameter. Now I'm talking about the quadratic stand diameter, the diameter of the tree mean basal area. And finally we looked at the change in saw timber potential.

For this study we used a very minimal criteria, that each tree, to be useful as saw logs, had to have at least one, 8ft log of usable material. What we wanted to look at was not what any one of these things said to us, but what was the composite evidence providing us with. Overall, how would we rate the condition in each stand, and then how did the stands compare across the 63 samples?

So we had these 63 stands and 38 percent of them came into a "good" category, the composite conditions made these look like silviculture, or something like that. At least they weren't degraded. They had a high potential for the future and with appropriate management would be sustainable. That was the general judgment.

The other category, in the middle, was what we could call "mixed". This was about half the stands we sampled. They were neither good, nor really bad. Many of these had had a single diameter limit cut in them. They had a modified condition or they were mediocre in nature. They were potentially fixable. And there would be some opportunities that had been lost, but some could be re-established. We can put these in a category called "silviculture purgatory". It is going to take a lot of prayers and careful thinking to get them back into a more productive and useful state. This would be the kind of condition which was clearly cut over but you can see some good trees out there and can begin to imagine how you might approach a rehabilitation of those. Most of this was due to diameter limit cutting, taking out the large and valuable trees for short term gain without thinking to the future.

Then there was a group of about 13 percent that were really ravaged. These were poor by any standard. It was interesting that in these stands we often found highly undesirable surface conditions on the skid trails, lack of setbacks for water courses, etc. It just looked like no one cared about these stands. They are ravaged and rough, degraded, dismal, with few options for the future.

The point is that when you do these diameter limit cuts (and often these ravaged ones were cut for a second time) you have really shut out your options for the future. There is not much you can do about them and that is going to say a lot for the potential to restore them.

Let us go back and look at a model again, this time of an even-aged stand, and let us see what happens when we do diameter limit cutting in this stand. Remember, we take out the big trees. In a single diameter limit cut, the result is irregular in the distribution of growing stock. There are some trees there that are not bad, but they are not good either. You will also notice dieback in the tops. It leaves trees with the poorest growth potentials, because it takes out the dominants and upper co-dominants. With this cut we would take out the trees with the best growth potential, and leave the ones at a later entry, only half, or less than half, of the growth potential of the ones that were cut. So they will get slowly bigger and then we take them out at a later entry. By that time we are into that "poor" category. I think the difference we are seeing is between stands that had one diameter limit cut and those after two diameter limit cuts. After two diameter limit cuts, the third entry will not likely be commercially viable.

We can look at another example where the problem in this case is that, not only is there a patchy distribution of trees, not only are they poor quality, but when we look at all the interfering vegetation that is on the ground, we observe no control over development of what happens. There is no deliberate plan for regeneration. The low vigour trees are going to have poor bowls which means that even as they get bigger they are not going to produce trees of good quality.

There is another thing here. Since these trees are ones of low position and very low vigour, they won't produce much seed. So you have regeneration that is compounded by at least two factors: 1) the probability of a high level of interfering vegetation and, 2) that you have a reduced seed source. This is not something you have to look very far to find. Such stands are all over the landscape.

Now, what about uneven-aged stands? Remember you are taking out age classes here, so there will be some acceptable trees of the smaller size classes. The diameter limit cut would take out the older age class, leaving something behind that is spotty, irregular and patchy. So you do a second cutting, and then you are moving gradually to something that looks quite even-aged. It is compounded by the fact that, if we have this irregular distribution of trees, we often then get a build up of interfering plants which compounds the problem of filling in the lower part of that age class structure.

There is nothing good you can say about any of these things. But whether we are working with even or uneven-aged stands, there are questions to ask. What might salvage the future, if anything? What will it cost, or what will cost the least that will get us into a better state? Will it satisfy the landowner's objectives? Remember, we have already taken away most of the opportunities. So the choices available to the landowner at this stage are limited. They have to choose from among poor alternatives.

Based on the things we have done, the first effort you must make is an inventory. So already we are spending money on a ravaged stand. But without that inventory, you have no sense of what is out there. Some people can walk through well-managed stands and, by eyeball, make some estimates of stocking. You can't do it in these kinds of stands. They are too irregular. So you are going to look for acceptable growing stock, and we can define it in these ways:

In an even-aged stand, you want to have at least a lower co-dominant tree; whatever would be the equivalent of a cohort in an uneven-aged stand.

You have to have trees that have good vigorous crowns, or reasonably so, and promise for the future.

You need to have 20–25 percent of the total tree height in live branches. The importance there is to go give you a potential for response of growth and development into the future. When you have trees with that much crown, you will get some seed production. In the uneven-aged stands, the crown size will build up and eventually you will have seed production.

No epicormic branches. The work that has been done in the U.S, has indicated that if you go into stands you can see the trees that will develop epicormic branches because they already have the signs on them, little short ones. Those are generally on the lower co-dominants and the intermediate trees. You can look at the trees and say if it has signs of epicormic branches they are going to flourish afterwards. We want to avoid those trees with epicormic branching. You should look at up to the base of the crown–at least in the merchantable length that you anticipate.

We would like to not have holes in the tree or fruiting bodies on the main stem. If nothing else, those are structural weaknesses and put the tree at high risk of being lost within a reasonable period of time.

A sign of vigour in hardwoods is to look at the upper part of the crown. If you have 25 percent or more of the upper branches dying, that is a sign of poor vigour. This comes out of the work of Eyre and Zillgitt in the 40s. It is a very good sign to use with hardwoods. Look for the mortality among upper canopy branches. If it is there you have low vigour.

Not leaning more than about ten degrees. That is obvious. If they are leaning over too far and they become loaded with ice and snow, they can come down.

So when you look at a tree you have to ask: is that something to work with or at least something to hold on the site in the interim while we make a change in the condition of the stand?

Let us consider two cases, the "purgatory" group, where there are at least some good residuals and we might have some possibilities into the future, and then the poor group that really have very little promise. What might be the options for those? We need not consider trees that might be managed under traditional silviculture, even though they may be low density. If there is an adequacy for silviculture, let us not think about them at present. We have already treated that part.

So we have case "A", where there are at least some residuals that have a potential for the future. There will probably be insufficient numbers of them for full-site utilization. We are below that "B" level. But there are some of them worth keeping. Often their density is way down. There is a general rule of thumb with these relative density guides that any stand that is at 45 percent relative density will go up to the "B" level within a 15-year period. In other words, they should be at full site utilization within about a 15-year period. That is assuming reasonable distribution of the trees across the site. So one of the thresholds you might consider here: if it is below 45 percent relative density, maybe it is better to replace that stand rather than try to do anything with it into the future. The objective here is to retain the best trees into the future, and to create a new age class underneath them.

