CANADIAN
SILVICULTURE
MAY 2007

BENCHMARKING HEALTHY ECOSYSTEMS

- USE AND UTILITY OF FOREST BIOMASS
- CROP TREE SPOT SELECTION
- ADAPTIVE FOREST MANAGEMENT IN QUEBEC

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Editorial

by Dirk Brinkman

Canada opts out of managing for forest carbon

Canada has chosen to pass on a great opportunity. The last editorial invited the Prime Minister to "champion a national initiative for forest carbon restoration, protection, and conservation." The official response of the Prime Minister's office advised that this is the Minister of Natural Resources' responsibility.

While we waited for the Natural Resource Minister's response, Canada filed its Initial Report on the Kyoto Protocol with the United Nations. Fifteen months late, the Minister of the Environment declared that Canada is now meeting all of its Kyoto reporting obligations - just not its targets. In the report, Canada also elected to not include "managed forests" on its carbon account.

Silviculture workers in search of a sense of purpose in the daily grind may find the government's decisions ludicrous - meeting reporting obligations but not reduction targets and reporting on the forests, but not acting in the forest. The silviculture industry is keen to enhance forest health in ways that increase the forest ecosystem carbon reservoir.

Some high profile projects will go ahead anyway. Haida Gwaii's Climate Forest Pilot Project is one such initiative. It plans to restore degraded lands back to old growth forests and conserve intact carbon-absorbing old growth. The Prime Minister's decision to not account for the carbon benefits of the Climate Forest Project may not stop this project. The world is impatient for climate action and a project in high profile Haida Gwaii with such obvious benefits to the traditional community may still be financed. However, the government decision to not put carbon from the managed forests on its account smothers worthwhile initiatives all across the country that may not be as high profile.

Environment Minister Baird indicates the government's decision is based on a forecast analysis of historic and projected incidences of fires, insect infestations, and forest growth. Every year from 1990 to 2005 (except in 1995, 1998 and 2004), Canada's forests have been net sinks. Canada's Fourth National Report on Climate Change (4NR) for 2004 reports that in that year Canada's forests emitted an estimated 81 MT (mega tonnes) of greenhouse gases (GHG). It notes that if Canada included its managed forests it "would…increase the total Canadian GHG emissions by 11%". This makes the decision sound reasonable but over those fifteen years the forests have been a net sink. The 4NR report warns the highest degree of flux takes place in the managed forests with a maximum absorption of 82 MT and a maximum release of 81 MT.

This just highlights why the decision is wrong. The higher flux in the managed forests is because it has accumulated a century of timber volume from tenure protection. The very presence of these healthy managed forests is proof that granting private rights can result in forest conservation. The historical analysis of forest carbon flux has been done on managed forests which only had timber tenures for harvest. These forests did not have the added advantage of being managed to optimize carbon.

The decision is even more wrong because it was taken, not only because of high flux in managed forests, but because of the risk of releases like 2004 becoming worse due to the reality of climate change. These warming risks simply put a greater accountability for its forests on a developed nation like Canada and make it more shameful to have opted out.

In 2003 the forests and ecosystems of Europe released more carbon than their industry.

Canada negotiated mostly against EU resistance, for the right to not include its managed forests on its Kyoto account in case disturbances like the pine bark beetle get worse. European countries wanted Canada to be accountable for protecting its incredible forest carbon reservoirs. Now Canada is opting out, and European countries have elected to include their managed forests.

We are giving the EU an advantage by opting out. Europe was the first to grant carbon benefits for bioenergy. Now the leading edge pellet equipment is all manufactured there. Granting carbon rights to those with forest tenures creates the kind of forest management innovation the Haida Gwaii Climate Forest Pilot Project exhibits.

Denying these rights puts Canadian tenure managers at a competitive disadvantage. Granting carbon rights in other countries creates environmental subsidies. California, Oregon, and Washington companies hiding behind the recent countervail agreement can now integrate carbon value to reduce the cost of managing their tenures.

It is a time of crisis in our forest's health and our forest sector. Canada has led the world in sustainable forest management and demonstrated that it is ready to find a way to integrate forest carbon.

Canada can still notify the UN that it has changed its mind and elected to include its managed forests. Let's support government in finding a way to grant our incredible Canadian forest management pioneers, innovative First Nation managers, and resourceful silviculture industry, the competitive advantages of trading forest carbon within a national covenant.

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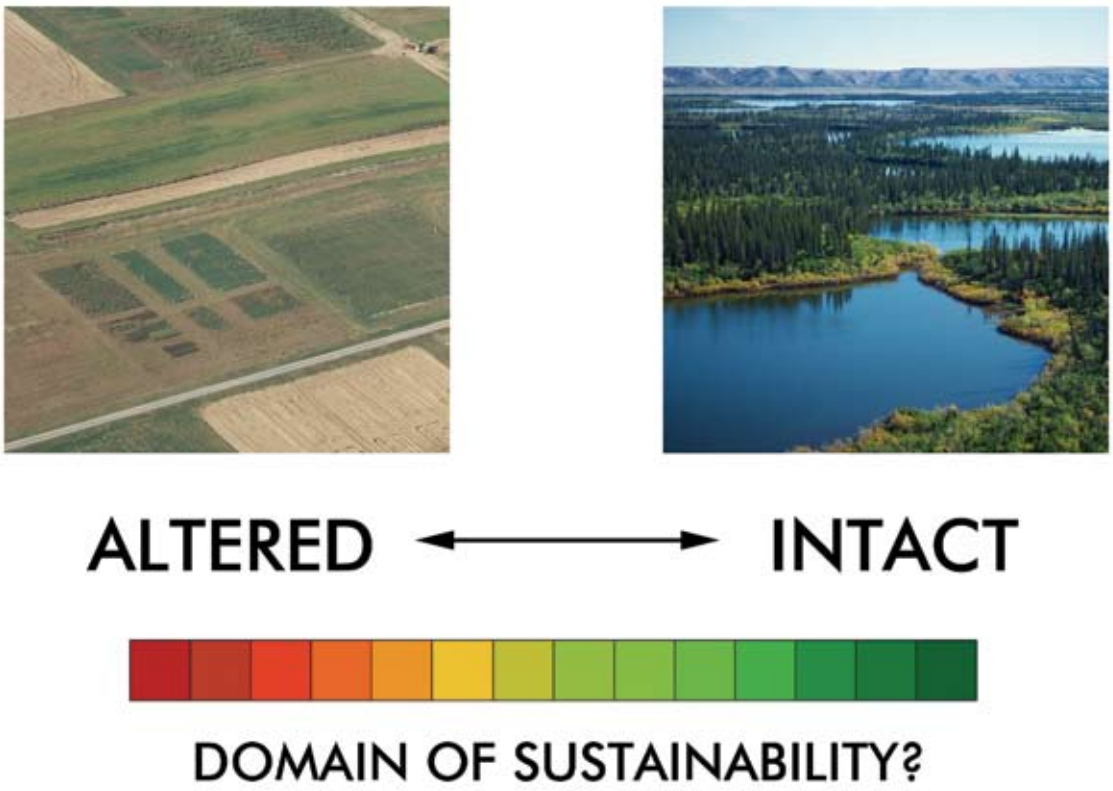
BENCHMARKING HEALTHY ECOSYSTEMS

by Dr. Fiona K.A. Schmiegelow

Canada is blessed with abundant forest resources. Forests form the fabric of our economy and their direct and indirect benefits support communities across the country. As a nation, we rely on the health of forest ecosystems to sustain many of the values that shape our concept of what Canada is. Globally, Canada's forests represent some of the last fully-functioning ecosystems, harbouring healthy wildlife populations and driven largely by natural processes. These systems have ecological integrity. In contrast, human activities in many other parts of the world have profoundly altered natural systems, resulting in increases in numbers of threatened and endangered wildlife species, reductions in air and water quality, and a loss of ecological integrity. Effects on socio-economic systems have also been significant.

As forests in Canada enter a period of unprecedented change, they face many challenges. Accelerating demands on forest resources, along with altered climate regimes and ancillary effects on natural disturbances such as wildfire and insect outbreaks, place increasing pressure on these ecosystems. They also compound uncertainties regarding the ability of forest management strategies to achieve their goals. Can we, in the face of these challenges, identify strategies to sustain the values these systems support? The short answer to this question is yes, and the solution involves benchmarking.

If we assume that the goal of sustainable forest management is to maintain the integrity of forested ecosystems and the socio-economic systems they support, and we accept the premise that natural ecosystems support a high level of ecological integrity, we can then frame the problem as one of determining how much resource development can be supported by natural ecosystems without compromising ecological integrity. This is a distinctly different approach from historic resource allocation strategies that typically maximized a single resource in the absence of other considerations. This also presents an opportunity to recognize and address uncertainties in decision-making processes that influence the sustainability of management activities. So, what is the link between issues of sustainability, management strategies, and benchmarking of forest ecosystems?



In highly altered landscapes, we have clearly exceeded the capacity of natural systems to absorb the changes associated with certain activities, resulting in a loss of integrity and associated values. At the other end of the spectrum, we recognize that intact systems have high natural integrity. The domain of sustainability lies in between. Because we are uncertain of the bounds, we need a framework to guide the evaluation of management strategies. The process of adaptive management is a powerful tool to address uncertainties and identify sustainable land management strategies. Adaptive management requires a structured and systematic approach to reduce the risk of undesirable outcomes, particularly those that foreclose future options, while recognizing the need to support local economies and communities through resource management activities. Adaptive management further recognizes the uncertainty inherent to resource management, and treats management activities as experiments that are carefully designed, rigorously monitored, and adjusted as additional information becomes available. A series of contributed articles on regional applications of adaptive management in Canada appears in recent and upcoming issues of *Canadian Silviculture*. The focus here is on components related to benchmarking.

A fundamental tenet of experiments is that they require controls. Controls are references against which something can be measured or judged; a standard for comparison. Medical trials routinely assign a treatment to one group while monitoring another for behaviour in the absence of intervention. In the context of resource management, controls are necessary to distinguish the effects of natural variation within a resource use area from the effects of changes induced by development activities. In the absence of such controls, we could fail to detect important changes in systems related to development activities; for example, if they are masked by natural fluctuations. Conversely, we could wrongly attribute natural variations to development activities. Benchmarking natural ecosystems can provide the necessary controls for resource management experiments, and the foundation for identifying sustainable activities.

