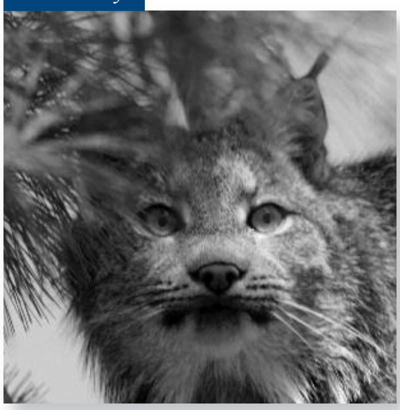
A Natural Balance

Working Toward Nova Scotia's Natural Resources Strategy

Biodiversity



Parks

Forests

Minerals

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Panels of Expertise Addendum
Natural Resources Strategy 2010

1.0 FORESTS PANEL OF EXPERTISE ADDENDUM (J. Porter)

1.1 Clearcutting In Nova Scotia

Introduction

Few other natural resource management activities result in as much public debate as forest harvesting by clearcutting. There are many reasons that cause this practice to be a public issue, including aesthetics, the perceived loss of forest cover, and a concern for possible environmental impacts. The practice of clearcutting is clearly raised in the report from Phase I of the natural resources strategy process, "Many participants felt large clearcuts are neither ecologically nor economically sustainable and that their frequency of practice should be reduced. Others feel that under specific conditions it is a necessary and environmentally appropriate management tool"(Voluntary Planning 2007).

This paper will review the use of clearcutting as an appropriate harvesting method in Nova Scotia.

Key Points

There are many different definitions of clearcutting and it is used to describe a wide variety of operations, which can lead to confusion. A harvesting operation that would be described as clearcutting in Nova Scotia is called "final felling" in parts of Scandinavia. The following definition from the Society of American Foresters (2008) is relevant for Nova Scotia: "Clearcut – a stand in which essentially all trees have been removed in one operation—*note* depending on management objectives, a clearcut may or may not have reserve trees left to attain goals other than regeneration." Similar to other definitions, it refers to the harvest of a forest stand and not to a particular size of opening. Variable retention harvest is a different method that is also used in Nova Scotia and is recognized as a distinct harvesting practice (Franklin, Mitchell and Palik 2007).

There are challenges in identifying the true extent of clearcutting in Nova Scotia based on different definitions that are used and inadequate data. According to the data in the National Forestry Database, clearcutting in Nova Scotia occurred on 92 per cent of the total area from which timber was harvested in 2007 (National Forestry Database 2010). The amount reported for harvests on Crown land was equivalent to 68 per cent, whereas on small private holdings and industrially owned land it was equivalent to 98 and 99 per cent, respectively. The proportion reported for Crown land may well be accurate, but those for private and industrial ownerships are significantly overestimated in the National Forestry Database as there is no process in place to collect the actual information.

Ecosystem-based forest management suggests using natural disturbance regimes to guide appropriate management practices, including harvesting methods (Franklin 1993). In addition, understanding natural disturbance regimes is an important part of some forest certification systems. The Nova Scotia Department of Natural Resources prepared a draft report on "Forest Disturbance Ecology in Nova Scotia," (Neilly et al 2007) but there have been a number of criticisms of the report, particularly with respect to the amount of land proposed as being subject to frequent stand-initiating disturbances. Some are concerned that this would be used to automatically justify clearcutting on all land identified as frequent, stand-initiating disturbance. No human harvesting will exactly match natural disturbances but society would not tolerate true natural disturbance patterns either, because they are often in conflict with societal needs, including jobs and forest products. According to Forbes (2010), there is no consensus among ecologists at this time as to how much stand-initiating disturbance occurred in Nova Scotia or at what interval. A final report on natural disturbance regimes in Nova Scotia would help provide objectives at the landscape level. It is important to recognize that as a result of climate change, disturbance regimes through the 21st century may not resemble disturbance regimes pre-settlement, so there may be risks to following the natural disturbance regime approach too closely (Duinker 2010).

We do not have to rely solely on historical information to develop ecologically sound harvest decisions at the forest stand level. As outlined in Stewart and Neilly (2008), the Department of Natural Resources has been developing a number of excellent tools to help implement ecosystem-based management in Nova Scotia, including the Ecological Landscape Classification, which provides a framework for landscape level planning, and the Forest Ecosystem Classification to guide forest stand management decisions. The Forest Ecosystem Classification takes into account many ecological factors, such as enduring features (soil, drainage, climate), an understanding of species that are adapted to those conditions, and the natural disturbance types the species are adapted to. This guide is a stand-level application of the Forest Ecosystem Classification and is based on extensive fieldwork throughout the province. These tools are intended to be a requirement on Crown land and to be recommended as a best practice for private land under the provincial Code of Forest Practices (NS DNR 2008a). A land owner can make a decision on an appropriate harvesting method based on a number of considerations, such as the Forest Ecosystem Classification (which would indicate recommended future vegetation types); current stand condition (including volume and species); risk factors (such as risk of blowdown); existing legal requirements (such as *Wildlife Habitat and Watercourses Protection Regulations*); as well as their overall land owner objectives. The challenge is to develop a range of tools, including the use of forest management plans, to encourage land owners to take these factors into account.

It is generally preferred to improve private land owner harvesting practices primarily through education and best-management practices. In their 1993 comparison of regulatory and voluntary programs directed at forest water quality protection, Hawks, Cubbage, Haney, Shaffer and Newman (1993) suggest that Virginia's education and evaluation approach is superior to Maryland's complex regulatory approach. A recent review by Gregersen and Contreras (2010) concludes that *"A continued reliance on conventional command-and-control approaches that set uniform standards for guiding forest management decisions has proven to be mostly ineffective and inefficient." They also found that "command-and-control regulations tend to provide few incentives to innovation and also include no motivation to exceed regulatory performance standards."*

It is essential that there is legislation/regulation to ensure key environmental values are protected. Such requirements are largely already in place or under development including, but not limited to, the *Forestry Act and Regulations* (particularly the *Wildlife Habitat and Watercourses Protection Regulations*), *Environment Act and Regulations, Endangered Species Act and Regulations, Wildlife Act and Regulations, Off-highway Vehicles Act, Wilderness Areas Protection Act* and federal *Fisheries Act.* The 2007 report on compliance with *Wildlife Habitat and Watercourses Protection Regulations* indicates that less than 30 per cent of sites visited were in full compliance with respect to protection of watercourses and legacy tree clumps (NS DNR 2007). The report recommends an intensive program of land owner and forest operator contact to increase awareness and knowledge of the regulations. The Department of Natural Resources needs to increase the level of compliance with these regulations.

If land owners are saddled with additional regulations that restrict their freedom to manage their woodlands according to their own objectives, which can include a combination of economic, social, or ecological values, many of them will indeed call for compensation. Private land owners are allowed to harvest the trees on their property in any manner, including clearcutting, if they are converting to another land use, such as agriculture or residential/commercial/industrial development. Land owners who keep their forest land as forest land should be encouraged, possibly even rewarded, for good stewardship and not subjected to additional regulations that dictate or restrict management practices. There are more equitable, more effective, and less expensive ways to achieve the desired outcomes than through additional regulations.