How do we do this? We should start by reducing the residuals to a wide spacing and a uniform spacing to the degree we can do it. We want to concentrate that growth potential on the best trees, even though there are relatively few of them per unit area. If there is desirable advance regeneration, we want to be sure we release that to promote its growth and development and establish a distribution of new trees that is as uniform as we can. That may mean some remedial measures to establish new trees where we don't have advance regeneration.

We can consider the even-aged stands and how we would do this. We would pick out trees that had uniform spacings and your reconnoiter of the stand would tell you if you could leave one every 50ft, or whatever spacing it is. You can come up with an average just walking around a stand and using your judgment. And what you are doing here is trying to leave some degree of uniform cover that would resemble the kinds of characteristics we associate with the shelterwood method, where you get some mitigation of environmental conditions, where these trees (if they are old enough) are casting some seed across the site. Because you are trying to establish that second age class beneath them. Now you probably won't get perfect distribution with those trees, but you want to work toward that. And that may affect your judgment on how many to leave. A stand given that kind of cutting would have very wide spacing, a lot of light at the ground stimulating a robust understorey response. We are building a two-aged stand. That is one direction we can move with these stands that have some promise in the future in the sense of having some trees worth keeping and where there might be a seed source amongst them.

How many trees can you leave? All you can. Here is a presumption: if we are thinking about two-aged silviculture and we want to have half of the crown space occupied by each age class, and we want to grow the trees to about 40 or 45cm by the time they get to maturity, they would then have a crown radius in Sugar Maple somewhere around 5m. So if I keep those trees at a 12m spacing, I would have about 75 trees per hectare, just under $4m^2$ per hectare. That is very low. But that is about the level of stocking that people like David William Smith are talking about for two-aged silviculture, the reproduction method. So we are leaving them there primarily as a seed source. We also leaving them to grow into the future as an upper age class while a new age class forms underneath.

In parts of the United States, we have regulations which say if you drop below certain threshold densities, you have a clearcut and, if you have a clearcut, you need a permit. If you have these kinds of regulations that require a permit, then

I would say start by keeping extra trees. Keep that stocking above the threshold density for a permit. Keep them on that spacing until the new age class grows up enough to give you the extra stocking where it would no longer be jurisdictional to remove more of the poor overstorey trees. So you might end up with more trees than you need in the long run for two-aged silviculture but, for a short period, those extra trees are stored on the stump. They will mitigate changes in environmental conditions. They will probably cast some seed if they are vigorous enough. And then you can come in as a second entry and reduce it down to a more reasonable level for two-aged silviculture.

Don't ignore the interfering plants in these even-aged stands; that is very critical. An example is Hayscented Ferns. The general rule of thumb we use is that, if these interfering plants occupy one third or more of the ground space within a stand, you need to take some deliberate action to reduce them. Otherwise, in the case of something like Hayscented Fern, with a heavy cutting they will just spread across the area and then there will be no regeneration. It just will not come through it. The only way to control that stuff is with herbicides, a combination of glyphosate and sulfur-mefron methyl. It takes that mix to get an effective control. Also don't forget about things like Striped Maple. It is very shade tolerant and then, when you open up the stand and you get high light levels, it just grows very rapidly. If it is a pre-existing plant, you will have seeds within a couple of years and those will germinate and grow and it will compound your problem. And it will be around for 25 years before it dies back again.

The most cost-efficient way to deal with these interfering plants is with mist-blown herbicides using a blower mounted on the back of skidder or a track laying vehicle, that will cost about $400 per hectare to do that treatment. If you don't do it, you get nothing, that is the alternative.

Now consider uneven-aged stands. Again you are reducing your regular stocking to low levels of density. If there is no saw timber left, then you have to reduce the stocking of poles so you begin to speed the growth and development of them to move into the saw timber status for the next entry. And you want to start adjusting the proportion of poles and sapling size trees. To begin rebuilding some kind of a structure within the stand. In stands lacking saw timber, you could try to leave two thirds of the basal area in poles. This would be trees greater than 15cm. You would try to uniformly space out those residuals so that they are not all clustered together. And you would keep as many large poles as you absolutely could, those over 20cm. That would be the first entry. Try to promote regeneration in the space between those trees. The key here is that if you don't have advance regeneration, you probably won't have a seed source and that is going to compound the issue.

Now consider the case where there may be some saw timber present. You can adjust the spacing across all the size classes. For the large trees, we can keep them at uniform spacing, probably at wide intervals. You may have to take out some in order to get some revenues to help pay the costs of these operations. You should begin to balance the age classes to the degree that you can, that is, regulating the proportion of large, medium and small size trees. And start a new age class if possible. If you have advance regeneration you can release that and you are on the way home. If not, you have to somehow establish a new age class to fill those voids, even by artificial methods. You can look for 12 to 13m^2 per hectare, if you can find it, as a total stocking within the stand. Ideally you would

have 20 percent of that in trees less than 15cm, 35 percent in trees 15 to 30cm, and try to get 50 percent in trees over 30cm. That would give you a cutting in about another 25 years, an operable cut, based on our simulations. For every additional square metre per hectare you leave, you can probably reduce the cutting cycle by five years. Work at readjusting the spacing, and trying to get an intermixing of trees of different age and size classes. It won't be perfect, but get as close as you can with each entry to the stand.

For the new age class, if you have that advance regeneration, then it is easy. Your cutting should release it and it is going to go quite well, particularly if it has any size to it. But so many of these stands, in our country anyway, have begun to see a Beech understorey built up because the Beech have been left. The logging disturbs the roots. The disturbed roots form callous, and adventitious buds form in the callous and that results in new root suckers. So the logging process actually helps facilitate the build up of an understorey Beech component. If it is present you have to remove it. Where we have a Beech understorey that is fairly dense, we have no tree seedlings of other species. We have reduced herb component, we have reduced herb diversity. The result of taking it out is you will get an understorey response if there is a seed source of Sugar Maple. You are changing the quality of light sufficiently that you will get a regeneration response. We have been able to do it on multiple sites. If you have promising trees, control the spacing and the stocking. With your first entry, be thinking about your long-term structure and move as close to that as is feasible.

Now, consider the stands where there is really very limited promise. You don't have enough acceptable trees to really work with. They are mostly poor in condition and low in vigour. All of these factors will confound the problem of getting a new age class. The objective here is to get rid of the low-grade remnants. You have to clean them out and you have to create a new age class. The problem here is that you may have so little volume that you can't operate these stands without investment. In the other cases, by going to low densities, you can often get at least sufficient volume to pay for the cost of the operation. But in most truly exploited stands you will not find enough volume for a commercial sale. You also probably won't have enough seedlings to fill the voids, and you will also have interfering plants to contend with. These may have been the stands that have had a couple of diameter limit cuts. They are really ugly. The tendency is to turn your back and get in the truck and go home.