The general proposition of establishing ecological benchmarks is largely intuitive. However, identifying the attributes necessary to facilitate meaningful comparisons is critical to their relevance. Ecosystem-level benchmarks should be ecologically intact areas, representative of natural environmental variation, including vegetation communities and productivity gradients, and sufficiently large to maintain key ecological processes and support natural ecosystem dynamics. In addition

to serving as controls for development activities, they play an important role as ecological baselines to increase our knowledge of the forest ecosystems. Benchmarks can also act as anchors of a protected area's network and contribute to the resilience of the larger system to climate change. Existing protected areas may be candidates for ecological benchmarks, but most were not established with this role in mind. As a result, many protected areas are either too small, or do not represent natural variation sufficiently to serve as ecosystem-level benchmarks. For example, many of the largest parks in Canada contribute little to benchmarking of forest ecosystems, because they are largely comprised of mountain systems and other natural features selected for their scenic value. Establishment of forest ecosystem benchmarks is an ambitious goal, but one that could be achieved in Canada, particularly in boreal regions.

Earlier I mentioned the significance of natural processes in continuing to shape the forests of Canada. We can also think of these as flows - of nutrients, water, wildlife, wildfire, among other things. These flows connect systems and provide resilience to change across many scales. In the medical field, health is commonly defined as an organism's ability to efficiently respond to challenges (stressors) and effectively restore and sustain a "state of balance". Ecosystem health could be similarly defined, with the important qualifier that balance does not imply a static condition, at least not over the scales at which we tend to think. A given forest stand could change in age structure and composition, due to succession or natural disturbance; perhaps even transition to a non-forested site, and still be a component of a healthy forest ecosystem.

Forests are dynamic, in both space and time, and understanding the contribution of these dynamics to the resilience of the system is what benchmarking permits. As the scale of human activities expands to the scale of ecosystems, and as we experience increasing effects of climate change, establishing references is critical to identifying effective management strategies. This involves benchmarking forest ecosystems now to establish a baseline for future comparisons, and over time, to assess relative change under different management regimes. This requires the commitment of many parties to a long-term process of learning.

Over the past decade, the concept of benchmarking has gained considerable traction in corporate circles as a method to increase efficiency and effectiveness of business operations, particularly in dynamic economic climates. Like benchmarking for ecological sustainability, successful corporate benchmarking requires careful attention to the relevance of data comparisons. Business applications require that a rigorous process be applied to benchmarking to enable meaningful comparisons and enhance understanding of why certain actions result in better performance. Performance is measured by efficiency (doing things right) and effectiveness (doing the right thing). Global leaders achieve high scores in both areas. While there is no single formula for success, analyses have revealed that world-class business leaders recognize that benchmarking to improve performance is a journey, not an event.

Canada has an unparalleled opportunity to be a global leader in sustainable forest management. An important element in realizing success is benchmarking of forest ecosystems. With more intact forest than any other country in the world, the condition and extent of our forests allow benchmarking at a scale unimaginable in other jurisdictions. Our stable political system and strong economy provide a foundation for long-term planning. Innovative partners in industry, an informed non-government environmental constituency, and emerging aboriginal governance structures can enable implementation.

Too often, we spend most of our energy examining what is probable, given past trajectories, rather than exploring what is possible, given vision and commitment. Uncertainty rests not with the projected outcome of conventional approaches to forest management, but in the efficacy of alternative approaches to achieving a broader set of objectives. This is where the opportunities for innovation lie.

Dr. Fiona Schmiegelow is an Associate Professor of Landscape Ecology and Conservation Science in the Department of Renewable Resources, University of Alberta, and a Research Scientist in the Wildlife and Landscape Science Division of Environment Canada.

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Forest Health

by Mike Francis

Jack Pine Budworm in Ontario

Jack pine budworm is the most serious insect affecting jack pine in Ontario. This insect looks similar to the spruce budworm, a close relative which attacks balsam fir and spruces. The jack pine budworm is a solitary feeder native to North America and can be found across Canada coinciding with its preferred host, jack pine. This defoliator prefers jack pine but can also be found on red pine, Scots pine, eastern white pine, and occasionally on fir, spruce, and larch when they are minor components of large jack pine stands.

Two to three consecutive years of severe defoliation by heavily infested areas of jack pine budworm can cause top mortality and some whole tree mortality in jack pine stands. A reduction in tree growth also occurs during and after an infestation of this defoliator. These impacts can affect wood supply, wildlife habitat, and aesthetics as well as increase conditions that are suitable for high intensity fires.

The life-cycle of the jack pine budworm closely resembles that of the spruce budworm but development occurs approximately two weeks later. Small overwintering second instar larvae emerge from under the bark in late May or early June and begin feeding on the pollen in male flowers or on developing needles of new shoots. The abundance of male flowers determines early survival of the larvae in the spring. The full-grown larva transforms into pupa case on the shoot and in July and early August the adult moth emerges, mates and the female deposits her eggs on the host tree's needles. These eggs are laid in clusters of two overlapping rows, with approximately 40 eggs per cluster. Within 10 days the eggs hatch and the tiny larvae find protected areas under the bark and spin up a silken shelter where they moult to the second instar and spend the winter.

In Ontario, outbreaks of jack pine budworm occur about every 8-10 years, and typically last 2-4 years in any one location (Figure 1). The most recent outbreak in Ontario began in 2004 when 851 ha of moderate to severe defoliation was aerially mapped in the Sudbury District of the Northeast Region (Table 1), and during regular forest health surveys egg masses were recorded in the Fort Frances District of the Northwest Region.

In 2005 the infestation dramatically increased in the Northwest Region to 88,445 ha of damage, and also increased in the Northeast Region to 3,552 ha. A small area of moderate to severe defoliation (222 ha) was also seen in the Pembroke District in the Southern Region.

In 2006 areas of defoliation were mapped in the Northwest Region reaching a total of 720,172 ha of moderate to severe defoliation. An increase was also mapped in the Northeast Region. The Southern Region experienced new defoliation in the Parry Sound District with a small increase in the Pembroke District.

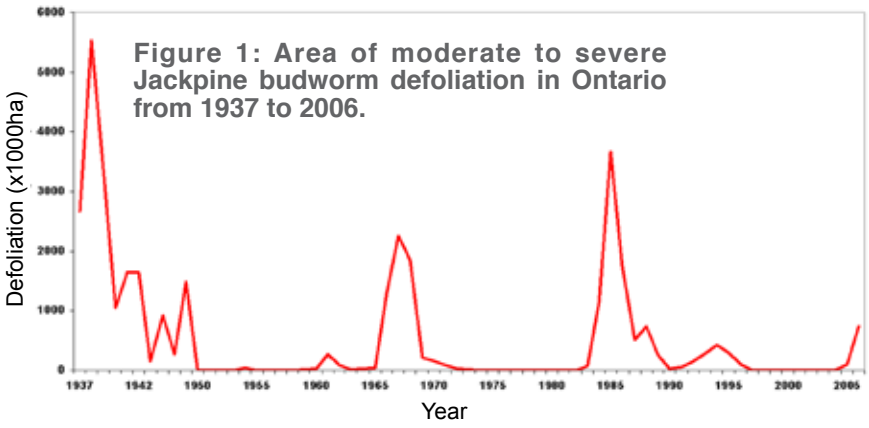


Figure 1: Area of moderate to severe Jackpine budworm defoliation in Ontario from 1937 to 2006.

Table 1: Gross area of moderate to severe defoliation caused by the jack pine budworm 2004 to 2006.

Region	District	2004	2005	2006
Northwest	Fort Frances	0	85,328	355,134
	Kenora	0	1134	248,843
	Dryden	0	1983	116,195
Northeast	Sudbury	851	2599	14,038
	Sault Ste. Marie	0	953	951
South	Parry Sound	0	0	4,548
	Pembroke	0	222	407
Total		**851**	**92,219**	**740,116**

The jack pine budworm defoliation in 2005 in the Northwest Region prompted an insect pest management program in 2006. The program was developed by an interdisciplinary team comprised of MNR district, regional and Forest Management Branch staff, staff of the sustainable forest licensees, and representatives of the local citizens' committee. In accordance with the Forest Management Planning Manual for Ontario's Crown Forests a range of management options were considered including no treatment, accelerated harvest, redirected harvest, salvage harvest, the use of insecticides, other controls, and a combination of no treatment and other controls. Overall, based on the evaluation of the management options, the planning team decided that aerial spray with Bacillus thuringiensis var. kurstaki (Btk) combined with re-directed harvest and no treatment was the most acceptable way to ensure that tree growing investments are protected with the least impact to the environment.

The purpose of the spray program was to protect the trees through the outbreak, mitigating wood and wildlife habitat losses as well as diminishing the fire hazard.

A total of 14 spray planes were used to spray 109,131 ha of infested jack pine stands in the Fort Frances, Kenora and Dryden districts in June 2006. Protection and spray deposit was very good in the blocks assessed. Defoliation in sprayed areas averaged 37%, while the control areas had an average of 72% defoliation.

Mike Francis is Provincial Forest Health Technician with the Ontario Ministry of Natural Resources - Forest Health and Silviculture Section. He can be reached at 705-945-6763.

USE AND UTILITY OF FOREST BIOMASS:

Benefits to the Forest, the Community, and Economic Development

by Dr. David DeYoe

This article follows "Global Trends, Local Options: Use and Utility of Forest Biomass" in the February 2006 issue of *Canadian Silviculture*, which provided a renewed look at the use of forest biomass for green energy, fuels, specialty chemicals, and materials capable of reducing our dependency on fossil fuels and petroleum by-products as part of a new economy, the "bio-economy". [You can access this article on www.canadiansilviculture.com.]

The bio-economy is composed of technologies and processes that are more environmentally benign, support the principles of the Kyoto Protocol, and create economic opportunities for rural businesses and either add value to existing industry or replace it with new bio-product industries.

Biomass is defined as all non-fossil organic materials including water and land-based plants (trees, shrubs, herbs, grasses, algae, lichen, moss, etc.) and all waste biomass such as municipal solid waste, municipal sewage and animal manures, forestry and agricultural residues as well as certain types of industrial wastes. Unlike fossil fuels, biomass is renewable and can be replaced within a harvest cycle. Biomass is also considered carbon neutral as its CO_2 emissions are offset by the growth of new plants sequestering CO_2.

Energy from biomass can be generated directly or by conversion to gas, liquid or solid bio-fuels for use in cogeneration of heat and electricity. Cogeneration using forest biomass is well established in northern Europe, New Zealand, and Australia. Presently, about 40% of electricity generation in Denmark is derived from biomass cogeneration plants using wood waste and straw. In Finland, cogeneration supplies about 10% of electricity using sawdust, forest residues, and pulping liquors. In contrast, bio-energy contributes only about 3-4% of the total energy in Canada and the US.