In the 1980s there were similar public concerns about clearcutting in the State of Maine, which led to the *Maine Forest Practices Act* being passed in 1989 with the intent of severely restricting the use of clearcutting as a harvesting practice (Fuller, Harrison and Lachowski 2004). Ten years later a report by the Maine Forest Service makes reference to a number of unintended consequences of the legislation, including high-grading, forest liquidation, land use conversion, and some decisions to refrain from actively managing land at all (Department of Conservation 1999). The report states that command-and-control regulation has many limitations and can result in unintended consequences, and it goes on to suggest that the state should focus on promoting, stimulating, and rewarding excellent forest management while still providing a baseline of regulatory protection. The *Maine Forest Practices Act* continues to govern forest harvesting in the state. It could be argued that the legislation was partly successful as it reduced public complaints about clearcutting, which is now less than 3 per cent of the annual harvest (as defined by the *Maine Forest Practices Act).* However, the long-term consequences of a doubling of the annual harvest footprint, increasing the use of undefined methods of partial cutting, and the homogenization of stand conditions across the Maine landscape have created another set of impacts that are not understood (Wagner 2010).

The Acadian forest can be appropriately regenerated and managed under a wide range of harvesting regimes—in many situations it is not the method of cutting, it is the way that it is practiced, that is the issue (Wagner 2010). Clearcutting is an appropriate harvest method that should continue to be used in Nova Scotia. For example, it can be appropriate for many stands where the provincial Forest Ecosystem Classification is being used as a guide; it can be appropriate where there is a goal of intensive management (including the intensive management zone under a TRIAD zoning approach (Seymour and Hunter 1999); it can be appropriate in stands susceptible to wind damage; and it can be appropriate where there is a restoration goal, following damage by insects, disease, or wind, or inappropriate past management practices. It is typically the most economical of all harvesting systems (Kimmins 1997, Erdle and Ward 2008), which can be extremely important for land owners to meet their management objectives. However, clearcutting has been overused in the past and continues to be used in forest stands where other harvesting methods would be considered more appropriate based on the Forest Ecosystem Classification. The Forest Products Association of Nova Scotia reports a significant reduction in clearcutting on land managed by its members over recent years (FPANS 2010). Their members would include the managers of most of the Crown and industrial land, but not the majority of small private land in Nova Scotia.

Rather than regulating the use of clearcutting in Nova Scotia, which could be expected to have serious negative impacts on private land owners, on the viability of the forest industry, and on the forests of Nova Scotia, the focus should be on getting appropriate harvest methods prescribed and getting them carried out correctly. This will require both an education and an enforcement component. The Atlantic Master Logger Program is a good example of a way to promote professionalism amongst logging contractors (Atlantic Master Logger Program 2010).

Forest certification can play an important role in the continual improvement of harvesting practices in Nova Scotia and is part of the reason for the recent reductions in the proportion of clearcutting. Certification systems support the implementation of an adaptive forest management framework that can be used to manage uncertainty and continually improve management outcomes over time. Forest certification is already used by most large forest land managers, and programs are now available in Nova Scotia to assist interested small woodlot owners with the certification of their land.

A strong extension program is critical to help woodlot owners understand their responsibilities as well as their rights, to understand the appropriate practices for their woodlot, and to support and reward them for maintaining their properties as well-managed forest land.

Conclusions

There is a desire and a need for change in harvesting practices in Nova Scotia, and that change is already underway with a reduction in the proportion of clearcutting. Further reductions in clearcutting will occur as a consequence of improved forest management decisions through a focus on best-management practices and an increase in other harvesting methods.

Regulations should not be implemented to control harvesting methods on private land. Compliance with existing regulations needs to be improved. The Code of Forest Practices needs to be completed, implemented on Crown land, and recommended as a best practice on private land. There is an important role for forest certification, including the use of an adaptive forest management framework, which is already used by most large forest land managers, and programs are now available to assist small woodlot owners with certifying their land. We need to develop a strong extension program to help woodlot owners understand their responsibilities as well as their rights, and to find innovative ways to support and reward them for maintaining their properties as well-managed forest land. There is also an opportunity to significantly increase the general public’s understanding of all forest practices.

1.2 Biomass In Nova Scotia

Introduction

It is clear from much of the recent debate in Nova Scotia that biomass means different things to different people. Many of us build and heat our homes with biomass from the forest. For the purpose of this paper, the term biomass will be used to describe the branches and tops that are normally left in a stemwood-only harvest together with trees that are otherwise unmerchantable due to size, species, etc. Technically, it would be more appropriate to use the term bioenergy feedstock or biofuel (Smith 2010). This paper will only focus on biomass removal as part of ongoing forest management where the intent is to keep the land as forest land. Forest clearing for other land uses, such as development, recreation, agriculture, and transportation, will not be included. In these situations even the stumps are normally removed and impacts on biodiversity and nutrient cycling can be significant.

This paper only considers the potential impact of biomass removal on the forest sites. The end-use of the product, such as the generation of electricity or production of fuels (solid or liquid) or chemicals is an important, but separate, issue. It is a commercial decision often influenced by government regulation. Bioenergy from forests can be expected to grow in popularity as governments look for low-carbon, renewable, domestic fuel supplies. Provided it is produced in an appropriate manner, it is renewable and carbon-neutral or, at least, low-carbon emitting (Lattimore, Smith, Titus, Stupak and Egnell 2009). A recent report on "Transforming Canada's Forest Products Industry" (FPAC 2010) presents a case for integrating Canada's forest products industry with the emerging bioeconomy, through bioenergy production and bio-product creation.

Key Points

Biomass can be removed from the site through whole-tree harvesting or through collection following a harvest. Whole-tree harvesting has been carried out in Nova Scotia and many other parts of the world for decades. In eastern Canada it has been the predominant harvesting system since the mid-1980s (Ryans 2008). Accumulation of branches and tops of trees at the side of the road initially created a disposal problem but that changed as biomass markets developed. Even when a site is whole-tree harvested, a considerable amount of biomass remains on the forest site (26 to 33 per cent in a recent study in Ontario) as a result of breakage and other operational issues (Ryans 2010, Ralevic, Ryans and Cormier 2010). In their study of operational forest biomass recovery in Ontario, Ralevic et al (2010) conclude that increasing demands for bioenergy will not result in a *"clearing or vacuuming"* of all biomass from the forest floor, contrary to popular perceptions and beliefs. When discussing biomass, the focus should be on the level of retention proposed for a particular site rather than the harvest method, which can be designed to meet the retention levels required.

In Hacker's (2005) review of the impact of logging residue removal of forest sites, he states that it is clear that the impacts of logging residue removals on forest sites are highly site specific and dependant on site soils, moisture regimes, forest type, season of harvest, and other factors. Hamish Kimmins, Professor Emeritus of Forest Ecology (UBC), supports the concept of site-specific impacts with his statement: *"We know that a substantial amount of forest biomass can be harvested periodically without long-term negative consequences, but for every ecosystem and every value there is some intensity of removal, beyond which forest ecosystem function and biological diversity will be impaired "* (Kimmins 2008).

There are numerous studies around the world, particularly in Canada, the United States, and Nordic countries, that have looked at impacts of forest harvesting on nutrient cycling and the potential impacts on site productivity and forest growth. A 1986 study in central Nova Scotia examining the potential impact of whole-tree harvesting concluded that it was unlikely that one or several whole-tree harvests with a rotation of at least 50 years would cause important depletions of site nutrients (Freedman, Duinker and Morash 1986). Freedman et al did caution that calcium may be a cause for concern. McLaughlin and Phillips (2006) report that much of the available information that suggests changes in the biogeochemical cycling and possible nutrient depletion resulting from whole-tree harvesting comes from short-term studies (five years or less). McLaughlin and Phillips suggest that longer-term studies are starting to indicate the management activities, such as clearcutting and whole-tree harvesting, may not have long-term effects on soil nutrient capitals. As shown in Figure 1, there are many factors that impact whether there are adequate amounts of nutrients available over successive rotations.