Here is what you must do: you have to get rid of those dregs out there. They will never develop into useful trees, so get rid of them. If you find suitable trees, particularly if they are big enough for a seed source, leave them, even if they are widely spaced and irregular. You likely need to do site preparation to reduce the interfering plants. Because if there is a lack of seed source you probably have to intervene by planting to put back trees that won't be there naturally. Herbicides turn out to be the most cost efficient way to get rid of the interfering plants, primarily because there is probably not enough volume for an operable cut to bring in a contractor. If you have a firewood market you may be able to recover them. But stem injection with any one of several herbicides will work quite effectively. Don't forget the small trees. With the small ones under about three or four inches in diameter, you can use a basal spray, something like Garlon 4 in oil will work very effectively in killing them. With the bigger trees, you have to put it in through spaced axe cuts or overlapping axe cuts. The feller buncher may help us here. That is, if you have a market for biomass wood, they can take that stuff and put it into chips and they won't care about the quality of those

trees. The key is whether there is sufficient volume per unit area to sustain one of these operations. Ideally you want to do "cost-neutral" treatments, meaning that you try to recover sufficient revenue from the stand to cover the cost of doing the work. Forget about making a profit. But if you can get enough volume to pay for the costs of what you need to do at this time, you at least move into the future without having made additional unpaid investments in the stand.

Where you have advance regeneration, you can take advantage of that by releasing it. That is the optimal situation. Hoping to get something that will be filled with trees of some promise and a new age class. If you have too little or no advance regeneration and there is no reliable seed source, then you have to invest in tree planting. Often that has to be coupled with site preparation. In these kinds of circumstances, either you have to clean out everything, or at least invest in regenerating those areas that are now occupied by interfering plants and where there is no promise of new trees forming and developing. Here again, the mist-blown herbicides are probably the most efficient way to get rid of the unwanted vegetation and start over again. This is a last ditch effort. This is trying to pull ourselves out of a deep hole. Then you have to follow that by tree planting and, at least in our country, we have not had good luck with planting hardwoods. So, at best for a period of time, you will grow a conifer mixture with whatever hardwoods are left and probably pick the local indigenous conifer species that has at least some commercial value. If you are not worried about bringing in exotics and you know an exotic that has a good promise for the future, go ahead and do that. You make that choice. But establish a plantation, even across the whole area. Now it is true there is a lot of concern about converting to plantations, but here is a case where there may not be any choice. It is a real cost to salvage the future and that is going to be the problem, that you will find people unwilling to make these investments. Then they have to sit there with a degraded stand and probably get nothing out of it for a century. I think it is best to look for a cost-neutral way you can go about this work. Try to figure out if there is sufficient volume you can recover to pay the costs of getting the other work done.

In reality, what might a rehabilitation treatment look like? Here, I want to refer to the work of Jean Martin Lussier. A couple of years ago, I had a chance to visit some sites he was working on over in Quebec. I became really enthralled with the idea of what he is trying to do using feller buncher technology to implement the treatments. So I am stealing from him an idea. He said it is okay. But let us give credit to the Canadian Forest Service and the idea of capitalizing on feller buncher technology to operate commercially. The work is being done not only by Jean Martin, but Phillippe Meek and Daniel Pin over in Quebec. We can make an illustration based on their work. Let us imagine a residual stand from past diameter limit cuts. Now this is probably of the "silviculture purgatory" category. Not the really bad kind. Consider there have been three age classes here because of past cuts, represented by the tree sizes. You will see patchy distribution of trees of different sizes. That is characteristic of diameter limit cuts. But here is the genius of what they have done. They recognize that from place to place within the stand, you actually get highly variable conditions. In some places it may be quite good. In other places quite awful. It would be unrealistic to come up with a single prescription that you would apply uniformly across the stand. Instead, let us go from place to place and treat what we find on the ground, taking advantage of the variability that is out there. It might be situations where you must do a complete rehabilitation, and some you have opportunities to do some work. There is a choice that you make. There

are four options to consider. It could be that you do partial cutting at some places. Elsewhere you might do overstorey removal which would be equivalent to a small clear cut to release advance regeneration. You might have some cases where you need to go to a shelterwood seed cut to build up advance regeneration and then eventually take it off. Or some other circumstance. The key to this is that you train the feller buncher operator to recognize conditions which would lead to one of those four choices. The treatment area for the feller buncher operator is what they can reach with the feller arm from any given position. Picture it this way: the platform of the feller buncher positions itself in a spot and the operator looks around and he says, "This is condition number two." So now he reaches out and applies prescription number two at that space. When that is done, the machine moves up. The operator looks around and says "Oh, this is condition number four." And so, at that space within the reach of that machine, he creates prescription number four. So it is kind of a moving bubble where, at each stopping point, the operator makes a decision based on what is seen in the immediate vicinity.

It could be envisioned this way: the first thing you are going to do is decide where these feller buncher trails go. You could space them out based on two entries to the stand, or three entries; whatever looks reasonable for you. The first rehabilitation treatment, then, will be done along these feller buncher trails. Again, the key is that the operator will treat what is in the immediate vicinity of the cage, what they can see within the reach of the feller buncher arm. So here is the first strip that goes in, and in this case there are some older trees that they can leave as a seed source. Maybe there is another case where there is really nothing worth keeping at a place and the operator takes out everything. So that across the stand you would have many of these treatment circles, each with a residual condition matched to a specific prescription. The genius is that you treat what is immediately around you. You do not fight the variability in the stand, but you capitalize on what you can develop as a prescription for that point, and then apply the treatment.

As time goes on, the areas that you have treated grow up. Now you have a second series of feller buncher trails that will go through the still untreated parts of a stand, and you are going to apply prescriptions to those during the second entry. Maybe then you have a third time you are going to go in and do another treatment. Eventually what this will lead you to is an uneven-aged condition that will be comprised of a series of groups or patches and partially cut areas, and then eventually you can probably get into an uneven-aged kind of silviculture. The strategy recognizes that diameter limit cutting leaves a patchy distribution of residual trees. Take advantage of that. If you have no interference, you should be able to establish a new cohort from residual trees that are nearby. You may find acceptable trees so you want to keep them. You may want to thin around them and release them to promote their growth and development. Wherever you can leave an upper canopy tree that is a seed producing tree, you want to leave it to help you get a new age class. In Yellow Birch country, you have more flexibility than if you are dealing with Sugar Maple, for example, because of the seed dispersal pattern. You may need to do site preparation and this may mean, going up and down the feller buncher trail, perhaps with a backpack mist blower mounted on the back of an ATV, and treating small areas as you go. In one area, they wanted to scarify for Birch, so they had the feller buncher operator drop the arm down and scrape it back for a couple feet to leave these little scarified patches to increase Yellow Birch. Use creativity. That is why we are here.