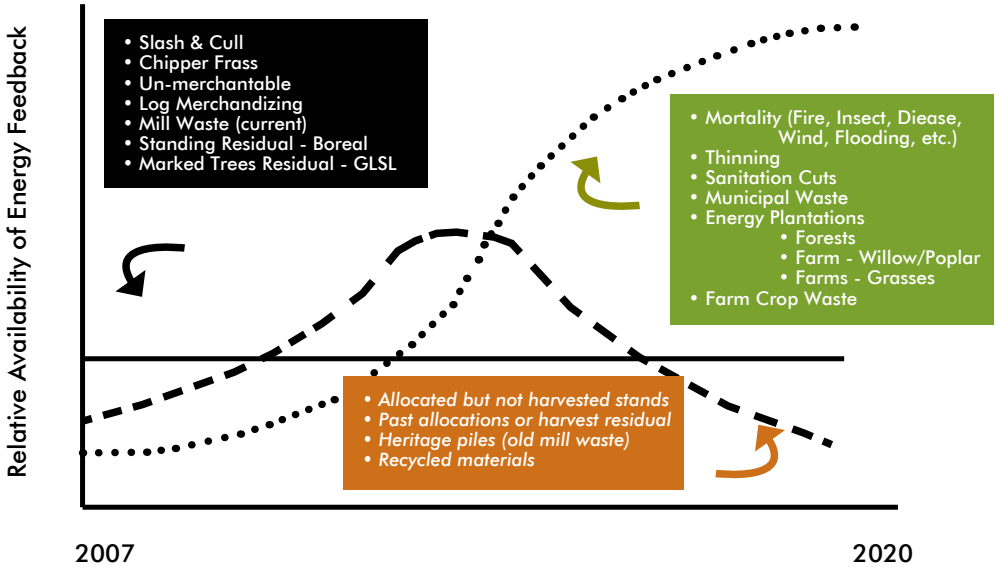
Benefits of using forest biomass for energy and transportation fuels include the following: 1) it is renewable; 2) it's increasing affordable; 3) it creates business opportunities and jobs; 4) it reduces global warming; 5) it generates profit from waste; and 6) it provides energy self-sufficiency for industry and rural communities. Given the rising cost of energy, the inefficiencies in energy transmission, and the rising uncertainty in dependable service for remote localities, energy self-sufficiency is a key incentive.

improves worker safety and regeneration and growth of seedlings as well as capturing potential economic benefits.

New market opportunities using biomass can help fund enhanced forest practices. The forest industry has traditionally viewed the woodlands as the cost centre and the mill as the revenue generator. Traditional use of the forest resource has created waste in which full value of the resource is not optimized and, in many cases, tree and stand quality has been eroded by economic harvesting. In the bio-economy, that scenario changes. Value-added outcomes can be derived from: a) residual biomass (energy, fuels and chemicals); b) different plant species possessing high value attributes (pharmaceuticals, functional foods, and crafts); and c) product dependent carbon reservoirs. The value from these outcomes can not only offset operating costs, but also can make the woodlands a bio-economy revenue generator. Future generations will expect a full product cycle bio-economy grounded in the woodlands.

Biomass utilization initiatives do not need to expand resource utilization beyond current allocations. The growing value and need for biomass can be accommodated by good planning. Efficient use of waste material and new or expanded options for biomass utilization and/or production will optimize utilization while alleviating pressure on areas valued for other uses, whether social, ecological, or economic. Figure 1 provides a colour-coded assessment of potential biomass evolution. The black box/solid line represents material from sustainable harvest allocations held constant. The red box/dashed line reflects backlog - materials allocated but not removed or old mill waste piles. The green box/dotted line identifies future stock such as energy plantations, municipal solid waste,

Figure 1: Biomass Use and Utilization Planning



Residual Utilization Benefits to The Forest

Current practices, which leave harvest residuals in piles or windrows, reduce regeneration sites on cut-overs up to 20%. Leaving harvest residuals dispersed hinders planting and seeding, delays regeneration efficiency and effectiveness, predisposes the site to fire risk, and creates a safety hazard for planters. Residuals can become artificial habitats for animals that feed on seed and seedlings, reduce survival, and may become sources for insects and disease. Burning piles, a common practice, releases combustion gases and particulates. Removing harvest residuals and mortality from fire, insects, and disease that may increase as a result of global warming.

A critical requirement in enabling a bio-economy is a comprehensive inventory of the biomass resources and the diverse array of new product opportunities this can create. A biomass inventory must clearly define availability, accessibility, quantity, type, qualitative attributes, transportation networks, delivered costs, etc. to foster integrated use of the forest and stimulate investment in bio-based ventures.

Regeneration success and economic value can be optimized by utilizing: a) existing slash piles; b) windrow material; c) unmerchantable logs; d) chipping frass; e) low value stands

allocated but not harvested; f) trees marked for harvest but left as a result of cutter's choice; and g) excess residual trees left standing in stands designated for clear cut. This would also free up between 15-20% of the area, or perhaps more, for regeneration and enhancing future stand quality. Allowing cutter's choice and/or bypassing low value trees in forest stands undermines silvicultural expertise and predisposes stands to a legacy of poor genetic quality.

Benefits to The Community

Adaptation and mitigation strategies using the forest resource to address climate change can provide significant benefit to communities. Thinning programs in the US help mitigate against stress-induced effects of climate change (minimizing competition for water and nutrients by using vegetation management practices in plantations), and help avoid drought-related stresses and fire, insect, and disease risk while utilizing the biomass for energy. Sustainable bio-practices create community jobs.

Biomass from intensive silviculture is commonly used in Europe for heat and power production (co-generation). These strategies for biomass use are integral to resilient systems for energy and water security in rural areas. An energy self-sufficient north could be, and should be, the provider for the power-hungry south, with financial benefits flowing back into the rural communities to foster business development.

Benefits to Economic Development

Longer-term planning will optimize use of the forest resource. Figure 1 provides a view of how biomass-based residual or waste materials can be planned over time. This approach allows communities or companies to address impacts associated with global warming while integrating biomass into the mix of renewable resource options (hydroelectric, geothermal, solar, wind, etc.), which can enable the move toward energy self-sufficiency. Biomass is a major piece of the renewable energy and fuels picture for Canada - it is not currently receiving the attention it deserves given the benefits it can provide. For example, in southeastern Ontario there are approximately 900,000 ha of abandoned farm and forestlands. Production rates for Ontario willow clones developed at Syracuse University are 10 bone-dry tonnes/ha/yr on a 3-year rotation. Using only 60% of this land base would produce 1,800,000 bone-dry tonnes annually on a 3-year cycle, or about 300 MW of electricity and 600 MW of heat. This is enough to serve 30 communities, each with a population of 2,500 to 4,000 people…not an insignificant contribution.

Canada and the provinces can address emission reductions inherent in the Kyoto Protocol by using biomass fuel to displace a fossil fuel source (petroleum, natural gas or coal). Some developing technologies take this a step further by recycling and using the CO_2 that would normally have been emitted in fossil fuel utilization. Further, just like wood and paper products, some products derived from biomass can capture carbon for long periods of time, particularly biopolymers or platform chemicals used in everyday products.

Besides forest and mill waste, areas devastated by mortality due to fire, insects, disease, and wind throw are excellent candidates for bio-energy projects. The volume loss due to the Mountain Pine Beetle infestation, for example, is now 6 million m³ or about 3 million bone-dry tonnes. Entrepreneurs

are currently capitalizing on the market demand for biomass in Europe to drive biomass for energy projects. Although some fear that the forest-based industry in this area may crash in 15 years, with innovative planning natural forests could be co-mingled with energy and bio-fuel plantations now. This would help sustain the boom and avoid the bust, although the products that support communities and business may be very different.

Challenges to Master

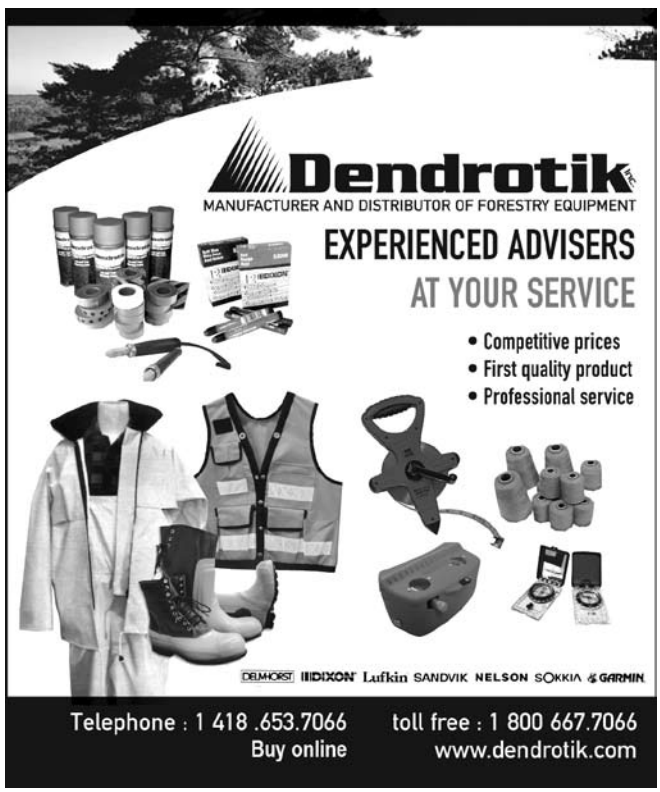
It is critical to avoid site degradation activity by diversion from best practices in accessing forest biomass. The removal of slash piles or windrows, standing residual, cull and frass, and unmerchantable logs will increase planting spots. The utilization of standing residual from scheduled clear cuts would be taken at harvest instead of being left to devalue the stand, and stands allocated but not harvested would likely be harvested due to new product options. There are numerous options for biomass utilization that contravene policies or guidelines for maintenance of long-term site productivity.

Over a typical Canadian forest rotation of 60-80 years, annual inputs of nutrients and organic matter occur in the form of fine root and mycorrhizal turnover, small root loss, loss of leaf material and small to medium sized branches, and isolated wind throw. These help maintain the productive character of the soil and site. These annual inputs do not include atmospheric deposition of nitrogen or any of a number of random natural disturbances (fire, insect and disease mortality, severe blow down, etc.) that occur regularly in the forest system. The harvest actually represents only a small sliver in a forest's rotational cycle. Table 1 provides a conceptual view of nutrient retention on a site over a 60-year rotation, by different plant components. The organic matter retention is represented by the components of the tree not removed, e.g. percentage retained or consumed on the site during the 60-year period.

Table 1. Biomass Use - Maintaining Long-term Site Productivity

Retention of Nutrients by Component (Nutrients/Gram Tissue)	Plant Components	% of Total Biomass Retained, or consumed on the site, based on a 60-year rotation
Very High	Leaves	Greater than 99%
High	Small Branches (twigs)	Greater than 90%
Moderate (Slash)	Large Branches	Greater than 35%
Low	Stem (large woody debris policy)	15% to 30%
Low	Stump	100%
Medium (Stump)	Large Roots	100%
High	Small Roots - Stump taken	100%
High	Fine Roots - Stump taken	100%

Full tree harvesting studies find no detrimental effects to longer-term productivity on most forest sites. However, more intensive extraction of round wood and residual over shorter rotations may require the use of soil amendments - a common practice in jurisdictions using rotations between 7 and 25 years, e.g. Finland, Sweden, Southeast US, and Brazil.