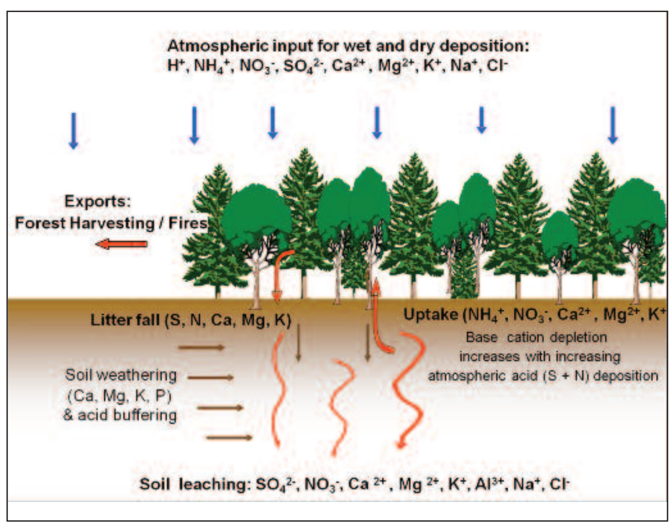

Figure 1. Overview of processes affecting primary nutrient supply and demand in forest stands, focused on upland soil conditions only (Arp et al 2008).

Nutrient supply must be considered over the entire rotation because the capacity of the site to provide trees with adequate nutrients will vary over time (Smith, McCormack, Hornbeck and Martin 1986). We are extremely fortunate to have long-term studies in the Acadian Forest Region, notably at Weymouth Point in central Maine where the treated site had been whole-tree harvested in 1981. Paired watershed studies (treated and untreated), such as those at Weymouth Point, that have been monitored over decades are key to understanding the impacts, both temporal and spatial, of forest management activities on nutrient cycling (Briggs, Hornbeck, Smith, Lemin and McCormack 2000). Briggs et al (2000) found that the impacts of intensive management had been relatively small and short in duration, similar to other sites examined in the northeast. Briggs et al (2000) concluded that from the perspectives of nutrient cycling, the system continued to function and emphasized the importance of minimizing physical site disturbance during harvest to avoid impacts on site productivity. The conclusions of an analysis of the Weymouth Point study area 17 years after regeneration were that whole-tree harvesting had not led to depletions of carbon, nitrogen, or the base cations (including calcium and magnesium) (McLaughlin and Phillips 2006). McLaughlin and Phillips (2006) cautioned a potential concern with the impact of acidic precipitation, particularly associated with magnesium. Long-term monitoring of these sites should be continued to provide important results on the environmental impacts of forest management. In the opinion of Dr. Ivan Fernandez (2009), long-term monitoring will be particularly valuable as we try to understand the impacts of climate change.

Nova Scotia has been commended for developing draft biomass guidelines in 2009 that were results-oriented, *"fairly clear, and easy to apply in the field"* (Thiffault 2009). Decision-support tools are now available to enable forest land managers to plan for sustainable biomass removals on a stand-by-stand basis (Arp et al 2008). They can be used to identify areas where biomass removal is not recommended, including where it could result in nutrient deficits or loss of soil quality (Arp 2009). Such a tool is currently being developed for the Province of Nova Scotia and a provincewide model will be presented by May 2010. According to Professor Arp, results for Nova Scotia will likely be similar to New Brunswick, but certain regions, such as the southwest, will show greater impacts on account of less easily weathered soil substrates and higher incidence base cation leaching due to atmospheric acid deposition (Arp 2010). Together with other planning tools, such as depth-to-water table mapping, appropriate harvesting systems can be implemented. Harvesting practices can be designed to meet target retention levels on a specific site. Winter harvesting in hardwoods and allowing some needle fall in softwoods before extraction are examples of best practices that could be used on some sites to reduce the loss of nutrients in the foliage. Harvesting operations should be planned and implemented to minimize physical ground disturbance. Stump removal is carried out in some jurisdictions but is not being recommended in Nova Scotia.

Furthermore, an adaptive forest management framework (a key component of most forest certification systems, including Sustainable Forestry Initiative and Forest Stewardship Council) can be used to manage uncertainty and continually improve management outcomes over time. It acknowledges the dynamic nature of forest management and encourages continual improvement through stakeholder participation and the continual incorporation of new science and knowledge (Lattimore et al 2009). Lattimore et al (2009) also provides a current review of potential environmental impacts of wood-fuel production.

A recent report prepared for Natural Resources Canada by Smith, Ralevic and Lattimore (2009) reviews biofuel sustainability issues in Canada, including both forestry and agricultural issues.

Conclusions

A review of scientific research clearly shows that the impacts of biomass removal on forests are site specific and will vary regionally, according to local conditions and practices. The long-term study at Weymouth Point in Maine indicates that there have been no nutrient depletions at this site in the Acadian Forest Region as a result of whole-tree harvesting. A blanket approach either supporting or prohibiting forest biomass removal on all sites would not be appropriate for Nova Scotia. It is recommended that the province implement site-specific guidelines for the removal of biomass under the provincial Code of Forest Practices. They should incorporate the model being developed for the province by Professor Arp at the University of New Brunswick. An extension effort will be required for private land owners.

2.0 FOREST PANEL OF EXPERTISE

(BANCROFT AND CROSSLAND)

2.1 Clearcutting

The idea of forests as a natural resource for human use is a singular perspective that might seem egotistical and foreign to a Mi'kmaq person, a barred owl, a moose, a trout, or a salamander; perhaps even a trained ecologist.

Forest Panel Members Donna Crossland and Bob Bancroft

Vision

Nova Scotia forests will be largely composed of multi-aged forest structure dominated by shade-tolerant, late-successional tree species resulting from predominately Acadian gap disturbance regimes, the regime under which nearly all Acadian forest flora and fauna in Nova Scotia evolved. A rich, biodiverse forest will sustain a flourishing, diversified forest industry, composed of large and small players; increased job markets; and more stable forest economies. Exceptions to this vision are the boreal forests that exist on the Cape Breton Highlands, generally composed of even-aged, short-lived forest stands susceptible to stand-replacement events such as spruce budworm and windthrow.

Objectives

1) Curtail the use of the clearcut harvest methods by adopting uneven-aged harvest practices.
2) Restore older age-class and structural diversity to forests through alternative harvest practices.
3) Encourage natural regeneration of shade-tolerant species through promotion of more ecologically appropriate silvicultural methods.
4) Enhance habitat for all native plant and wildlife components of the Acadian forest.
5) Adopt a range of private land management program options that ultimately enhance stewardship strategies, reduce long-term environmental impacts, and require proper assessment of sites prior to harvesting as well as management plans.
6) Invest in a diversified, more economically stable forest economy.

Background

"Clearcutting, per se, means the cutting of all trees larger than seedlings and small saplings of a new reproduction stage to leave an area of land looking "clear." Normally, roots and stumps are left intact, and a layer of slash covers the ground" (School of Forest Resources 1975).

Clearcutting - "a stand in which essentially all trees have been removed in one operation" (Helms 1998).

Recently clearcuts have been defined by retention levels: Clearcuts retain less than 5 per cent of trees, while other types, such as aggregate variable retention, seed-tree release, etc., may retain 5 per cent or more of forest. These too are functional clearcuts and produce even-aged stands.

A strong public distaste for clearcutting has been voiced in Nova Scotia for decades. To understand the forest ecology that leads to the conclusion that clearcutting has been misapplied to most forests in Nova Scotia, the process of natural forest succession needs to be understood. Tree species with the ability to grow from seed on sunny, open ground become the pioneer forest (i.e., early successional forest) after a major stand-replacement disturbance, such as fire, that kills or removes the original forest. Those short-lived, shade-intolerant pioneer trees are gradually replaced through successional processes by longer-lived, late-successional tree species that can germinate and grow in shade, growing slowly as seedlings and saplings on the forest floor until an opening appears in the forest canopy. When disturbance events, such as mortality from insect infestations or uprooting events, cause openings in the forest canopy, the shade-tolerant trees are well positioned to bolt for the light. Late-successional forests (climax forests) can self-perpetuate in a more or less steady state, occupying a site indefinitely in the absence of catastrophic disturbance (Mosseler et al. 2003).