This is a very creative approach which, in a sense, is recognizing that in some parts of the stand we can practice silviculture. Some parts of the stand we can do "Case A" kind of rehabilitation. Some parts of the stand we need to do "Case B" rehabilitation. We are use creativity and imagination and treat the stand as we find it.

Diameter limit cutting and other exploitive treatments have really robbed us of opportunities. I think that is the conclusion of it all. In many cases, landowners will be tempted to just pause and wait it out and sometimes that works. As trees grow, size increases, volume builds up and then we may be able to return and do something where there is a bit of revenue to pay the cost of treatments. In some cases, you may want to put it on hold for a short period of time. Don't put it on hold permanently but put it on hold until you can do something. Remember that if you ignore the problem it doesn't get any better. Some people just turn around and sell the land rather than treat it. That is what is happening across the northeast of North America today. I think it is better to begin rehabilitation by removing the dregs, stimulating the regeneration that is there, doing some fill planting, and adding other treatments as funds permit. But get started on it as best you can. Clearly, the amount of money a landowner can afford to spend on the operation, coupled with how much they can generate from a rehabilitation treatment, will determine the kind of rehabilitation that you can do in these cases. If you ignore the problem it just passes on to someone else. A couple of you have mentioned that you now have lands that were cut over in the past. Someone passed the problem on to you. We need to not pass it on to the next generation of people. I would say you should do something, and if you look for trees with good crowns and bowls, you keep the best and cut the rest. You cut to some minimal operable state. Don't try to make money but try to make it cost neutral, if you can. Leave trees at good spacing, uniform is best. Start a new age class and do site preparation. If you can do that, we have a potential to begin rehabilitating these stands. I think you need to do something.

Here is what I say to landowners. If you haven't done it yet, (that is the diameter limit cutting) don't do it! If you are doing it now, stop! And if you did it already, rehabilitate the stands. The choice is out there for people.

Circle Talk

Mark MacPhail, *UINR*
"Circle Talk" is a common thing in Mi'kMaq culture, to have an exchange of information. After these past two days, we have heard a lot of different thoughts, a lot of information to absorb for people. What I, as the Forestry Manager for UINR, would like to see following this two-day conference, and perhaps with the aid of the Circle Talk, is to decide what is our next step. Where do we go from here? With the management of hardwoods in Cape Breton Island, what are some of our options? We had a diverse spectrum of speakers from very technical to the more environmental. It was a nice combination for people to absorb and see where people's thoughts are coming from about hardwoods and how we should manage them.

Ed Swift, *CWFC*
We can start off with a series of questions. One thing that frustrates me is we have these workshops and everybody leaves with a new knowledge, but you never know what people wanted, was it good, where we should go. I think we can have a lot of people from different backgrounds because we are now in a global world. It is more than just Cape Breton that you are dealing with. There is a whole world out there that influences us.

I guess we could start with the first question: if we were going to do this in two years' time, what would you want us to improve upon? What topics would you want us to handle?

Mark MacPhail, *UINR*
As far as another workshop, Ralph had some ideas for questions and topics. I think even before we jump into our next workshop, I'd like to take some of the information we've been taught about tried and true methods of improving the forest, and maybe actually do something on the ground right now. The next step for me, personally, will be to implement that. I spoke with Tim McGrath, who is the hardwood guy with DNR, and his boss and they said they would like to do something with UINR. So maybe a workshop with people who have been implementing and maybe some contractors who know what works, and consider things like what machinery is the best to use. Where do we go next?

Martin Béland, *University of Moncton*
Maybe a field tour to visit these projects?

Mark MacPhail, *UINR*
That is a great idea, yes. There was a conference back in 2003 that Tim McGrath hosted and it was quite educational. We went out and actually visited a lot of the sites that were treated, and the controls versus what he treated, and showing the different options. That was going on six years ago now. So it is kind of hazy right now. So maybe the next step for UINR would be to see some on ground stuff.

Ed Swift, *CWFC*
One of the best examples would be if we go to Black Brook and see what JDI is doing. They have been into hardwood management and they are actually

playing with LIDAR this summer. They have got things worked out. There is a little group that I work with in northern New Brunswick, simply because that is where the hardwoods are in New Brunswick, in the northwest. I could also arrange trips to go into the States if we wanted to see stuff.

Dave
In a management plan, we determine what are the landowners objectives. I think one of the most important things to do early on is to determine what are the objectives of say, the provincial government on the crown land? Of New Page? Of UINR? I think those are important questions to ask. Are we looking for really easy ways to market the wood, or looking for added value, or are we looking at enhancing the biodiversity of stands? Those kinds of things are all good questions to ask right at the outset.

Mark MacPhail, *UINR*
Just to go on that question, Dave, I think even within a community like, say, Eskasoni, the objectives of even different community members would vary quite greatly. For instance, the objectives of Albert Marshall are quite different than the objectives of the guy that wants to get a job and make money. Maybe not too far away, but on the onset they could be quite different. And how do you get a best match, to meet both objectives, and of the community as a whole? I think some community consultation might be in order, and working with New Page and the Province.

Jean-Martin Lussier, *CWFC*
I don't know how to do it, but we need to link different jurisdictions to the expertise of each other, an inter-provincial community of practice. We are starting to have common projects between Quebec and New Brunswick and it is not very easy to share information. Just being here for two days for me has been a big bath of knowledge and wisdom. I know in all areas we have good stories and bad stories to tell, and we could probably learn from each other and avoid bad stories in the future. So how do we do that? I think one thing would be, if it is possible, to broaden the invitation if there are other meetings, and instead of saying we are going to work on Nova Scotia problems, we could say we are going to work on Eastern Canada problems. I know, for instance, the restoration problems we just considered are common in Ontario and Quebec and there are people in different places working on that. But we don't have a lot of occasion to share the experience. I am highlighting a problem, but I don't know how to answer that.