Although we tend to discount the importance of the below-ground contribution to organic matter and nutrient inputs, it is significant - annually and over the rotation. For sites that are cold, wet, and nutrient-poor (boreal and subalpine zones), trees allocate a large proportion of their total carbon for root structure and function below ground. This provides fine root infrastructure to sequester nutrients (Figure 2), and can amount to 50-70% of the total annual biomass distribution. Even on warm, moist, nutrient-rich sites the below-ground annual allocation is 35-50%. This organic matter, and the associated nutrients, remains on site, as does large, woody debris occurring from natural disturbances. Interestingly, below-ground distribution is even greater for herbs and grasses, which can allocate 80-90% of total annual carbon below ground - one reason why the grasses and herbs are such tenacious competitors for water and nutrients in young plantations. This below-ground contribution accounts for a substantive quantity of organic matter and nutritional capital retention on site at harvest and beyond.

Future Directions

The use of forest and agricultural biomass goes far beyond energy. Energy, and perhaps certain enhanced fuels (ethanol and green diesel), will comprise the first wave. However, as the technology to convert biomass develops and becomes integrated with industries focusing on platform chemicals, polymers, and enhanced fuels, a whole new wave of renewable products from biomass will evolve. This is the market that is catching the attention of entrepreneurs and the innovators and early adopters of big industry. Whether a farmer or a forester, the opportunities to capitalize on this market are significant. The key to rural revitalization will be retaining as much of the value chain in the rural area as possible, and to develop business models for rural ownership.

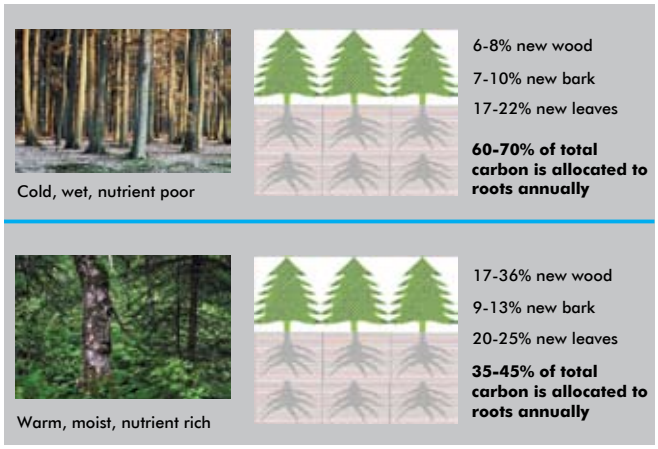


Figure 2. Carbon Allocation in Trees: Adjusting to Sites and Conditions

New directions are all about positioning companies and communities to capture the opportunities inherent in global trends. Although the implications of most global trends appear to paint a rather bleak picture of what lies ahead, the reality is these trends unveil opportunities with significant economic, social, and/or environmental benefits to rural areas. The trick is to identify trends for which there exists a "silver lining", and then develop approaches to capture the opportunities.

Dr. David DeYoe is President of Bio-Trend Systems Incorporated. He was General Manager of the Ontario Forest Research Institute between 1992 and 2004 and a Reforestation Biologist on the Faculty of Oregon State University from 1979 to 1986. He has had a long career in the silviculture industry.

WESTERN

SILVICULTURAL CONTRACTORS' ASSOCIATION

by John Betts

WSCA 2007 Conference Summary

Strategic Session Cites Forest Advocacy Role for WSCA

Following on the momentum of last month's WSCA annual conference, at a recent strategic summit silviculture contractors agreed that the silviculture industry must take a more prominent and professional approach to getting its message out on forest health and reforestation in BC. A public affairs consulting firm has been asked to draft a communications strategy for the WSCA, and once approved, it will be implemented as soon as practicable. The strategy intends to raise the profile of the silviculture industry by drawing attention to its accomplishments and its credibility as a resource to assist government in finding remedies and strategies to deal with the ongoing forest health crisis.

At the WSCA conference contractors agreed there has been a recent change that has put environmental issues foremost in the public's mind. If the WSCA doesn't position itself promptly on the environment and forestry issues, its voice may be lost in the political clamour already developing. Integral to any communications strategy is the message. Contractors identified the disconnect between government dollars promised to forestry and the amounts invested in actual programs. The province's slow approach to restoration and the absence of an overarching, integrated strategy to deal with the forest health problem were also identified as concerns needed to be addressed by the WSCA. The communications strategy will identify plans for working with local media, identifying strategic allies, and working with all levels of government. To see the draft framework for a communications strategy discussed at the WSCA conference, go to www.wsca.ca.

Planned Large Scale Eco-system Restoration Will Need Skilled Crews and Contractors

In order to restore large tracts of lands damaged by pest and fire, the province will need a skilled workforce capable of treating millions of hectares of forests in threatened communities, watersheds, and habitat. According to Greg Anderson, MoF Restoration Manager, the potentially massive strategy will involve mechanical treatments, prescribed burns, reforestation, and hand tool work. However, its chances of succeeding will, in part, depend on the silvicultural contracting industry delivering workers with the necessary skills and competencies.

Chief Forester Defends Go-Slow Approach to Restoration

Siliviculture contractors challenged Chief Forester Jim Snetsinger over the pace of restoring forests lost to the mountain pine beetle, citing the plummeting reforestation ratio and the extraordinary extent of the forest health disaster. Snetsinger stated he didn't want to compromise future industries that might emerge to harvest damaged stands by leveling forests that may have future worth. Contractors replied that even under the most optimistic circumstances it is illusory to think these potential industries could materialize in time to put a dent in all the grey wood in the province. They fear these stands could eventually pose a threat to the forests that are replanted.

Expect Massive Wildfires in the Wake of Mountain Pine Beetle Epidemic

Beetle-killed stands across the province will eventually be fuel for fiercely intense wildfires according to fire ecologist Bruce Blackwell. Citing the 2003 Chilko fire west of Williams Lake, Blackwell noted this fire took hold in stands attacked by beetles 20 years ago producing a conflagration that exceeded most scales for measuring fire behaviour. But only a third of that forest had been killed prior to the burn. Today the pest devastation is occurring at a greater intensity suggesting even larger fires capable of spotting farther and spreading faster. Beetle-killed stands become more volatile as the dead trees fall out, usually after the first decade, building up fuel on the forest floor under the emerging canopy of new trees. Strategies such as landscape fuel breaks and wildland-urban interface treatments need to be implemented on millions of hectares across the province to mitigate this threat. So far this is not happening on a large enough scale.

Forestry's Elder Statesman Calls for Action and Permanent Review of Forestry Management

Every so many years forest policy needs to re-evaluate its assumptions and conventions to keep in step with the changing landscape and society's management expectations. Usually this process takes the shape of a royal commission. Forestry veteran Mike Apsey says we are at that stage now, but we don't need a royal commission. We need something more. Apsey's 50 years in forestry on both the government and industry sides have shown him that royal commissions and their results can hardly be put into effect before they are outdated by the pace of history. That problem is more acute now than before so we need a permanent board of enquiry with the powers of a royal commission, the processes of a round table, and the resources of a think tank. Apsey reminded silviculture contractors of their sector's considerable accomplishments and urged them to become active and effective in influencing forest policy across Canada.

Forestry Workforce Safety and Productivity Trends - Some Good, Some Not

Forestry Ombudsman Roger Harris aptly titled his recently released report on the forest sector workforce "Not out of the Woods". The fatalism of that title points to a situation where Harris says he can see logs not harvested or milled because of a disappearing forestry workforce. He attributed that discouraging trend to an aging workforce, the loss of typical worker recruitment paths, reluctance of employers to train employees, and the expectations of the new workforce. Silviculture reflects some of those trends, but it is seeing a younger and less experienced workforce filling the shoes of exiting experience. Researcher Jordan Tesluk's 2006 Report on Health and Safety in the BC tree planting industry described some encouraging trends in safety. (See the Focus on Safety report in this issue.) Younger workers are generally more accident prone, but attitudes among young tree-planters surveyed show a growing intolerance for risk taking - a leading indicator of safe behaviour.

John Betts can be reached at 250-229-4380 or hotpulp@netidea.com.

ONTARIO

FOREST RENEWAL CO-OPERATIVE INC.

by William F. Murphy, RPF General Manager

Forest managers in Ontario are saying that there will be less furnish cut for their mills and less saw logs cut for dimensional lumber. Other products that normally use wood fibre will also be down. This is the sign of the times. The dollar is still high and costs do not seem to be dropping. To produce a profitable product, companies are renegotiating for additional union support, or even going as far as amalgamating with other companies to combat the influence of new opportunities coming into the marketplace.

A workshop was held on the topic of co-op sustainable forest licences: "Are They the Future Forest Management of Ontario?" Speakers discussed this "new" direction that the Ontario Ministry of Natural Resources (OMNR) is working towards, but there were probably more questions raised than answers given. The OMNR recognizes that there are too many existing forest management areas (SFLs), and they are looking to reduce these again to a number that is less costly to them and hopefully easier to manage. There are existing co-op SFLs in Ontario, and overall they seem to be doing well, with managers overseeing the day-to-day operations. They appear to be successful in separating management from the operations.

Some companies are involved with both types of SFLs, and they have experienced hidden costs that arise when developing a co-op. They feel that the method of managing a new co-op is essentially the same as managing a single SFL, except there are more players at the table. Overseeing the SFLs becomes the responsibility of a management group where each company is represented.

The First Nations, on the other hand, feel that once again they are not being consulted in the formation of either of the SFL types. The OMNR is putting the responsibility onto the companies to deal with their issues. They do not see things changing in this regard.

The SFL is not a moneymaker, but just the opposite. It's expensive to start one and to maintain its integrity. Companies coming into one of the newly formed co-op SFLs are investing their years of work, roads, regeneration, and successes into the hands of another management group.

What happens if a co-op fails? One forester believes it would create a real mess, as it would necessitate litigation to see who gets what, from the old inputs to the new successes. If the boundaries had changed, do the old boundaries come back into effect? Who becomes the new manager? Is it the original SFL holder or will a new scenario come to head?

There are commitment holders who definitely see the benefits of co-op SFLs as they now become a player in the direction of wood flow and planning development strategies.