Clearcut harvesting favours shade-intolerant (sun-loving) tree species and creates even-aged forests. While these early successional species, such as poplar and white birch, are important to the Acadian forest ecology, they are currently over-represented in Nova Scotia, and have replaced mid- and late-successional forests of red spruce, yellow birch, sugar maple, and white pine. These long-lived and magnificent trees, capable of impressive heights and large-diameter growth, were once characteristic of Nova Scotia forests. They are becoming increasingly more difficult to find. In many areas, early successional forests, e.g., poplar and white birch, are repeatedly harvested, not allowing a long enough period between harvests to proceed to later-successional stages and recovery to more valuable species. Eventually, seed sources for late-successional species in some instances can become scarce.

Clearcutting diminishes the wealth of our forests in a variety of ways besides eliminating more valuable species. Since post-clearcut forests are open-grown, saw-log quality is often diminished. These less valuable softwood trees remain an acceptable source of wood fibre for pulp and paper industries and emerging wood chip and pellet markets. Aspen and other deciduous species, which have had less market potential under the current softwood-based industry, can be used for biomass energy, though profit margins are relatively low.

To summarize, early high grading and subsequent clearcutting have ecologically degraded forests. For decades, clearcutting has been an over-used harvest tool exacting considerable long-term ecological damage. In most cases clearcutting encourages the regeneration of sun-tolerant species like white spruce, grey birch and poplar, instead of shade-tolerant sugar maple, red spruce, and hemlock that were capable of self-perpetuation over hundreds or perhaps thousands of years.

Nova Scotia's forests are currently 80 to 90 per cent clearcut. Maine has reduced clearcutting to 3 per cent. While foresters assure us that the transition to alternative, uneven-aged harvest is economically viable for large industry to do (Seymour 2010), clearcutting remains the harvest method of choice in Nova Scotia for reasons of quick financial profit. Little has been done to encourage alternative, more sustainable harvest practices. Forest education institutions have promoted the "clearcut, plant, spray" model, with little debate about whether this approach is appropriate on lands that formerly supported uneven-aged, shade-tolerant, mixed-wood forests. The focus has been an agronomist mindset: using a variety of silivicultural techniques to increase growth and yields of fibre-producing forests.

Increased awareness and understanding is required about such harvest impacts to our complex forest ecosystems (wildlife habitat; nonmerchantable vegetation components, such as herbaceous plants, lichens and bryophytes; and ecological processes).

The Department of Natural Resources has currently formulated Integrated Resource Management teams that have some representation by biologists/forest ecologists. This may assist with broadening the focus.

Despite public outcry, industry will not alter harvest practices without government regulation.

Wildlife Habitat and Watercourses Regulations have made an ineffective attempt to compensate for the damage of clearcutting by legislating 20-metre riparian zones and small legacy clumps (10 trees/ha). These stipulations fall short on meeting the requirements to maintain all affected ecosystem components. The idea is that under a shifting mosaic of stand-replacement events, the components will simply move to other patches on the landscape. Many species have limited dispersal capacity (e.g., some lichens and bryophytes). Highway beauty strips may please members of the tourism industry, but serve little ecological function.

Clearcutting has persisted not only because of its quick flush of cash, but also because of taxpayer-derived government subsidies awarded after the harvest to create a new, more simplified forest ecosystem. Subsidized activities have included the costs of site preparation, planting, and herbicides or pre-commercial thinning.

Land owners have rights to make decisions pertaining to the use of their lands, but they also shoulder social and environmental responsibilities that accompany that ownership. To break the clearcutting habit, government must voice an appropriate forest philosophy and practice, and mount a concerted effort to raise the ecological awareness and understanding of woodlot owners and the general public.

Our concerns - The ecological issues with clearcutting Acadian forest

According to Phase I, public distaste for clearcutting is shared by urban and rural people alike. Many in the scientific community share their concerns. Forest ecosystems have been altered so much that some may collapse. It has been suggested that 50 per cent of the pre-European settlement forest supported late-successional old-growth forest types, with the remainder in earlier successional stages (Mosseler et al. 2003).

In terrestrial systems-

1) Altered species composition: Acadian forest is naturally dominated by long-lived, shade-tolerant species, most of which are incapable of regenerating in a wind-exposed, sunny clearcut. Smaller gaps are required to maintain these representative species.

2) Forest age: Forests have become more even-aged and younger under an intensive harvesting regime of clearcuts. Estimates are that only 0.6 per cent old-growth remains.

3) Forest structure: Trees of large dimensions were typical in unaltered Acadian forests. A considerable number of wildlife species require large trees for habitat. Examples would include slow-growing lichens that require stable bark surface, and cavity species such as owls and flying squirrels.

4) Forest fragmentation: Many species of lichens require forest stand continuity to maintain humidity and shade levels appropriate for growth. Some wildlife species also require large forest areas with continuous canopy.

5) Increased soil nutrient depletion: Clearcuts allow soil to heat up, which speeds up the decay process, and causes nutrient leaching and loss.

6) Increased erosion.

7) Wildlife displacement from habitats with other habitats already occupied.

In aquatic systems-

Clearcutting has well-documented detrimental effects on watersheds, flow rates, aquatic habitats, aquatic species diversity, and stream bank erosion. Increased water fluctuations appear to be flooding loon nests and impacting nesting success. Stream ecosystems are sensitive. Clearcutting even < 1 per cent of the basin has caused rapid decline of some invertebrate communities in streams (Martel 2007). Other research has concluded that the type of harvest treatment can have significant influence on water quality and quantity *"particularly on the smaller streams that are found at the headwaters of catchments"* (Nitschke 2005).

Justifications for clearcutting

Industry has become skillful at delivering a number of public messages and justifications for clearcutting, such as: 1) *The stand is over-mature and will only fall down. You will lose everything.* 2) *Clearcutting is acceptable as long as they replant.* 3) *Forest stands are over-mature and will become a haven for forest pests.*

Education and outreach are required to send out more ecologically appropriate messaging for our forest region. "Over-mature" is a forestry term and is more appropriate to apply on boreal ecosystems. While boreal forests, with more even-aged structure and shorter-lived species, such as balsam fir, will reach maturity (or over-maturity) and start to break up, mixed-wood forests composed of long-lived shade-tolerant species will not fall down all at once. As many of these species can live for 100 to 300 or more years, it is more appropriate to refer to them as "old-growth," rather than over-mature. Species, such as eastern hemlock and red spruce are capable of self-perpetuation under their own canopies for thousands of years. Stands become uneven-aged, and do not die simultaneously. Varying tree sizes and structures within uneven-aged forests allow a range of resistance and survivorship to wind, fire, and other disturbance events.

Many members of the public believe that replanting after a clearcut acceptably compensates for this harvesting technique, failing to recognize that planting will convert the original diverse forest to a plantation, and drastically reduce species diversity. Many wildlife species will be displaced and understory herbs will no longer grow in plantation conditions. The current industrial focus is interested in growing softwoods only. If they invest in planting seedlings, herbicides may be used to keep young conifers from being dominated by vigorous hardwood sprouts.

Over-mature stands of boreal species, such as the balsam fir stands on Cape Breton Highlands, can become over-mature and vulnerable to insect infestations. This was part of the natural disturbance cycle of such forests. However, an impending insect attack in more typical Acadian forest is hardly a reason to clearcut.