Martin Béland, *University of Moncton*
Maybe to inform people, Ed and I (and Jean-Martin is also involved), we have a project with the Canadian Wood and Fibre Centre. We hope to get money soon from the National Research Council. In this project, one of the topics is to build some kind of hardwood task force for the hardwood community of Eastern Canada. So far, one of the ways we think we could do that, because it is quite a large distance from across this region and quite a lot of people to gather up all the provinces, is through the Internet. We need also gatherings and meetings. But what we suggest is to start some kind of strategic planning process through the Internet, through the course of about two years. That is the plan. Start inviting people to participate and basic steps would be identifying the major concerns or problems facing the hardwood management, and share the common views and the finish of the problem, also the strengths and weaknesses of the group solving these problems. All the typical steps of strategy

planning, and ending up with some solutions and sharing ideas to implement these solutions to end up with a work plan for the whole group. So we are trying to make this a structured, common effort for the whole hardwood community of Eastern Canada. That is an ambitious project.

Mark MacPhail, *UINR*
That certainly is a good idea. The more people involved and the more ideas, the better information we will have in the end. And that is thinking outside the original idea of hardwoods in Cape Breton. Eastern Canada has, for the most part, very similar types of problems and issues and we should be looking at a broader spectrum, and that way we will have more partners to try and restore some of the forest.

Bob Bancroft, *Biologist*
I think it is excellent information, but it is very compartmentalized. I see two levels here that we should probably consider pursuing. One is the way that you have just been talking, because you don't finish a big wood pile all at once. You take it a step at a time. But I see it as a much bigger issue than hardwood. I really think that we need to get down to what the community wants. We need to get down to deciding on a land ethic. We have got to start doing land management and water management together which transcends individual governments. How do you separate the water from the land? I realize that everybody doesn't think like Mr. Marshall or me but, as a biologist, I graduated with a couple of degrees and I very quickly realized that forestry was manipulating more habitat for animals than a biologist did flogging around by himself for a lifetime. So I bought a piece of land so I could learn on a piece of land. I love trees, but to me it is habitat. All the other things that can't be here to talk because they don't speak English or Mi'kmaq, they all have a right to be here too. Somehow or other, Russ and Bruce have got to make money, and even the Canadian Forest Service is supported by industry and tax payers' dollars. We have to resolve this issue of where we are going to go. What I see in government right now, is people torn apart. We have a separate moose policy on the mainland. We should be looking at a land use system that basically takes account for the different habitats, the different animals that use those habitats and, in most cases, we can manage and we can make a profit (maybe not as much at once) and figure out if we can do it and still maintain these things. And then there should be exceptions that come along. We should be striving for the forest restoration that Dr. Nyland is talking about, but I think we have to do it in a context of a community understanding what is going on and why and the government's understanding. I really think it is a larger task than what you are talking about. It sounds so holistic, but if we don't do it, if we just keep working in our little silos, it is not going to happen. It doesn't mean the silos aren't doing worthwhile work. But it is very narrow.

Ed Swift, *CWFC*
Maybe these workshops are a start of being able to work together and share our ideas. It is not going to be an overnight thing that we restore the forest or find ways.

Bob Bancroft, *Biologist*
I have been working at it for 33 years, and some of it does work.

Ed Swift, *CWFC*
But I think it has come to a point where we have to think outside the box. I'll explain what FP Innovations is. Paprican was always private, it looked after paper. Foratech was part of us and at one time they looked after timber structures. The rest of CFS sort of did environmental things and industrial forestry things on the silviculture side. I think it is a great idea that they decided to build FP Innovations. The CFS component, that is what Jean-Martin and I are, is 20 percent of the contribution–they took 20 percent of the resources so they are getting this whole thing streamlined. We also, in our documents, have to consider environmental things. Although some of my colleagues in the Division are thinking that it is going to go back to the way it was before, and they are still very much entrenched in "I am very much a part of this Division", they don't realize that, as of the end of this year, there will be no ForaTech. There will be no Paprican. There will be FP Innovations. Wherever it goes to, it is not going back to the past. And I can see forestry going that way. We have to find ways to keep some of the bigger players here being profitable. We have to get some of the smaller ones and we have to all work together. And yet there is a lot of information in there, a lot of expertise, that we started thinking how to do things differently, how to work together. And I think here is the time to do it because we are at a point where forestry in Canada is at a change. It is probably the most exciting part of our careers. George keeps asking us, "How do you expand out of New Brunswick? How do you expand to Eastern Canada?" So here may be the opportunity to start that and I can always look at George and say, "It was your idea, you told me to." If the Fibre Centre works, then we may not have to worry too much about partnered money, but it will help. They are going on Memorandum of Canada. They realize the industry in the provinces is in a bad state. So we can start building up and rehabilitating even forestry concepts and ideas. I think there is an opportunity here.

Bob Bancroft, *Biologist*
I really think we need a land and water ethic that goes beyond forestry. When you read books like Jared Diamond's *Collapse*, and you head off in directions and there is too much exploitation and say that the way to deal with this is at a level of, whether it is forest communities or communities, that you have got to get together in a way that you are not stabbing each other and you are respectfully discussing things. You've got to make adjustments. If you read that book, *Collapse*, that is exactly how people have got to overcome the major obstacles, is to work together in cross sections and understand each other and have some faith that humanity can change course in a beneficial way.

Mark MacPhail, *UINR*
I have a comment just on Ralph's last presentation, talking about degraded stands and forests and rehabilitation. Do you think, speaking about the bigger aspect of the wider spectrum, that these degraded forests or stands are degraded wildlife habitat?

Bob Bancroft, *Biologist*
Yes.

Mark MacPhail, *UINR*
So you do? So you think there is going to be an improvement both ways?

Bob Bancroft, *Biologist*
To answer, in my stands I saw mink and otter tracks all over, looking for denning logs. So my answer to that was, my wife follows me at a respectful distance with the chainsaw now, and she lays out the brush like a tree would fall. So the small animals can move up and down. It is not a new idea and it is not my idea. But the other thing I did was, I got a contractor to save me big, hollow, hardwood logs. People don't want to buy them as firewood because there is this big hole. I just drag them out in the woods. So there is all kinds of degradation for wildlife habitat and there is a lot of displacement of animals. There is a lot of decreases of population.

Mark MacPhail, *UINR*
A lot of the talk over these last two days has been about increasing the value and most of us are thinking about dollars down the road. I'm just wondering, by making that step in that direction, can we also bring up the wildlife habitat in a much more positive manner?

Bob Bancroft, *Biologist*
A quick example: there is science now that first came from Scotland. I had all softwood trees along the waterway, just a small brook. But needles don't do much for an aquatic food chain. Hardwoods do, and that is what was there in the first place. There are all kinds of things that I think we could work together on. Good forests make good wildlife habitat. There are ways of restoring the degradation.