Questions arose regarding co-op participation - is it strictly limited to the companies presently managing the single SFLs? This inquiry came from some of the companies that supply regeneration services to the present SFL holders. Since business decisions are made by a number of players at the table instead of one entity, suppliers feel that they should be part of the team as regeneration is a high priority to the Crown, SFL holders and suppliers alike. It seems that if a business has the funds and is willing to put them into the system, (and funds can be calculated on a per meter basis) the company should be allowed to become part of the team.

QUEBEC

ASSOCIATION DES ENTREPRENEURS DE TRAVAUX SYLVICOLES

par Audrey Harvey, Responsable des communications, AETSQ

Un printemps hâtif au Québec

Premier signe annonciateur du printemps: AETSQ a tenu son 7e congrès annuel les 21, 22 et 23 février derniers. C'est sous le thème « La sylviculture : la voie incontournable vers le Sommet » que s'est déroulé l'événement. L'objectif était de réunir les intervenants majeurs qui prendront part au Sommet sur l'avenir du secteur forestier québécois afin d'amorcer les discussions et connaître leur vision de l'avenir en ce qui concerne l'aménagement forestier. Les discussions qui ont eu lieu au congrès de l'AETSQ nous permettent d'être optimistes. En effet, tout le monde s'est dit très satisfait des échanges qui ont eu lieu. Cette rencontre a permis à tous et chacun de prendre connaissance des visions des autres groupes et d'entrevoir déjà quelques points susceptibles de faire consensus. Puisque le succès du Sommet et la relance de l'industrie forestière au Québec passent par un vrai dialogue entre les partenaires, il nous est donc permis de croire qu'il y a de l'espoir. Toutefois, quelques semaines avant la tenue de notre congrès, on nous annonçait que devant l'ampleur de la tâche et les délais trop courts, on avait décidé à l'unanimité de reporter la tenue du Sommet à l'automne prochain. Il s'agit d'une bonne nouvelle puisqu'on semble avoir décidé de donner une véritable chance au dialogue. Ce n'est donc que partie remise.

Quoi de neuf pour l'industrie?

Au moment d'écrire ces lignes, la campagne électorale bat son plein au Québec. Après avoir consulté les plates-formes électorales des différents partis en cause, force est de constater que les travailleurs forestiers ne font pas partie des priorités de nos politiciens. En effet, aucune proposition ne se démarque plus que les autres. Par contre, il pourrait y avoir de bonnes nouvelles pour l'industrie sylvicole puisque chacun des partis promet, s'il est élu, d'intensifier massivement les travaux sylvicoles pour redonner la santé à nos forêts. Promesse électorale ou projet d'avenir? Tout ça reste à voir!

Un printemps de plus pour la grille de taux

Un autre signe que l'hiver tire à sa fin : le gouvernement a dévoilé l'arrêté ministériel sur la valeur des traitements sylvicoles, communément appelé la grille de taux. L'indexation proposée est équivalente à la hausse du coût de la vie (ou indice des prix à la consommation), soit 2,34%. Les consultations sont en cours. Les intervenants intéressés doivent faire connaître leurs réactions dans un délai de 30 jours à la suite de quoi un décret viendra officialiser le tout. Une nouveauté cette année : le ministre est en train de réaliser une étude sur les coûts de campement afin d'indexer l'allocation pour les camps forestiers qui serait effective dès le 1er avril 2007. Le tout a pour objectif d'amener les taux alloués à l'hébergement à un niveau se situant plus près des coûts réels d'exploitation.

QUEBEC

ASSOCIATION OF SILVICULTURE CONTRACTORS

by Audrey Harvey, Communications Coordinator, AETSQ. Translated by David Hayne

An Early Spring in Quebec

First harbinger of spring: AETSQ held its seventh annual congress on February 21-23. The event took place around the theme “Silviculture: The Inevitable Road to the Summit”. The objective was to bring together the major stakeholders who will be taking part in the Summit on the Future of the Forestry Sector in Quebec in order to stimulate discussion and to ascertain their views on the future of forestry management. The discussions that were held at the AETSQ Congress allow us to be optimistic. In fact, everyone expressed satisfaction with the exchanges that occurred. That meeting allowed each and every one of us to become aware of the visions of other groups and to catch a glimpse of some points that might lead to a consensus. Since the success of the Summit and the revival of the Quebec forestry industry require a genuine dialogue between the partners, we have grounds to believe there is hope. In any case, a few weeks before the congress it was announced to us that, in view of the magnitude of the task and the shortage of time, it had been unanimously decided to delay the Summit until next fall. That is good news, as it seems to have been decided to give dialogue a real chance.

What’s new for the industry?

As these lines are being written, the Quebec election campaign is in full swing. After consulting the election platforms of the various parties involved, we have to say that forestry workers are not a high priority with our politicians. In actual fact, no proposal stands out more than the others. Nevertheless, there might be good news for the silvicultural industry because each of the parties promises, if elected, to give massive support to silvicultural activity in order to restore our forests to a healthy state. Is this just an election promise, or is it indicative of a future project? That remains to be seen.

One more year for the rate schedule

Another sign that winter is coming to an end: the government has released its ministerial order on the value of silvicultural processes, usually called the rate schedule. The indexation proposed is equivalent to the rise in the cost of living (or consumer price index), namely 2.34%. Consultations are under way. Interested participants must make official. There is a new feature this year: the Minister is undertaking a study of camp costs to be able to index the grant for forestry camps, which would become effective as of April 1, 2007. The objective is to bring shelter rates to a level closer to the real costs of doing the work.

AGFOR REPORT

by Gaston Damecour, RPF

Value Shift

The forest sector is going through a challenging period, one that has been in the making for a long time. The axe started to fall on the pulp and paper sector in 2003 and the bite is now being felt in the lumber sector.

In both sectors, remedies include revitalization measures, concessions and rationalization - the latter paramount in the current super-mill discourse. In both sectors, wood users implement a string of cost-cutting measures that almost always target wood supply.

We often refer to supply and demand as drivers, but there is a third component – price – and price can be a driver or be driven. Downward pressure on price usually suggests a saturated market, one that will reduce:

- contractor margins for that product creating a financially difficult situation
- value to the landowner in terms of revenue and in terms of a long-term outlook on investing in forestry
- need for a resource management strategy to satisfy a low-end market – this depends on proximity to market
- the instigator's economic wood basket. It is no surprise to see wood deliveries from private lands slow or even stop in some regions. The market can simply dry up when contractors and landowners choose to stop servicing the market at a loss and shift their interests elsewhere. Alternatively, the depressed product can continue to expect higher value product(s) to carry the overhead, effectively extracting a subsidy from them. This works when the other markets are strong and reliable.

In the face of the combined effects of lower prices and potentially long-term limited access to markets, the following short-term strategies might be considered:

- Sell out when the markets are down - this is not a retirement plan.
- Stop, cut losses, and wait for prices to respond to lack of supply. There is some validity in this approach for certain products if you can afford to put the operation on hold - OPEC does it all the time.
- Extract and generate more value to offset the loss incurred while servicing the unprofitable market. Contractors combine marketing efforts followed by merchandising at the stump, landing, or yard. By increasing the overall value of the operation, the outcome is more profitable.

This brings us to government policy and intermediate strategies. The current conditions (many of which, in my opinion, are now structural rather than cyclical) do not support continued investment as proposed by current silviculture programs. In fact, experienced large woodlot owners have chosen to shift their energies and resources elsewhere.

Bringing new or previously unappreciated value to the business and ultimately the woodlot owner will provide the optimism to make it work. The newfound value will eventually be reflected in resource management and silviculture only if there is secure access to a diversity of value-markets to support the investment.

These are the same rules and incentives used to support large industrial investments (which, incidentally, often span less than one forest rotation). Woodlot owners and the government programs that support silviculture should expect similar support.

With equitable security of economic access to markets for contractors and landowners, attention can be shifted from survival mode to more value-oriented fibre production. The contractors, landowners, wood businesses - and the resource they rely on - will fare better.

Gaston Damecour, RPF, NB & NS, is the principal of AGFOR Inc, a forestry business consulting firm based in Fredericton. He can be reached at 506-462-0333 or gdamecour@agfor.nb.ca.

by Don Cameron

Experts discuss future outlook of our Acadian Forest

Recently the Nova Scotia section of the Canadian Institute of Forestry (CIF) hosted a well-attended one-day conference focused on the future of the Acadian Forests of the Maritimes. Over the last several years there has been much interest and debate regarding the health and future well-being of this type of forest, which is located across mainland Nova Scotia, New Brunswick, PEI, and part of the northeastern New England states.

The keynote speaker, Karen Beazley, a Dalhousie University professor, spoke about a special project that she is part of entitled, "Science-based landscape conservation in the Northern Appalachian/Acadian Ecoregion". She outlined how this international effort, including more than 50 organizations from the Maritime provinces, Quebec, Maine, New Hampshire, Vermont, and New York have been working collaboratively. The main objective of the project from the landscape to the local level is to protect the unique, natural heritage of the Northern Appalachian/Acadian region. Karen stated that the vision of the project was to scientifically determine why the ecoregion is worth conserving, and then publicize the conclusions and affect policy to help attain the objective.

Researchers are determining the current human footprint and then the future footprint of society in this ecoregion. Then the sites that are determined to have critical conservation values will be identified. Networks of conservation areas will be determined and analyzed using various computerized models and analysis systems. Various scenarios will be developed, given different input factors to determine future conservation targets.

Sean Basquil of the Atlantic Canada Conservation Data Centre provided an interesting discussion regarding the pre-settlement history of the Acadian Forests. He stressed the importance of considering the scale and time period being analyzed, as there has been tremendous change over millions of years in what is now the Acadian Forest type.

Early post-glaciation and pre-settlement historical data is available from various sources such as early land survey data, old existing trees, dendrochronology (analyzing the past through tree rings), and preserved pollen deposits in bogs (paleo-ecology).

Sean tracked climate warming post-glaciation and the resulting encroaching vegetation cover in the Maritimes, on what we now consider our native plant and tree species. He concludes that climate is the strongest determinant of forest composition and distribution. Other major influences on forest landscape patterns include post-glacial species spread and interaction, island effects, and the disturbance of mankind. Sean also acknowledged that the relationships of plant species are still relatively new, and are still changing and naturally adapting as time passes. Peter Neily, a senior forester with the Department of Natural Resources, spoke about natural disturbance regimes in the Acadian Forest of Nova Scotia. He described how natural disturbance regimes are part of the ecosystem-based management system, whereby the land base is identified according to appropriate similar characteristics, which are indicators of similar ecosystems. Natural disturbance-based management is a prescriptive method of managing the various ecosystem units.