Managing forests for biodiversity

Managing forests so that all components of the diverse Acadian forest ecosystem continue to exist is essential. From an economic viewpoint, the natural diversity of the Acadian forest may offer more opportunities to develop new types of products and markets.

Climate change is an overarching and compelling reason why forest management must maintain natural biodiversity and not put all its "eggs in the softwood basket." A more diverse forest will be a more resilient forest. Climate change is predicted to result in increased frequencies of ice storms, winter thaws, wind events, drought, and pest introductions (Vasseur and Catto 2007). Some tree species will have greater capacity to adapt to certain types of events than others. Fortunately, the ranges of many of our temperate species, such as red spruce, white pine, and sugar maple, extend farther south into the United States, and may find optimal growth conditions in a moderated Nova Scotia climate, while more boreal species, such as white spruce and balsam fir are predicted to experience difficulties (Canadian Council of Forest Ministers 2009). Scientists agree that the rates of change and the introduction of *"novel impacts and stresses have accelerated tremendously"* during recent times (Motzkin and Foster 2004). Maintaining biodiversity is our best preparation for the future.

Emulating natural disturbance regimes

Forest harvesting that emulates natural disturbances is viewed by many as an essential management paradigm for achieving sustainable ecosystem-based management. Stakeholder response was positive during the natural resource strategy process (Phase II) to the question of whether the province should emulate natural disturbance regimes. Furthermore, the Department of Natural Resources has begun to adopt this approach in Integrated Resource Management planning. Information on Nova Scotia's disturbance regimes is integral to the Forest Stewardship Council process, which sets forth principles, criteria, and standards that span economic, social, and environmental concerns about the practice of sustainable forestry.

There is a huge disparity of views on what types and frequencies of natural disturbances operate in the senescence and renewal of Nova Scotia's forests, with little peer-reviewed scientific information to substantiate the wide-ranging perspectives. Natural disturbance regimes that once influenced our forests have been masked by human-dominated disturbances. Repeated, catastrophic land-clearance fires during the 18th to 19th centuries wiped out the character of many early forests, as described by Titus Smith in 1801 to 1802 and others, and, according to Johnson (1986), altered soil properties in some cases. Forest conversion to farming and homesteading, logging and clearcutting, and introduced pathogens (e.g., beech bark disease) have all impacted the natural disturbance regime. Research is required to accurately define natural disturbance regimes in Nova Scotia, similar to research completed in Prince Edward Island (Sobey 2002; 2006; Ponomarenko 2002) and New Brunswick (Crossland 2006; Ponomarenko 2002; Lutz 1997). It must draw upon a variety of scientific disciplines and information sources to define native disturbance dynamics. Among the most promising research approaches for defining Nova Scotia disturbance regimes are ecosystem archaeology used in several Atlantic Canada national parks (Ponomarenko 2002; 2007; Ponomarenko and Ponomarenko 2000; 2002; 2003) and dendrochronology (Fraver and White 2005).

The Department of Natural Resources' Ecosystem Management Group, consisting of Peter Neily, Bruce Stewart, and others, completed some widely circulated documents on Nova Scotia natural disturbance regimes (Neily et al. 2007; 2008). This information is being used as the primary basis for ecosystem-based decision-making for sustainable forestry, although the amount of fire caused by human activities, as opposed to natural fire, remains unclear. This is a concern for the Forest Panel. Conclusions that may over-emphasize the role of catastrophic fire are being used to justify clearcutting (and its frequency) for Forest Stewardship Council certification and the soon-to-be-fully implemented Integrated Resource Management process. Clearcuts are widely accepted as approximating natural stand replacement disturbance such as catastrophic wildfire (and hurricanes). Thus this harvest method could continue to be justified under the new Integrated Resource Management process. More research must be satisfactorily completed on Nova Scotia's natural disturbance regimes or we risk implementing improper harvest strategies on the landscape that do not, in fact, emulate the type of disturbances under which Nova Scotia's forests, and all of its ecosystem components, evolved.

There is consensus that natural regeneration of dominant species within the Acadian forest occurs within canopy gaps resulting from small-scale, frequent stand disturbances (White et al. 1985; Seymour et al. 2002; Fraver et al. 2009; Mosseler et al. 2003), and not large-scale stand-replacement events such as those associated with catastrophic fires and blowdowns that are typical of boreal systems (and the Cape Breton Highlands) (Runkle 1982). Such large-scale events were rare and highly variable in size (Seymour et al. 2002). It has been estimated that only about half of Nova Scotia's Acadian forests were subjected to stand-replacement disturbances only after many centuries (Mosseler et al. 2003). Ecosystem archaeology research in Kejimkujik National Park has concluded that four large-scale fires occurred within the last 1,500 years (500, 1200, 1500, 1720 AD); all four fires following shortly after hurricanes (Ponomarenko 2007). During the last millennium, just prior to European influences, the fire return interval was approximately 240 years for the eastern sector of the park (Ponomarenko 2007). More importantly, high-intensity wind events, not fire, may be the key disturbance agent for stand-replacement events in Nova Scotia. This was also the conclusion for natural disturbance regimes in Maine forests (Seymour et al. 2002).

What does all this mean in terms of harvest practices?
If harvest practices are to approximate natural disturbance regimes, clearcutting is appropriate only after roughly 250 years or more in certain areas of southwest Nova Scotia. (Some lower-lying areas could be deduced to have even longer intervals between clearcutting, or natural stand-replacement events.) Even then, clearcutting may not be as appropriate as partial-harvesting silvicultural systems. Comparisons between the effects of clearcuts and wildfire have led to conclusions that partial cuts may more closely emulate fire effects (Nitschke 2005). Similarly, Foster et al. (2004) concluded that hurricane events do not generally give way to entire stand replacement. The trees remaining in Point Pleasant Park following Hurricane Juan in 2003 provide some evidence in this regard.

Since partial disturbances dominated in the form of small gaps and various-sized larger canopy openings, cutting cycles must be managed for multi-cohort stands (Seymour 2002). Harvesting that approximates gap replacement is often equal to, or less than, two tree heights in width. Openings wider than this begin to create a clearcut situation and the dry, harsh, hot regeneration microclimates that are characterized by large openings.

It is time to turn away from even-aged silviculture (i.e., clearcutting and its variations). Clearcutting was an agricultural model applied to forestry; it is not ecological forestry (Seymour 2010).

The future: Moving forward

Phase I of the Forest Strategy strongly recommended a transition away from clearcutting. We believe this can be accomplished at minimal cost, using a combination of regulations and incentives. Maine and New Brunswick (also within the Acadian forest region) have already made substantial silvicultural improvements. It is clear that we cannot continue with the status quo on clearcut harvesting, based on public outcry, scientific research, and a declining forest economy that is reliant on ecologically unsustainable harvest practices in Nova Scotia.

The future must emphasize forest health and long-term site productivity.

Recommendations

Promote and restore structure, older and diverse age classes, and late-successional species compositions to Nova Scotia landscapes by means of the following:

1) Implement the Department of Natural Resouces' new Forest Ecosystem Classification system and other components of the Integrated Resources Management process (e.g., Forest Code of Practice and Ecological Land Classification).

2) Create multi-aged stands using silvicultural systems that meet all ecosystem components at once. There are a variety of techniques that meet such criteria. Irregular shelterwood systems, particularly irregular group shelterwood and expanding gap systems, have been successfully implemented in Maine (Seymour 2010). Alternating strip cuts, or "Light Re-entry Silvicultural Harvesting," as described in Salonius (2010) has been successful in New Brunswick. These systems all have in common small gaps that allow shade-tolerant species to establish and grow. They also have legacy areas that ensure that other essential forest components that require closed-canopy conditions and/or limited dispersal capacity survive. Direct consultations with Dr. Seymour could greatly assist the implementation process in Nova Scotia.