Ed Swift, *CWFC*
But is the solution to form another committee amongst ourselves? Because my job is not to form policy. My job is not to tell you how to manage. Mine is to take problems and try to find solutions to them. If I can't do it, I try to build a team that can, or direct you to who I think has the expertise for that. That is basically my whole career. And there is an awful lot in the literature. I am beginning to discover that there isn't a whole lot of new things out there, even if they put them in the proposals. Because if you dig deep enough, somebody has looked at it before in the literature. So what are our problems? When I talked to Patricia, she identified two problems that are difficult: one is, who is going to pay for the degraded stands. Now that is key. Nobody wants to do it, yet we have a lot of them out there. So do we just wait through time or do we try to find mechanisms like the Fibre Centre that would do that and ways to do it. And the other thing is, even if you do that, we are having difficulty getting good, qualified workers that are willing to do the work. Those are two really tough questions for me to answer.

Jean-Martin Lussier, *CWFC*
I'm involved in a pilot project on forest ecosystem management and I am on a small committee on solutions and the problem we have is the problems are not defined. Everybody agrees we need to do restoration. In the territory we are talking about, the major issue is restoring a proportion of mature and over-mature forest. That said, we are lacking more details on targets and what is a mature and over-mature forest. How do you define this? What are the attributes we want? Often, we do have the means or technical stuff to do it, but we need an objective. Setting the objective is the whole problem.

Unidentified
You need a toolkit.

Jean-Martin Lussier, *CWFC*
The toolkit already exists. For instance, for coarse, woody debris what is the number we need? So there is a technical issue there. This is probably an easy one to tackle. The harder one is a multiple objective management plan. So there are many stakeholders. How do you agree? How do you set priorities? Is it only a chamber of commerce type of situation? How are decisions made? In this part of the country there is a lot of interest in moose hunting. If you increase the amount of old growth forest and mature forest, the moose population will decrease necessarily. So you can not have both, a very healthy ecosystem and a high moose population. How do you make the choice? So we know the technical issues, but we have to have some decisions and the decision process is not clear. Often we are pointing to the lack of methods. The methods are potentially there. They are quite easy.

Bob Bancroft, *Biologist*
We are not going back to an old growth forest everywhere on Cape Breton Island, though. The moose are a disturbance forest animal.

Martin Béland, *University of Moncton*
Maybe a comment on the need to look at the broader picture. The process you propose through this project of making a task force, I think, could include such topics as looking at the broader picture of landowner objectives, also, as one of the problems to solve. It could be part of the discussions taking place in this group.

Mark MacPhail, *UINR*
I don't know if you guys are ready to respond, but Bruce or Russ, is there anything New Page with the crown lease, do you guys have any ideas in the future, or is it kind of obvious? Everybody knows it is a softwood mill that is operated there. Is anything planned?

Unidentified
We have a mill that uses softwood but we also have a crown limit that is 40 percent hardwood by volume or, if you include the mixed wood, it is probably more like 50 to 60 percent. So we certainly have an interest in hardwood management as well. The market for hardwood has been relatively small in Eastern Nova Scotia until recently. In fact, it is still very small. The potential with bioenergy and all the other stuff that is going on would be significant and larger as time goes on. We are certainly very interested in that. But I think the problem is we have lots of good research that has been done, lots of good knowledge that is in that base, but the problem is translating that to the people that are actually doing the work on the ground. We are sitting here talking about this but there is harvesting going on now, everyday. Not large scale hardwood at the present, but it is getting larger. Even with the hardwood market, it is getting larger. So there is a great opportunity there for us to implement some of the stuff that has been talked about here. I think concentrating on getting the message out to people who actually do the operations is probably the next step that should be taken. We have had our staff here, and I know our staff are going to go out and implement a lot of the stuff we heard about here because, when we do hardwood management, we do it with the objectives that we want to improve the stands and grow for the future. The challenge in Cape Breton is like we heard about in Quebec, we have some good stands and it is easy to deal with those. We also have a lot of degraded stands, and it is very difficult to deal with those economically. It is

easy to tell you what to do, it is not easy to find a way to do it economically. So that is another area that I think we could spend some more time on.

Ed Swift, *CWFC*
So would it be helpful if we came up with designs that we test and start building proposals and start to learn how to?

Unidentified
Yes, I think that would be helpful. I think spending time with training courses designed for operators would probably be as helpful as anything. Seeing what people are trying to do with the woods, how they are trying to deal with problems, facing the day to day economics they have to face, and seeing what kind of techniques could be used to help workers.

Patricia Amero, *Picea Forestry Consulting and Woodlot Services*
How much those things cost; that is the thing. Maybe we need to have a trial area so contractors realize how much these things cost, because they do cost money.

Ed Swift, *CWFC*
You could build that into the training.

Patricia Amero, *Picea Forestry Consulting and Woodlot Services*
Yes. That is part of the training. Now, in the project I am doing, of course it all comes down to economics. So I am thinking it would be great to even have some kind of template or something for contractors to use. With this restoration, there is so much time involved and the material that you are getting is certainly not even a break-even venture. What are the costs involved on the ground to get it done successfully? Where does the money come from? It comes down to that question. Where is the money going to come from to help pay to have this done?

Ed Swift, *CWFC*
We can explore avenues. I know in Quebec and in Ontario that part of FP Innovations is to start addressing that. We could talk to Denny and ask for a sub-component to be down here in the Maritimes. There are efforts where there are other divisions to start building large projects and start addressing these economic things.

Jean-Martin Lussier, *CWFC*
Particularly for this province we are talking about, I think one problem is the lack of the tool to assess the current potential value of promising trees. We are talking about degraded stands. The first time I worked on that, we discovered that only half of the stands were really degraded, that there were no promising trees in them, so that we have to start from scratch. The other half we were saying the stand was degraded only because there were a few trees with actual values, but it was a sea of saplings and seedlings with potentially high value, but there is no way to appraise that correctly. So when you are improving something, there is nothing to measure the improvements. So there is no way to be paid on that. One question is, are there any tools in your part of the world that helps in that way?

Dr. Ralph Nyland, *SUNY-ESF*
You mean for valuing the potential quality of small trees?

Jean-Martin Lussier, *CWFC*
Yes. I don't know if it is possible to say, "I have inherited a stand at this point of the value, and I've gone out and I've improved it by five percent or 10 percent, even 20 percent of the potential value of it?"

Dr. Ralph Nyland, *SUNY-ESF*
The only criteria I know were developed by Stephen Boyce, and he came up with a grading criteria for sapling size trees, trees less than 12 inches or 30 cm in diameter, and a rather unique approach. He counted the number of grading defects on the bottom 12ft (4m) and if there were fewer than four it would potentially be "Grade One". If there were more than eight it was going to be potentially a "Grade Three". We tested that on larger trees and it seemed to match up pretty well with the Forest Service standard grading practices. One of the things you might do is use something like his Growing Stock Grading Standards to determine how many trees you have with potential "Grade One", and then if you have growth values you can project them into the future and see what their sizes would be at given times and calculate returns on them this way. That is the only set of guidelines or criteria that I know about. I think Sunderman may have later re-issued those.