Peter recognizes that there is much debate about the past stature of the Acadian Forest, which can vary greatly depending on perspective, time-frame, and scale. There are various disturbance agents such as fire, wind, insects, and man that may cause small or large forest disturbances over different periods of time. He stated that by man becoming so efficient at preventing and suppressing wildfires, he has dramatically decreased the amount of land burned, which at one time was common across the landscape. He also showed the routes and times of past hurricane events in the province that have caused tremendous disturbances and destruction. Surprising to many in attendance was the fact that there is currently more than 20% more forested land in the province then there was 100 years ago. The natural disturbance regimes that have been developed include frequent, infrequent, gap replacement, stand maintaining, and open seral.

Tony Pesklevits of Dalhousie University discussed old growth forests within the Acadian Forest. He conceded the difficulties and confusion regarding the defining of old growth and its importance. He spoke of the contextual, emotional, and practical aspects of old forests such as age, structure, and the amount and type of disturbance.

Generally, the characteristics of old growth forests include large live tree stems, large snags and downed trees, decaying of dead and dying trees, uneven-aged tree canopy, and multiple vertical layers. They are composed of long-living, shade tolerant species.

Don Cameron, RPF, is CIF (NS Section) Information Officer.

CROP TREE SPOT SELECTION

by David Lloyd, RPF

Why are Crop Tree Spots important?

Crop tree spots can be defined as those places where your crop trees will grow. In the past stands often supported 200-300 crop trees/hectare. Now, in our most productive working forests, we are seeking 700-1,000 uniformly, fast growing, highly valued stems, with short rotational ages to economic maturity. This transition is no small task and requires deep understanding of the soil/stand interaction dynamics within your plantation areas.

Effective crop tree spot selection will determine how quickly we meet our crop development goals, whether these be short-term, like 70 cm to be cattle deterrent, 1.3 m to exceed ungulate browse height, 1-3 m to achieve free-growing/green-up heights; or longer-term, like duration until revenue flow achievement through commercial thinning, or final harvest size. Seedlings planted in crop tree spots will establish faster and will dominate the future stands. Seedlings planted in ineffective places will remain suppressed and contribute to waste in the final harvest of short rotational stands. Waste results in lost profit!

Longer durations to plantation performance achievements often increase the costs. They require greater numbers of inputs reduce crop growth rates, increase risk of non-achievement, and lengthen revenue return/amortization periods. In addition, costs associated with extended adjacency periods for surrounding stands, which have already achieved their economic rotation age, must be considered. If you don't realize what extending amortization curves past age 40 does to the exponential value growth of your investment, create a spreadsheet of it right now!

Concepts for Understanding Tree Growth vs. Crop Tree Spot Selection/Development

If we can't grow roots, we can't grow trees! Root establishment/early growth is the most important factor in new seedling establishment. Roots must be placed in their new "home" with care for their growth requirements. Our objective must be to establish growth momentum first in the root growth, and then in the foliar growth.

Oxygen is the most important nutrient! Root metabolism requires that oxygen be breathed in at the growth point. Soil porosity must be friable enough to allow oxygen to move through the soil atmosphere. Tree seedlings cannot extract oxygen from water against the force of the hydrogen bonds. Therefore soils must be aerated and humid but not wet to encourage root growth.

Soil temperatures must be in the 10° to 25°C range to promote root growth. Wet soils will be colder, dry soils may be hotter; both will inhibit root growth and should be avoided throughout the root plug depth profile.

Two centimetres of organic litter will protect deeper soils from excessive drying. Exposed mineral soils will dry down 10 cm to provide the same amount of humidity protection. Unfortunately, in cold climates soils are often too cold to promote root growth at depths greater than 10 cm.

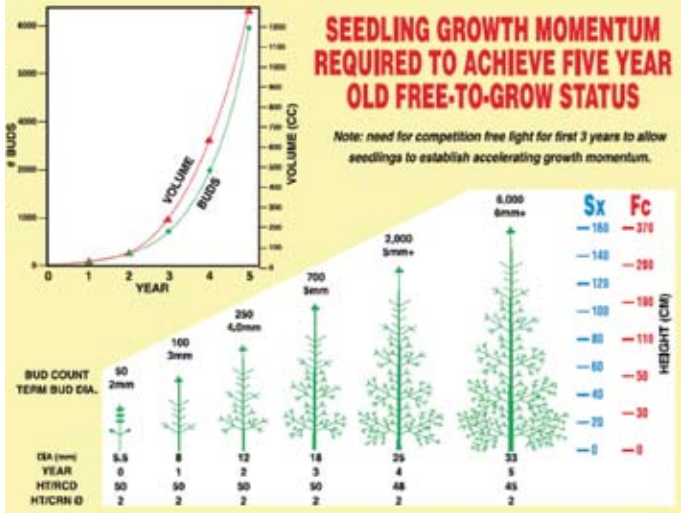
The thicker the roots are, the more foliar growth will occur next year. Roots have annual rings. A two year-old root can easily be 1 cm thick near the seedling's stem. These are the root diameters required to support strong foliar growth. Dig up a well-established seedling that is several years old, and compare the root ring size with the initiation of strong leader increments. You'll find that strong root diameter growth precedes strong leader growth by one year.

Storage sugar needs must be filled by year's end to ensure effective survival through winter and strong growth for next year. Fulfillment is indicated by waxy green needles, large stem diameters and large bud sizes and numbers. Inadequacy (chlorotic yellow needles) forces the seedlings to re-hydrate/soften and begin photosynthesis too early next spring, making them susceptible to mortality from normal spring frosts.

The most important 10 seconds in a tree's life are those between the planting bag and the enclosed new root home. In the end, the tree planter is the most important person on the planting site, for it is the planter who delivers the infant organism from the protected nursery community to the final growing site, the new root home. Roots must be protected from the sun's photooxidation and housed in a humidity-sealed, aerated, non-compressed, nutritious soil environment, all within a few seconds if the planter is to make money. Perhaps the most important thing that planting team leaders can do is to help their planters to establish a rhythm of efficient good behaviour in the delivery of seedlings to their new root home. Only through the continued, diligent application of good behaviour will this tough job be completed properly. Everyone on the planting site needs to know what good behaviour is and be easily able to identify it for each other.

Seedling growth momentum development is illustrated in Figure 1. Note that the ratios remain consistent with stem height to diameter at 45–50:1, and stem height to crown diameter at 2:1 for openly growing seedlings. Narrower ratios indicate increasing vegetation height competition. Note also the growth momentum in bud size, numbers of buds, and stem volume. The first two years are critical in exponential growth establishment. If the exponential momentum is not established in years one and two, then the development will be delayed and the seedlings' ability to occupy the sites quickly and easily may be lost.

Figure 1



Roots are missing in Figure 1. Effective seedlings have roots colonizing a circle twice as large as that of the waxy green photosynthetic crown foliage. Root growth is more important than top growth in early seedling establishment.

Planted poorly, the spring root growth momentum is missed and the seedling will flush without root growth, so nutrients will not be available for foliar completion to waxy, green, photosynthetic needles. Instead, though satisfactory leader length extension may occur, the needles will be chlorotic yellow and unable to manage their water resources. These cannot photosynthesize sugars effectively. Such seedlings do poorly through the mid-summer quiescence, particularly in drought years, and will not be able to produce sugars to support root growth in the fall. Then the seedlings will go into winter with insufficient stored sugars, and will remain too depleted to grow roots in spring. In the

following spring top growth cycles, leader extension will be very restricted, until the roots can finally get ahead of the tops. We call this cycle "planting shock" but more appropriately we should call it "incorrect planting shock".

Success of our planting program can be measured by the second year leader length, which should exceed 15-70 cm depending on the climatic capability. Leader extensions of 2–5 cm in the second top growth year indicate root growth failure properly due to incorrect planting.

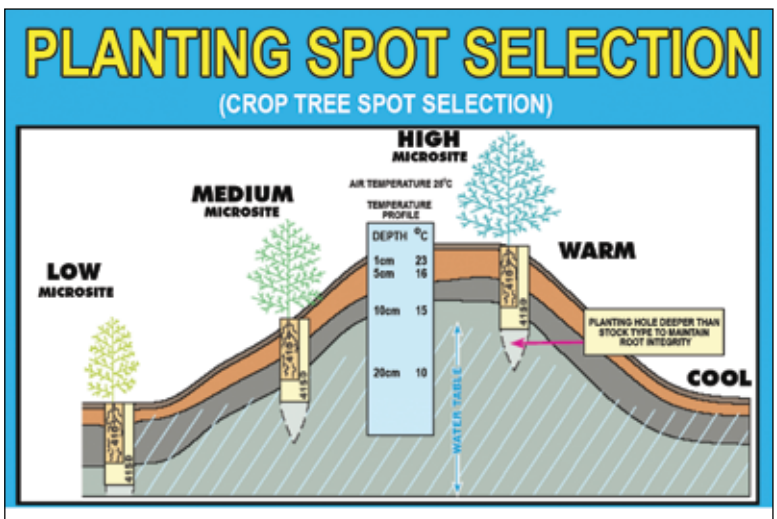
Root home characteristics are illustrated in Figure 2. Where do we normally find the largest trees in our forests? They're always on high places. Why do we dig our soil pits in low places? Is it because there's less chance of encountering roots there? High spots have a different vegetation community, which tend to open up earlier in the fall, allowing greater light penetration to establishing seedlings than do low spots.

In Figure 2, note that the composting, nutrient providing, fermenting layer tends to be thickest on high spots. The composted, organic clay, humic layer is thickest in the low spots. The water table that restricts oxygen availability and chills the soil is closest to the surface in the low spots. The litter layer is uniform across the site, and is critical to maintaining the integrity of the nutrient contribution of the fermenting layer, and should not be scraped off in the planting process. Screefing off the litter layer, only turns the top 2 cm of the fermenting layer into litter, thereby reducing its effectiveness.

Soil temperatures are warmer on the high spots, extending the growing period both throughout each day and each season. Therefore, roots have the greatest seasonal growth capability in the fermenting layer on high spots.

The seedlings planted on high places tend to bear more waxy, green, photosynthetic needles, which tend to be bluish on spruces. As we drop off the side of high places, needle waxiness tends to decrease until foliage is chlorotic yellow in the low, wet places.

Figure 2



Highest oxygen content and warmest rooting zones are found in the litter and fermenting layers. These are most favourable for early spring root growth and maintain the highest level of available nutrient supplies. The fermenting layer is deepest on high spots.

The humic layer generally has high moisture holding capacity and is cooler than the litter and fermeting layers. Oxygen exchange is limited due to moisture levels. Humic layers are deepest in low spots.

Mineral soil remains cooler longer in the spring, dries throughout summer, and has fewer available nutrients. Spring root growth is impeded due to low temperatures.