3) Approximate natural disturbance regimes on the landscape through techniques mentioned above and by completing research to define our disturbance regimes.

4) Plantations and other even-aged forests (resulting from previous even-aged harvest practices) can be improved and restored by a variety of silvicultural

methods, such as thinning and planting appropriate seedlings in small gaps or narrow strips, and using the residual plantation as a nurse crop to afford protection (Salonius and Beaton 1997; Salonius 2007). Areas left uncut can eventually be harvested after regeneration has been established.

5) Crown lands will become leading examples of uneven-aged silviculture techniques, following ecosystem-based management employed under the Department of Natural Resources' Forest Ecosystem Classification system. Plantations and intensive forest management on Crown land will be phased out, as per public request.

6) Develop new management and stewardship strategies (and infrastructure capabilities) to properly assess potential harvest sites. Specific harvest methods will be prescribed and based upon actual site assessments.

7) Develop a reverse-onus policy on clearcutting, where one would have to demonstrate the absolute need in spite of the ecological implications to get a permit to use the clearcutting method. Clearcutting should have to be justified on a permit system according to the department's Integrated Resource Management framework (e.g., Forest Ecosystem Classification system).

8) Enact legislation to prohibit clearcutting of tolerant hardwood stands, and phase in restrictions on clearcutting shade-tolerant, mixed-wood softwood stands. Allow selection cuts, small patch cuts, "string of pearls" and other harvest methods that provide the appropriate environmental conditions to regenerate the shade-tolerant species.

9) Restrict the planting of a few species or monocultures after clearcutting to zoned, privately owned lands. Include provisions for landscape connectivity, wildlife, and biodiversity. Natural forest retention areas should be encouraged.

10) Ensure that Department of Natural Resources' staff are well-trained and versed in uneven-aged management techniques, and that public education and outreach programs about appropriate harvest techniques are available.

11) On private lands, promote working-forest conservation easements. A successful example is the forest bank program in Indiana, managed by The Nature Conservancy (www.nature.org/). Annual payments are made to the owner based on the value of timber present. A professional forester manages the woodlot with an emphasis on biodiversity. This may be especially appropriate for absentee land owners (Floyd and Chaini 2007).

12) On private lands, incentives that encourage uneven-aged management and other appropriate forest practices must be put in place by: a) amending legislation on silvicultural credits under the *Forest Sustainability Regulations*, adding another Category 7 to financially assist with uneven-aged management, while reducing assistance for even-aged practices; b) mandatory riparian zones can be increased to 45 metres on clearcut sites, while requiring only 15 metres (with a no-travel zone) within uneven-aged management systems with sufficient canopy retention. Legacy tree retention regulations would also be exempt.

13) Implement a permit system for all contractors of commercial tree operations who operate on private lands. The contractor would be required to post a performance bond, of a cost to vary with the scale of the harvest. The bond will be held in escrow by the Department of Natural Resources and returned to the permit holder after the logging operation is completed, provided no infractions of regulations have been discovered by the department. If the department withholds bonded money due to an infraction of regulations and resulting environmental damage, the onus is on the permit holder if he or she wishes to contest the department's decision. This will provide a powerful deterrent against illegal cutting and an easy enforcement mechanism.

14) Herbicide use would be phased out on Crown lands, and used mainly in unusual circumstances, such as for controlling invasive exotic plants. Where necessary, thinning can be accomplished with trained, employed workers. Uneven-aged management, whereby smaller gaps are created, will produce desired tree species while avoiding the costs of site preparation, planting, and removing unwanted competition. Enhanced awareness of the ecological function of hardwoods can assist with forest operator co-operation. Costs associated with the traditional approach of site preparation, planting and herbicide application would better invested in a higher per-acre labour rate for pre-commercial thinning.

15) Complete scientific research on Nova Scotia's natural disturbance ecology. The application of current assessments may erroneously allow continued justification of frequent clearcutting over large areas of the province.

External forest research by universities and scientists who are uninfluenced by biases of economically driven forest interests should be supported by the department. Defining our natural disturbance ecology requires the application of a variety of information sources and scientific disciplines. Research is challenging since it is difficult to distinguish anthropogenic change from natural disturbances and much of the physical evidence on which to base conclusions has been lost. Furthermore, different Acadian forest ecoregions will have substantially different disturbance regimes: "one size does not fit all." A variety of information sources remain as yet unexamined that could provide empirical evidence of disturbance regimes: Archives, including the Department of Natural Resources' archival holdings, can assist the history of the Acadian forest with early surveyor notes and sketches, using witness trees and forest type descriptions. A collation of historical documents, letters, newspapers, and reports from the French and early British period (similar to the work of Sobey [2002; 2006] in Prince Edward Island or Crossland [2006] in New Brunswick) is recommended.

16) Research using ecosystem archaeology methods is strongly recommended, as it is one of the few retrospective research methods that can discern between natural and European influences, and can reveal influences of hurricane and insect events, as well as fire. It generates a comprehensive understanding of a variety of disturbance agents in a given area at relatively low cost. Other retrospective techniques, such as fossil pollen in combination with interpretation of charcoal fragments, would provide worthwhile evidence of past forest types.

17) The Department of Natural Resources needs to increase its transparency on the state of forests over various regions and the extent of clearcuts, etc. Clearcuts are currently monitored on an annual basis (Beyeler Pers Com.), yet this information is inaccessible. Statistics on clearcuts are generated from a variety of groups and data sources, rather than being reliably generated and available to the public from the department. Forest databases and other information sources are publicly funded and need to be made accessible, with appropriate caveats, to researchers and other members of the public.

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2.2 Biomass

The idea of forests as a natural resource for human use is a singular perspective that might seem egotistical and foreign to a Mi'kmaq person, a barred owl, a moose, a trout, or a salamander; perhaps even a trained ecologist.

Forests Panel Members -
Bob Bancroft (chair),
Donna Crossland
January 15, 2010

Rationale

The following is intended to provide the Minister of Natural Resources with the Forest Panel perspective on the potential utilization of wood biomass for energy production. The Forest Panel has outlined many of the benefits, as well as concerns and potential impacts associated with biomass energy. Our focus is on whether forest ecology will be further degraded by making increased commitments to biomass energy.

Background

The province of Nova Scotia is currently compelled to explore all reasonable energy alternatives that could reduce the province's current unsustainable dependency on fossil fuels for energy. The *Environmental Goals and Sustainable Prosperity Act* (EGSPA), (supported by all political parties), states that 18.5 per cent of total electricity needs in Nova Scotia will be obtained from renewable energy resources by the year 2013. In an effort to reduce greenhouse gas emissions, the province has set a target for 25 per cent of the province's electricity to be produced from renewable energy by the year 2015. Currently, Nova Scotia imports more than 80 per cent of its energy from world-energy markets, many of which are politically unstable, and from energy sources that are in decline (e.g., coal and oil) (Hughs 2009). While burning wood biomass for space heating and cooking in Nova Scotian homes has been practiced for centuries, the use of wood biomass to produce electricity is a relatively new concept.

With an ever-increasing world population, we can expect the demand for forest products for shelter and fuel to rise. Industrialized countries recognize that they need to decrease their dependence on oil. Forest biomass has been touted as the new petroleum that will serve to meet ever-growing demands for carbon-based products, formerly produced from fossil fuels and electricity, to support our current high standard of living. There is growing public interest in green energy.