Martin Béland, *University of Moncton*
Ed and I have used those for our study of pre-commercial thinning in New Brunswick.

Dr. Ralph Nyland, *SUNY-ESF*
Boyce was the one who really got that started. You can go to the publication by Trimbal. Trimbal worked in West Virginia with the Forest Service research, and he evaluated the development of sapling size trees based on their structural characteristics, and set up some guidelines for acceptable/unacceptable trees based on their characteristics as saplings, that is, not bigger than four or five inches in diameter. And those could be used as well.

Bob Bancroft, *Biologist*
Does it take into account the fact that deer come along and take the velvet off their antlers on them?

Dr. Ralph Nyland, *SUNY-ESF*
Well, it looks at defects on the stem, at forking, at straightness. I think it separates out single stem versus clumps, things like that.

Unidentified
There may be some things that have been developed where people have done a lot of hardwood spacing already, because the guy with the spacing saw has to recognize those same things. I think they are fairly simple rules. In my years at Naqawick, they had some basic rules. I wasn't involved in that area at the time, but there were some basic rules about species choice, obviously, but then form and that kind of thing. It doesn't have to be too complicated I don't think. It is better if it isn't, or it would take too long to assess an area.

Unidentified
In Eastern Nova Scotia there are a lot of hardwood stands that are degraded, and that is the challenge that we have, to try to restore those back and historically, they have been clear cut because it is what people know and it is predictable, and there has been some success in regenerating more desirable

species. The downside of that is that the forests in Nova Scotia are much younger now than they were historically. Even if we get something good in several decades, there is still a long period there where there is still a lot of young forest. I heard some ideas like the work that Jean-Martin and others have worked on of doing more patchy harvests and having more structure left in the forest as we go. I suspect the downside of that is the added cost. I'm curious to know if there has ever been a comparison in the cost of clear cutting versus those types of methods. And if there hasn't been, that could be done so that we've got some numbers that we are confident in, and then decide whether it is worth it.

Jean-Martin Lussier, *CWFC*
There are numbers. In (unintelligible) it was profitable, more profitable than clear cutting, because clear cutting, you are removing a lot of small trees that are low in value. It is far more cost effective than attempting selection cutting. In the report you have cost estimation and people are very happy about it.

Unidentified
Do you know if that kind of thing would be applicable to Nova Scotia, where the forest might be more degraded than that location?

Ed Swift, *CWFC*
It depends on the curves, because I had a commercial thinning study that was way off the curve for the tree sizes. But the curve was so flat, Phillip said, "That is profitable, just way back there." So it depends on where it is on the curves.

Unidentified
You have to consider our forest is very different. We don't have the tree height that Ralph showed us. The only places you find tree height like that are down in the sheltered valleys in Nova Scotia.

Dr. Ralph Nyland, *SUNY-ESF*
But you will notice if we went to parts of New York where they have done this diameter limit cutting, they are spotty forests. The tall trees have been taken away. I think we have misjudged the growth potential of our sites because we are looking at trees that are the dregs. You may be surprised at the height you could get on some sites.

Unidentified
The site is better than we think it is.

Dr. Ralph Nyland, *SUNY-ESF*
Yes.

Ed Swift, *CWFC*
If it is like PEI, it never had a chance to show its true height because you have already cut it again.

Unidentified
Certainly one of the biggest challenges in the short term is that a lot of these stands have almost no saw log content. Ten or 20 percent is good for these sites. If you target all of the best, cherry pick the stands, you might have 45 percent and that would include pallet wood, which is a very low-value product. The challenge is you end up with so much low-grade material generated to

generate those higher quality saw logs and the occasional one or two percent veneer. So you have this huge market issue.

Jean-Martin Lussier, *CWFC*
The first step would be a field trip.

Group
Yes.

Ed Swift, *CWFC*
Is there anything you didn't like about the conference? If we did plan another conference or workshop, what would you want included or how would you like it handled the next time around? Do you want another one?

Unidentified

I think as already mentioned, a field trip component to have a look at some of these treatments in actual use would be very helpful. Also, trying to target the audience to get more actual contractors to attend.

Mark MacPhail, *UINR*
Yes, and that was addressed. When the timing for this came around, first weekend of July, a lot of people are on vacation. I was talking to a couple of co-workers of mine and they were talking about it being on a Tuesday/Wednesday. For the average working man, he can't afford to take two days off work. There were barriers to putting it together and trying to accommodate everybody. But yes, it is getting the contractors, the people who are actually on the ground with the powersaw or the piece of machinery, it is those guys that need to be educated. These managers can tie ribbon or spray paint, but it is the guys out there that we need to reach. Even when you are tying your ribbon or spraying your paint, leaving your crop trees is no good if they are brushing up against it and banging them all up either. So it is a real education process for the people, and I think that is what we will probably go for next time.

Ed Swift, *CWFC*
Do we want to do it sooner than two years and aim at a workshop just for contractors, and address your restoration?

Unidentified
I don't know if you'd say "just for contractors". I think that it is useful to have the whole group together. I think the other issue that has to be addressed is the economic issue. Biomass may be part of the solution but I don't think we should put all our eggs in that basket, because it may turn out not to be as profitable as everybody is dreaming it is going to be. In fact, I'm sure it won't be. People don't high grade because they are stupid or because they are greedy, they high grade it because that is the way they had to survive. They can't afford to do anything else. If you've only got so much money that is going to come in, you are going to survive. You are going to feed your kids and that is what you are going to do. Sure, New Page can enforce regulations and avoid high grading, but an individual contractor or private landowner who only has so much money to invest in his woodlot is going to have to get some value out of that woodlot if he is going to carry out an operation in it. Somehow or other, we have got to address that economic issue.

Ed Swift, *CWFC*
So should we put a committee together and start seeking out that information? Do you want a committee put together? I hate to use the word committee because we have more committees than we need.

Unidentified
Well, we already have a Hardwood Working Group in the province that is quite active.

Ed Swift, *CWFC*
So should we request them to do that?