In Figure 2, note that a cavity is left below the root plug. Planting holes 1.5 times the plug depth is recommended, leaving an oxygen opportunity beneath the plug where roots are not compressed, or "J'd" and can grow freely into soils below. Planting holes should be narrow, minimizing disturbance to the natural soils. Seedlings should be placed at one corner of the hole and the soil closed gently against it to form a vapour seal 10 cm deep.

All foliage remains above ground. The most temperature-resistant part of the plant is the root collar area. Foliage is sensitive to both surface soil temperatures and penetration by soil pathogens. Burying foliage in the planting hole is a bad and often lethal habit that some planters use in an attempt to get the roots closer to water. Both ideas are wrong.

New roots tend to grow along the interfaces between the fermenting/humic and mineral soils. Seedlings should be placed with the top of the plug within the litter layer, and roots spanning all three other horizons. As long as the shovel tip contacts mineral soil, roots can be placed exclusively in organic soils and the roots will access the environments that they need.

Always keep seedlings at least a shovel width (10 cm) away from stumps. Never slip the plug down the side of stump. This will place the roots in litter only, and probably doom the seedling to an early death.

Site improvement must be the goal of expensive mechanical treatments. Costs of $0.20-$1.00 per planting spot are being expended, often without improvement of the site, and then are poorly utilized by the planters. Mechanical site improvement should supplement, not degrade, the existing natural high spots. The treatments should raise the profile height and mix mineral with fermenting layer materials. Roots grow well in such spots and poorly in purely mineral spots. Given the high cost of mechanical treatments, it is usually better to pay a few cents more for greater care in placement of the seedlings, and less on mechanical treatment.

Mounds of humic black materials are similar to those of mineral clay, and produce similar results in poor seedling root growth and early frost mortality.

Mound sizes do not need to be larger than a 30 cm square; just enough to get the seedling established and let the roots grow out to access surrounding areas as needed. Larger mounds waste mechanical energy, and tend to turn up much more non-productive parent material, non-biological soils.

Planting in mechanically treated areas must find the highest profile of mixed fermenting/mineral soils for oxygen, nutrient, and moisture availability. Planting in pure raised mineral soil can cause growth retardation.

Early performance differences are evident from the review of all plantations. Figures 3 and 4 illustrate such differences from seedlings planted at Woss in the spring of 2006. In Figure 3, note the green, waxy needles throughout the seedling, the large stem diameter, and large numbers and size of buds. All of these indicate strong root establishment momentum, and a seedling well prepared to survive its first winter and grow well in its second top growth year.

Figure 3: Well chosen planting spot

Figure 4: Poorly chosen planting spot

Figure 4 shows a poorly planted seedling, slipped in against a stump. Foliage is a chlorotic yellow, indicating non-waxed needles with little ability to resist leaching of nutrients or to manage water reserves. Stem diameter, bud sizes, and numbers are small. Food reserves are inadequate to resist winter/spring stresses. Root colonization would be small, probably sparse, and not further than the branch tips, since the needles are not effectively photosynthetic. This microsite offered the opportunity to be a crop tree spot, but the chance was lost by planting too close to the stump.

Establishing high performance plantations through utilizing crop tree spots has an intricate simplicity of artistry. It's not rocket science, it's way more complicated than that! We need healthy, biologically capable seedlings that are:

- carefully handled to minimize shocks and stored sugar loss
- well planted/housed, and in time with their biological cycles
- planted soon after harvest for advantage over competing vegetation
- fertilized as suitable for the climate and soil sites
- protected from animal browse as required

David Lloyd, RPF, is Manager, Product Research Education at PRT and can be reached at 604-465-5411.

ADAPTIVE FOREST MANAGEMENT IN QUEBEC:
Bits of the big and small pictures

by Nelson Thiffault, Stephen Wyatt, Marc Leblanc, and Jean-Pierre Jetté

"Always in motion is the future." Yoda was right. And that's why people invented adaptive management.

In its simplest expression, adaptive management is often described as "learning by doing". At the other end of the spectrum, academics emphasize the need for adaptive forest management to "incorporate knowledge from multiple sources, make use of multiple system models, and support new forms of cooperation among stakeholders". In between, we find operational definitions that revolve around a systematic process that ensures a continuous improvement of management policies and practices, based on learning from outcomes of operational programs.

Forestry is becoming more complex with increasing social demands requiring ever more detailed planning and management. As described by Bell and Baker in a previous issue of *Canadian Silviculture*, adaptive management is a response to this complexity. It involves setting goals and objectives, evaluating, implementing, and monitoring options as well as performing appropriate adjustments based upon the results. Adaptive management is not just trial and error nor is it just the usual reviewing and adjusting cycle used by most managers. Instead, adaptive management is similar to a scientific experiment for testing different policies or processes for managing forests. Managers need to decide what they hope to achieve and how this can be done. They should be able to put forward hypotheses and identify observable results or measurements that will indicate success. Critically, a monitoring process is needed to look for these results as well as to identify any unintended effects before major problems arise. Perhaps most importantly, information must be circulated back to managers so that policies and processes can be adjusted as necessary. This set of activities takes place at various levels, from the management of a given forest unit to the provincial forestry regime itself, and so we believe it is useful to distinguish between big picture and small picture adaptive management. The big picture is when forestry regimes are adjusted in response to new issues. By contrast, the small picture is found at the management plan level, where tangible actions are taken to evaluate various options in a process aimed at modifying goals and forest management prescriptions.

Therefore, our objectives are two-fold. First, we aim to briefly describe selected reforms the Quebec forestry regime has gone through over the past 20 years. This will help highlight the extent to which adaptive management takes place at the policy and legislative level. Second, we will look at adaptive management in smaller scale applications, describing initiatives where this approach is used to deal with the uncertainty of outcomes. Although incomplete and far from perfect, we believe this two-level assessment provides interesting insights into the way adaptive management is currently implemented in Quebec.

Big Picture Adaptive Management

For over a century and a half, until the mid-1980s, the Quebec government granted forest concessions to private industry over large territories. Concessionaires held extensive rights and responsibilities for forests within their concessions. As early as the 1950s, people questioned the long-term viability of this approach for wood supply as well as the social impacts on rural communities. In the early 1970s, a strong popular movement emerged seeking to cultivate the public forest as a way to survive and occupy the territory.

These factors, along with others, led the government to revoke forest concessions. This was a fundamental change that was initiated in 1974 and culminated in a new forestry law in 1986. This reform was colossal, eliminating forest concessions along with all the rights and privileges that came with them. From thereon, legislation controlled all activities that could affect the productivity of the public forests. In short, private industry signed contracts with the government to supply a certain volume of wood on a specific area. In exchange, companies would have to produce management plans and respect new regulations. Notably, the government officially integrated the principle of sustainable forest management in its forest policy.

Following public hearings conducted in the early 1990s, the Quebec government adopted the Forest Protection Strategy in 1994. This strategy essentially aimed at

gradually reducing pesticide use in public forests, while maintaining a sustained wood supply and favouring harmonious uses of all forest resources. It was comprised of preventive silvicultural measures and identification of needs for new knowledge as well as legislative and management adjustments. A systematic follow-up of the results obtained was planned and carried out. Among other results, the strategy has led to a complete ban on chemical pesticides in public forests.

Commencing in 1996, the government undertook a review of its forestry regime. A number of changes were proposed, but events were overtaken by public controversy over forests and sparked an independent enquiry into forest management, commonly known as the Coulombe Commission. The commission held public hearings in numerous towns and communities across the province and tabled a report in late 2004. Among the major shifts proposed were the adoption of an ecosystem-based approach for forest management, decentralizing forest management, and establishing a new post of Chief Forester.

This brief review illustrates that the Quebec forest regime has gone through major modifications in its history, particularly in recent years. Can we consider this evolution as adaptive? Adaptive management requires the deliberate use of policies designed to enhance the rate of improvement in a proactive manner. Many reforms were mostly reactive in nature, driven by economic, social, and technical factors, and especially by public opinion - a process common to most forestry regimes. However, there are also emerging elements representative of an adaptive approach: setting policy goals, planned and systematic review processes, incorporating the most recent scientific information into management, and adjusting policy, legislation, and practices accordingly. As a result of this evolution, Quebec's forestry regime now recognizes sustainable forest management, embracing criteria such as biological diversity and social responsibility, ideas that were not a priority 40 years ago.

Small Picture Adaptive Management

Implementing Ecosystem-based Management

One recommendation of the Coulombe Commission was that ecosystem-based management become central to forest management in Quebec, a principle now included in legislation. Ecosystem-based management is a way to conserve biodiversity and ecosystem viability while responding to socio-economic needs and respecting social values associated with forestlands. It implies stakeholder participation in decision-making, and is based on the identification of critical ecological, social, and economic issues. Ecosystem-based management requires an adaptive approach; it implies embracing the unknown as an integral part of management.

The Laurentian Wildlife Reserve was selected as one of three pilot regions to test ecosystem-based management at an operational scale. The Reserve covers 8,000 km^2 between the Saguenay-Lac-Saint-Jean and Quebec City regions, dedicated to wildlife conservation and development (Figure 1). The pre-industrial forest, dominated by old-growth, irregular fir stands, has been altered by interactions between natural disturbances and more than 50 years of various forest practices.

Respecting the co-management principle underlying the ecosystem-based approach, project partners are involved at the very top of the management structure. The Partner Table, responsible for preparing the management plan, includes representatives of interested governmental agencies, forest industry, native communities, recreational associations, and ecological groups. A scientific committee, which includes scientists recognized for their expertise in fields such as silviculture and ecology, ensures that decisions and actions integrate the relevant scientific knowledge. Partners consider scientific information along with socio-economic considerations to progressively build the ecosystem-based management plan.

Although decisions are made using the best available data, it is a practical reality that many decisions have to be made with less information than managers would like to have. It is here that the process will adopt an interactive, non-sequential approach. Action decisions will have to be made, but they need to be accompanied by requests for additional information coupled with a commitment to monitor effects and to review the decisions within a specified timeframe. For example, a decision on maintaining certain old-growth forests may be accompanied by biodiversity research and by the monitoring of effects on all management objectives. As monitoring and research provide new information on specific ecological targets, the partners will be able to review their earlier decisions.