The Interim Renewable Energy Strategy (Adams and Wheeler 2009) encourages the Nova Scotia Government to consider biomass energy production, if conducted to the *"highest possible environmental standards."* The report suggests a large-scale forest biomass energy production of up to 70 megawatts by 2015, and an additional 70 megawatts by 2020. As such, biomass would contribute approximately 35 per cent of renewable energy. (Large-scale and community wind farms and tidal power are proposed for additional percentage of renewable energy.) The question is how the province will ensure the ecological integrity of forests before it endorses further adoption of biomass energy. What are the "highest possible standards" for biomass harvesting? Many members of the public are skeptical in light of the fact that the integrity of forests up to now, without biomass harvesting, has already been severely jeopardized. The Acadian forest is classified as one of North America's most endangered forests (Davis et al. 2001). How do we ensure improvements in forest biodiversity, forest health, and forest structure, while moving forward with well-intended endeavours to produce green energy? Interim guidelines for biomass harvesting on Crown land have been drafted by the Department of Natural Resources. There is nothing in place to deter detrimental harvesting practices for biomass on private woodlots.

Nova Scotia has been participating in the biomass industry for the past decade or more. Pulp mill and sawmill wood wastes (hog fuels) are being used to make electricity and also for space heating. Biomass energy has been efficient for facilities that are situated near forest manufacturing operations that produce wood waste. Nova Scotia has also been exporting wood chips and pellets to European countries for a variety of purposes, among them biomass energy. In 2006, a total of 135,994 tonnes were shipped out of various Nova Scotian ports (Figure 1). (Quantities exported by truck to New Brunswick and Maine were not obtained.) The exact quantities and world destinations of our biomass, attached, show that Netherlands and Denmark have emerged as the biggest importers of Nova Scotian biomass. Reduced exports in recent years reflect increased uses at home and a contraction in the forest economy.

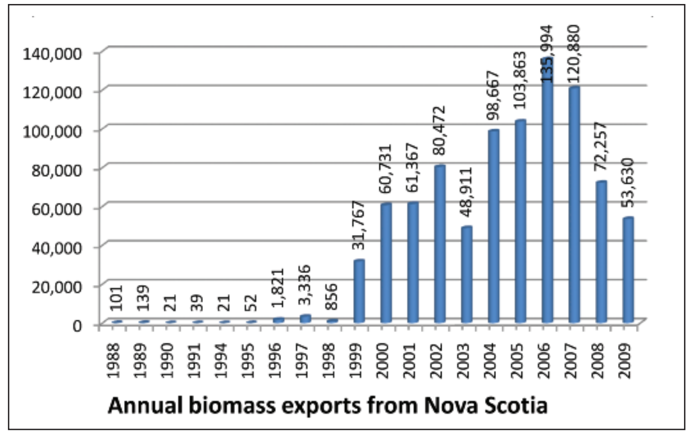

Figure 1

The promising aspects of biomass energy

There are some potential benefits of burning biomass for electricity. From an economic development aspect, some communities, such as those in the Digby-Cornwallis area, view biomass as a stimulus to their economy (Lindsay 2009). Providing that Nova Scotia Power Inc. made some necessary changes to the power grid system, biomass could bring additional economic opportunity to small, rural communities, particularly if they could generate and sell power to the province, while also maintaining and creating jobs. If this power generation was coupled with district heating to use waste heat, then the process would be an improvement on the use of fossil fuel to produce power, as much of the heat produced is wasted.

Members of forest industry and some private woodlot owners view biomass as a possible stimulus to a currently struggling forest economy. Biomass is a means to market low-grade softwood and hardwood for which there has been little market in recent times. It can use waste wood, such as mill scrap, hog fuel; and non-commercial wood, such as knotty trees, tree stumps, and nutrient-rich branches and foliage (although not recommended); and scrap lumber to fuel power plants. Mills can decrease energy costs by burning mill waste.

Biomass is a relatively cheap energy source compared to expensive foreign oil. Additionally, biomass could help Nova Scotia generate fuel-security, with reduced reliance on volatile markets for petroleum-based fuels. Biomass can help Nova Scotia meet climate change goals and reduce pollution that causes acid rain by reducing fossil fuel emissions. Co-firing biomass with coal at some of the current facilities allows for considerable renewable electricity generation without large capital investment.

Forest Panel perspectives on biomass energy

The Forest Panel provides the following viewpoints, based on: 1) Reviews of relevant scientific research and our knowledge of Acadian forest ecology; 2) Acknowledgement of the importance of a strong forest-based economy, a traditionally important source of employment that is currently in decline; and 3) Citizen values expressed during Phase I of the Natural Resources Strategy process.

The Forest Panel does not hold expertise in energy production and cannot address issues with Nova Scotia Power Inc. and tests to co-fire biomass with coal. Our objective is to consider potential impacts and demands on the forest environment over the long term, through examination of a range of scientific sources. As such, we look past possible short-term opportunities to examine broader outcomes. Our instructions were to think "big."

While bioenergy currently constitutes a relatively low-cost renewable energy source for the province, most of the science dealing with the lowering of carbon emissions through biomass energy and the associated harvesting practices do not provide information on long-term site productivity. The Forest Panel agrees with the caution stated by Adams and Wheeler (2009) that more discussion on forestry management and the ecological integrity of the province's forests is required.

We also respect the views of some members of the public who see the biomass industry as a questionable lack-lustre endeavour. Wood can be made into a wide range of products, including hardwood flooring, salad bowls, house construction, or as a heat source (firewood). There is a concern that burning wood for electricity risks further lowering the value of our forest resources.

Four key issues greatly diminish the possibility of burning wood as a source of electricity in Nova Scotia: 1.) Forest biomass is a relatively inefficient generator of electricity, and therefore would require a large and guaranteed wood supply; 2.) Nova Scotia is less suited than other areas for biomass energy due to land ownership. The Crown land forest base is relatively small (approximately 24 per cent of the land base), and is currently allocated to other forest industries; 3.) Privately owned forests would be required to be major biomass contributors, but government is limited in how effectively it can regulate to minimize permanent environmental damage on private lands, while not impinging on the rights of land owners; and 4.) A new and fully implemented Integrated Resource Management (IRM) strategy on Crown land, whereby harvest practices must follow the Code of Forest Practice and manage towards forest types defined under the new Forest Ecosystem Classification, and where harvesting will approximate natural disturbances, will leave less wood allocation for present forest industries, without further allocations for biomass. A fully implemented Integrated Resource Management strategy is currently endorsed by the Forest Panel because it uses an ecosystem-based approach, but it places constraints on harvesting practices and greatly reduces the wood volume that can be removed on an ecodistrict or ecosite basis. This will indirectly result in placing the biomass demand squarely on privately owned forests.

The carbon issue: harvesting wood biomass may represent a net carbon emission

Is burning wood biomass for energy really carbon neutral? We base the assumption that carbon dioxide released when biomass is burned is, in turn, taken up in equal amounts by growing forests (carbon sequestration). This is the premise for considering biomass energy as clean energy.

Carbon science in brief: Life on earth is based on an organic carbon foundation.

When we speak of biomass, we are essentially referring to carbon, (with a minimum of 16 other elements involved in much smaller quantities that are essential to life and directly involved in the buildup of biomass based on carbon, such as nitrogen, calcium, and potassium) (Mahendrappa and Pitt 2000). Carbon is the major constituent of tree biomass, litter, and the soil organic layers. Tree foliage fixes carbon (from CO_2) with the aid of solar energy (photosynthesis) into plant organic matter. Thus we can consider energy from burning wood to be solar energy (indirectly). Every other component in forest ecosystems, including wildlife, depends upon plant-derived organic carbon produced by photosynthesis. Carbon is not only contained in the standing trees in the forest, but also in the soil. Up to 66 per cent of forest carbon is in its soils (Post et al. 1990), soil carbon sources being largely accounted for by decaying leaf litter, tree branches, and trunks. One of the keys to any sustainable forest harvest program is maintaining or improving organic soil condition.