Mark MacPhail, *UINR*
I think maybe, in a setting like this right now, it is a difficult time to try to get commitments from people. Everybody has e-mail. I think maybe a few people sit down and bang around a few more ideas and maybe it would be better to work as a collaboration with the Hardwood Working Group. Maybe that is a better idea than form a completely separate group. Again, it has to consist of a lot of what we had talked about before. As a forester going to school, one of the instructors kept telling me, "the objectives of the landowner." A lot of that is tied around economics. But from what we have heard here these past couple of days, there is a lot more to the forest than growing high-value trees and making that almighty dollar. I think that is where UINR, with this being the first step of a multi-step process, is moving in the right direction. It is just nice to network and make contacts and move ahead, and figure out where we are going to go next. I certainly have ideas where we are going to go next. Stuff in the field and educating contractors is part of it. Another one would be talking to community members and asking, "what is important to you?" So maybe some consultation.

Jean-Martin Lussier, *CWFC*
In reply to your question, my dream is more than field trips. It is to have field exercises. I do appreciate looking and having demonstrations, but I learn much more when I am in front of a problem. If we could have an exercise with small teams in the forest where I have to solve a particular problem with a team with a biologist and an operator, it would make a more interesting solution at the end. More so than just a discussion. Whether it is a real or a virtual problem doesn't matter, it is more the process of building the solution together and sharing information. It should be more effective than just sitting and listening.

Mark MacPhail, *UINR*
I agree. It is a better way of learning when you actually have to form a group and come up with a solution. If it was a diverse group like you said, an operator, a biologist, a forester and whoever else would be a part of that team, and actually walk into the stand of wood and ask, "What are we going to do with this?" I think that is a great idea.

Ed Swift, *CWFC*
Do what Ralph said. Get a wildlife person, a water quality person and get a real live piece of land and say, "Okay, how do you optimize this for all these values?" Put your expertise together and come up with a solution. And then test it and see if it works.

Jean-Martin Lussier, *CWFC*
One version could be if you go in the field, separate the group into ten small

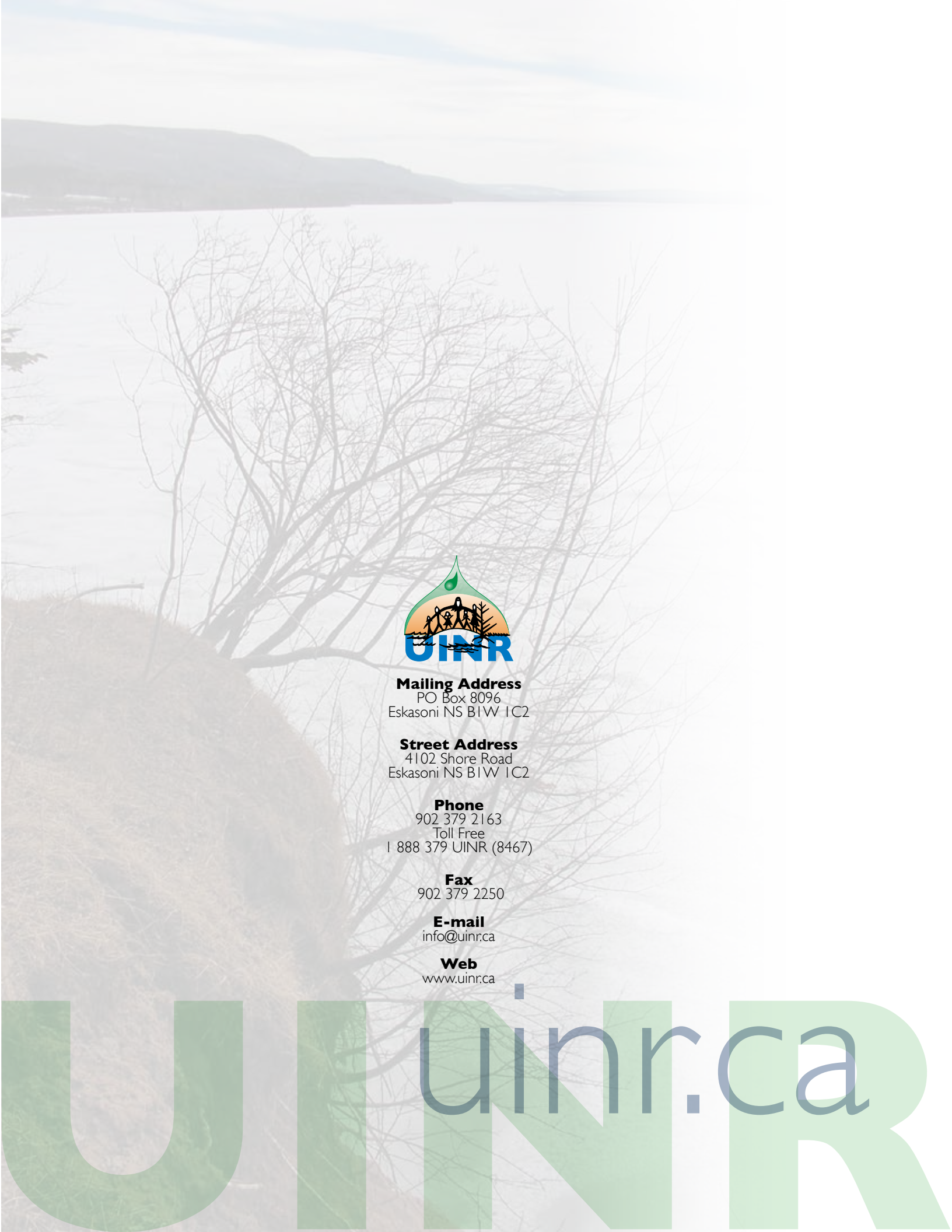
groups. Each of them have different objectives for the same woodlot. Different scenarios.

Mark MacPhail, *UINR*
Like was said earlier, we have some good quality stands in the province and Cape Breton Island. Those are the easy ones to deal with. We know you can do your crop tree releases or your patch cuts or whatever to also leave your crop trees yet get some value out of it. Those are the easy ones. If we are going to be doing this, we should be going into the more difficult ones, the one that is degraded, and try and bang around some ideas.

Unidentified
I asked Ralph yesterday whether he did any consulting work. What I was thinking was it might be good if you feel like coming back sometime if we could get you into some of these stands to see how the situation in Nova Scotia relates to what you have seen, and see if you have some suggestions. Maybe that could be tied in with having a lot of contractors here at the same time.

Dr. Ralph Nyland, *SUNY-ESF*
Well, I'm always glad to come back here if you give me a good bed and a good dinner and a nice glass of Chardonnay, and we could make a deal.

Mark MacPhail, *UINR*
Well, this is a nice way to sum up the conference, and I appreciate the people that did stay and hash out some ideas. I'll be contacting people and sending e-mails and throw out some ideas on where we are going to go next. I appreciate it. Thanks to all the speakers for attending.



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