An Adaptive Approach to the Protection of Forest Soils

In line with its commitment to sustainable forest management, the Quebec government initiated a process to attain specific soil conservation objectives. Compaction, rutting, loss of productive areas and surface erosion have been identified as the most important physical soil perturbations induced by forest

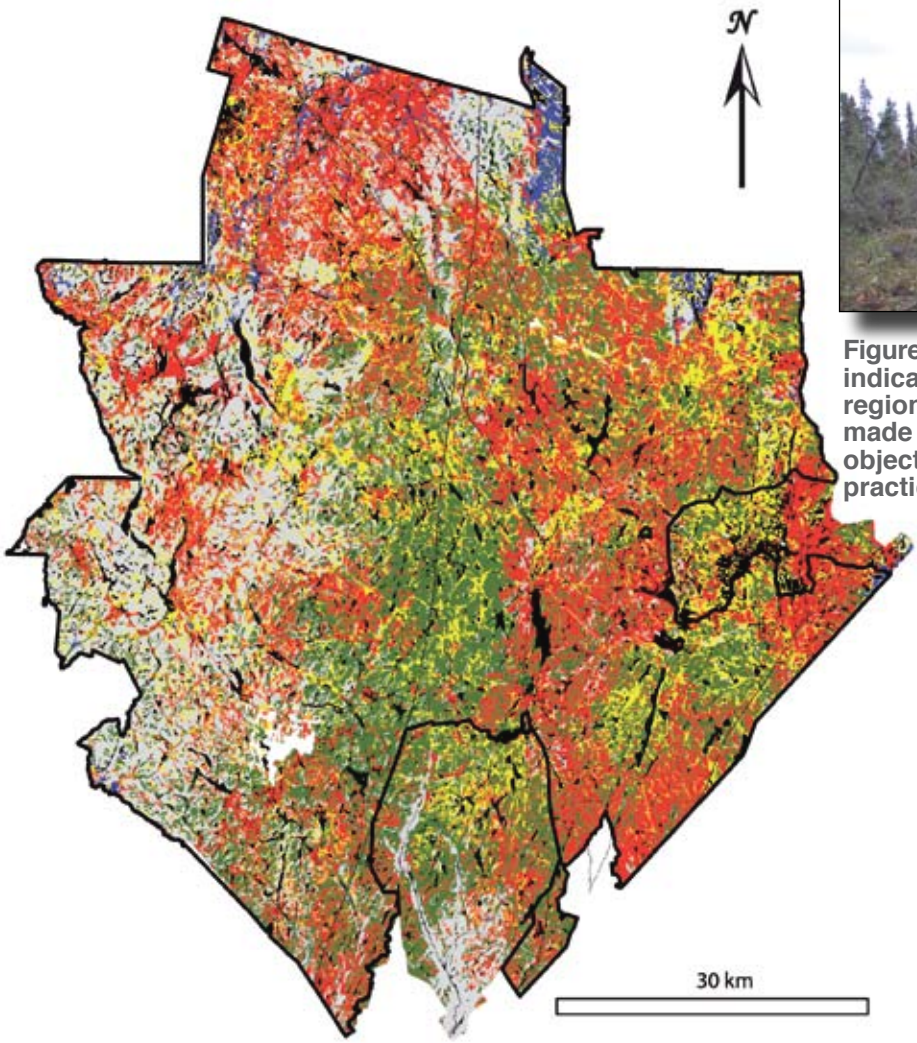


Figure 1. The Laurentian Wildlife Reserve, a 8000 km^2 territory that spans from Quebec City in the south, to Lac-Saint-Jean in the north.

Figure 2. With the assessment of critical indicators of soil perturbation, local, regional, and provincial diagnoses are made in regards to soil conservation objectives. Policies, legislations, and practices are modified accordingly.

activities (Figure 2). Specific, easily measurable indicators were set in place and included in the current management process. As these indicators are periodically monitored, and compiled into databases, it is possible to perform local, regional, and provincial assessments of the situation for specific soil conservation objectives. Focussing on results in protecting and conserving forest soils rather than on means, this adaptive approach enables professional foresters to develop solutions appropriate to specific contexts. This approach is complementary to the usual regulation, and is a privileged tool to ensure continuous practice improvement and facilitate accountability processes.

Looking back, looking forward

Adaptive management is establishing itself at various levels in forestry. Looking at the big picture, the evolution of the forestry regime in response to new issues includes re-assessment mechanisms to evaluate the effectiveness of policy and practice. An increase in monitoring and information-sharing processes under adaptive management will help to attain such objectives. At a smaller scale, implementation of ecosystem-based management demonstrates how an adaptive management framework can help stakeholders incorporate new information and collaborate in decision-making. Managing with environmental indicators, such as those used for forest soils in Quebec, is an example of how adaptive management can be implemented as part of usual forest practices. We hope that such initiatives will contribute to expanding the place for adaptive management as forest management in Quebec and across Canada becomes increasingly complex.

Yoda: *" Impossible to see the future is."*

Luke: *"Well, let's be adaptive."*

Dr. N. Thiffault is a research scientist at the Quebec Ministry of Natural Resources and Wildlife. He is currently chair of a scientific committee advising on biodiversity issues related to ecosystem-based management in Quebec. He can be reached at nelson.thiffault@mrnf.gouv.qc.ca. Dr. S. Wyatt, formerly General Manager of the Conseil de la Recherche Forestière du Quebec, is Professor in Forest Policy at the University of Moncton at Edmundston, New Brunswick. M. Leblanc and J.P. Jetté are ecosystem management specialists at the Quebec Ministry of Natural Resources and Wildlife.

Focus on Safety

by John Betts

Safety is a powerful tool for worker retention

On top of supporting day-to-day forestry, silviculture in BC needs to restore millions of hectares ravaged by the mountain pine beetle and woodland fires. While meeting the demand - planting 265 million seedlings in 2006 alone - the BC silviculture industry also improved injury rates in recent years. Key issues affecting our performance, and some potential threats to sustaining it, can be seen in new research that may be useful elsewhere in Canada's silviculture industry.

Released in February, the report entitled *Health and Safety in the Tree Planting Industry* documents major changes in our workforce, and cites how on-the-job safety influences our recruitment and retention capabilities. Conducted last year, this study surveyed 833 workers across BC and compared the results to similar 2004 research. The full 60-page report can be viewed at www.wsca.ca.

Researchers tracked how tree planters assessed their own safety behaviour and that of co-workers and supervisors. Despite less experience and more youth in the industry, the study found generally safer behaviour, although some unsafe conditions continued. In 2004 and 2006, for instance, only half the planters would stop work because of a toxic hazard and only 43% would report a supervisor for speeding.

Overall, however, the survey indicates declining risk tolerance in a workforce with an average age of about 25 years. By itself, this finding may seem counter-intuitive with this age group, but other results show a higher safety profile for supervisors and an association between supervision and planters' safe behaviour.

The bad news is that only 20.8% of last year's workers saw silviculture as a career, compared to 25.5% in 2004. Reinforcing this trend is the 2006 finding that only 23% intended to return to tree planting in 2007. This is potentially devastating to silviculture because veteran planters are twice as productive as newcomers, and relying on rookies ratchets up demands on supervisors.

The research also leaves no doubt that occupational health and safety is a powerful tool to help us retain experienced workers. The tree planters themselves made this clear in their survey responses:

- Wages are important, but so are jobs with contractors demonstrating good organization and competence, which definitely includes safety.
- Workers need and want good supervisors; they are the main reason for the study's good news.

Acting on this information is crucial - for tree planting and other silvicultural treatments that rely on experienced tree planters in the off season.

When it comes to safety, more is needed than the three Es of engineering, education, and enforcement in promoting safety. This is literally a survival issue, for both workers and the industry. We must build and sustain a deeply rooted culture of safety, for everyone's sake.

John Betts is Executive Director of the Western Silvicultural Contractors' Association and represents it on the Board of the BC Forest Safety Council. The two groups collaborate on the ongoing BC SAFE Silviculture Project.

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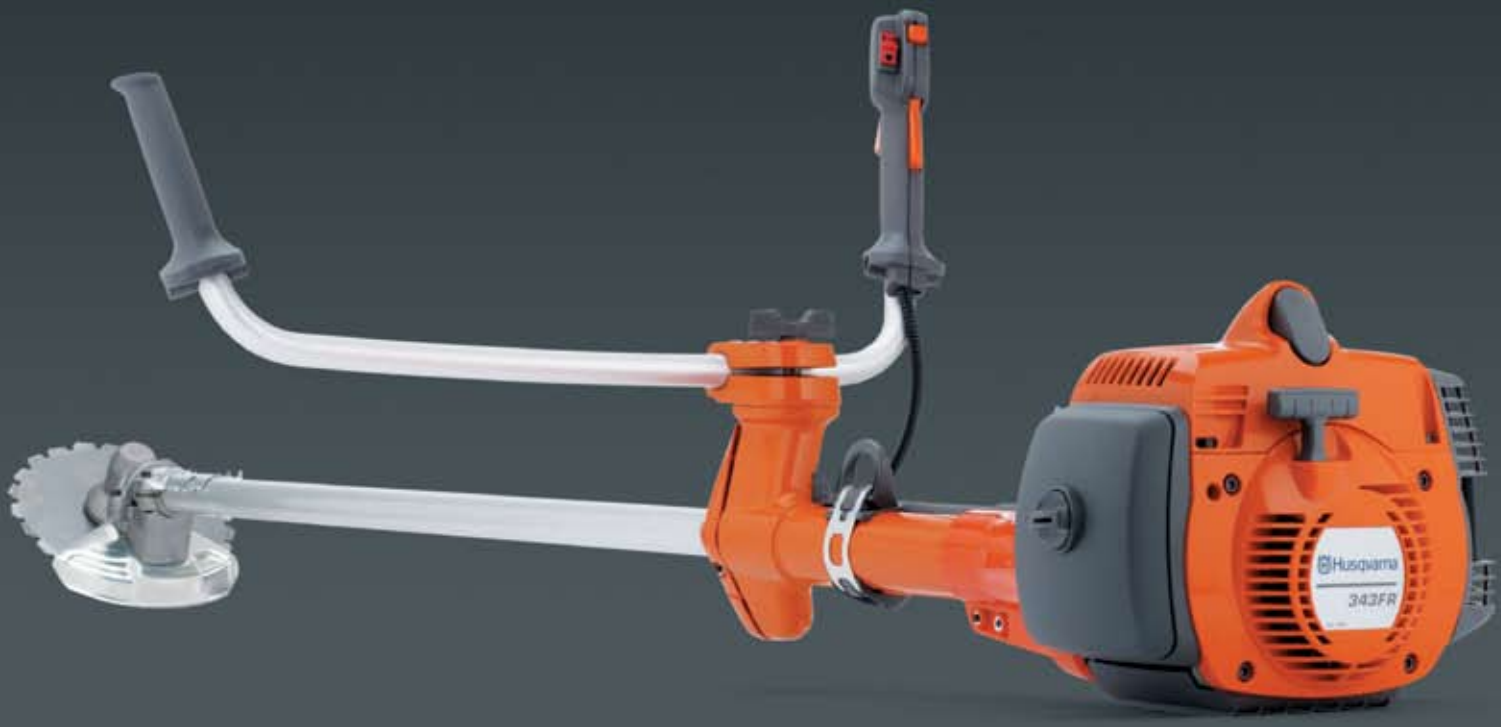

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