It is possible that the harvest of biomass and its combustion may actually contribute a relative increase in carbon emissions rather than realizing the goal of reducing atmospheric carbon dioxide (Patriquin 2009). After harvest, carbon can no longer be sequestered from the atmosphere for a period of time because the trees are no longer on the landscape to absorb the CO_2. A deforested landscape is sharply reduced in its ability to sequester carbon. There are carbon emissions from combustion of fossil fuels used to harvest, process, and transport biomass. An increased rate of decay from stored carbon in forest soils unleashes stores of carbon to the atmosphere, and combustion of the biomass causes a sudden release of carbon that has been stored in trees for 40 to 150 years or more (depending on tree age) and will require another 40 + years to sequester again. These factors create doubt that electricity generated from biomass is carbon neutral in the short term (that is, the amount of carbon dioxide [CO_2] released from burning wood is equal to the amount of CO_2 consumed during growth). Clearcutting for biomass, even on better sites, is likely to increase carbon emissions, not reduce them (Patriquin 2009).

Is biomass as efficient as wind, solar, and other green energy sources?

Burning wood to generate electricity is a greener energy source than burning coal, however, it is not as green as modern alternative sources: wind and solar energy. Biomass use is reliant on fossil fuels to harvest and process wood into chips or pellets and to truck the biomass to thermal generating facilities. Efficiency is better where there is sufficient biomass available from mill waste sources. However, most mill waste is currently allocated and so any increased biomass must come from existing, naturally generated forests (or plantations, addressed later).

Burning wood is only ~ 30 per cent efficient in converting potential energy into electricity, whereas wood burning for space heating can reach up to 80 per cent efficiency. In this era of technological advances, burning our forests for energy does not demonstrate a futuristic strategy, nor the types of ingenuity the people of Nova Scotia want to carry forward to a modern world of technological achievements.

Impacts on soil associated with whole-tree biomass harvests

Biomass harvesting usually constitutes an intensive harvest regime, and can make use of any trees, regardless of species or size. All tree parts, including traditionally non-merchantable portions such as fine branches, foliage, stumps, and roots, represent a potential biomass fuel source, since they are comprised of carbon and produce energy when burned. Concerns with soil impacts centre mainly on carbon and nutrient depletion that may occur through whole-tree harvesting.

Carbon depletion: Intensive biomass harvesting can reduce soil carbon reserves, which affect soil structure and health. Foliage and branches left on site to decompose contribute 25 to 30 per cent of total tree biomass to soil organic matter (Anderson et al. 2005). The industrial forester perspective on this, however, is a 20-30 per cent gain in biomass if whole-tree harvesting takes place, thus increasing the temptation to process the entire above-ground tree portion through a chipper. Harvesting that removes more than traditional stemwood (i.e., trunk wood) can potentially reduce the structure of soils by reducing the organic input from decomposing tree material. Reduced organic matter in the soil reduces stand resiliency to droughts and other stressors, such as insect infestations. Stand resiliency may be of increasing importance as climate change brings new stressors to forest ecosystems. Additionally, this previously non-merchantable biomass, in the form of coarse woody debris and slash, protects the soil surface from direct exposure to the sun. Removal of all shade material allows soils to heat up in the interval before lesser vegetation grows to provide shade, speeding up soil decomposition, thereby further depleting the organic matter in the soil that would be available to soil microorganisms, as well as to the next generation of trees.

Nutrient depletion: Reduction in soil productivity caused by nutrient depletion may be an even greater concern than the reduction of organic carbon resulting from intensive biomass harvest practices (Olsson 2008; Freedman 1981; Freedman et al. 1980). Branches and foliage range from 55 to 75 per cent of total nutrients in hardwood and softwood trees (Mahendrappa and Pitt 2000; Anderson et al. 2005). Harvesting this fine biomass constitutes a direct removal of nutrients from the soil and will eventually reduce forest growth. With harvest slash removed for biomass, the unshaded soils release nutrients as decomposition of organic components take place. Since the newly released nutrients from decomposed matter cannot be absorbed by tree roots, they are leached more deeply into the soil and out of access to subsequent tree generations (Mahendrappa et al. 2005).

Soils become more acidic in conjunction with biomass harvest practices (e.g., clearcutting and whole-tree harvesting) (Olsson 2008). Removal of large quantities of biomass that normally shades the forest floor sets off a chain of chemical reactions (most notably nitrification) in response to increased decay rates. As nitrogen is mobilized, *calcium* and magnesium also react, and they are all leached out of the soil, leaving behind hydrogen ions that ultimately increase soil acidity (Anderson 1991;

Mahendrappa 2005). This increased acidification then causes a "domino effect," whereby other elements enter into soil solution, such as aluminum (toxic to most trees), copper, iron, and zinc (Mahendrappa and Pitt 2000). Acid deposition from atmospheric pollution in combination with these acidifying reactions from harvesting can have significant impacts on forest growth and productivity (Olsson 2008).

Despite the adverse impacts from whole-tree harvesting on soil carbon storage and nutrient depletion, considerable research has been directed towards the possibility of allowing whole-tree harvesting on the most productive soils, where geological conditions have resulted in higher reserves of essential elements. This is a groundless argument, since whole-tree harvesting represents a net withdrawal from the soil nutrient capitol (Anderson et al 2005). Nutrient replacement from soil weathering and atmospheric sources is not likely to compensate the depletion rates of every essential element taken out of the system from whole-tree removal. Productivity will eventually decrease, as has been demonstrated around the world. There have been yield reductions of up to 20 per cent in many European countries, Australia, and New Zealand (Lundkvist 1987, Anderson 1991, Proe et al. 1994, Hakkila 2004, Skinner et al. 1988). Moreover, it is not economically viable to fertilize sites to replenish essential nutrient levels following biomass harvests, and in some cases tree growth does not respond to fertilization (Anderson et al. 2005). New Brunswick and other provinces with higher proportions of Crown land can implement complex management regimes and alter silvicultural approaches according to site conditions. In Nova Scotia, however, high numbers of private woodlot owners are unlikely to discern between nutrient rich and nutrient poor sites, and would probably not alter harvest prescriptions to protect the subtle nature of soil properties. This would be a regulatory nightmare.

In Nova Scotia, calcium appears to be a key limiting element (Freedman et al. 1986). Calcium impoverished ecosystems exist over much of Nova Scotia due to naturally acidic soils and underlying geology. Our woodlands are subjected to chronic acid deposition from industrial pollution sources in United States and southern Ontario, which further depletes soil calcium. While trees can grow adequately on acidic soils, whole-tree harvesting can remove 27 per cent of total site calcium (Freedman et al. 1986). It appears that Nova Scotia soils are far more sensitive to whole-tree harvesting effects than soils in other regions of the Acadian forest, as Nova Scotia soil calcium depletion was twice that of forest soils in New England (Hill and Garbary 2010 *In:* Tritton et al 1987).

There are other far-reaching effects from calcium removals. Detrimental effects of whole-tree harvesting do not stop at the forest edge, as the removal of high-calcium branches and foliage reduces the level of calcium available to our rivers and lakes (Jeriorski et al. 2008). Thus, the effects from whole-tree harvesting may ultimately affect salmon and trout and other environmentally stressed aquatic components. Moreover, we cannot target all nutrient-rich or calcium rich sites for intensive biomass harvesting. Calcium-rich sites are relatively uncommon and are important wildlife habitats (Freedman 2010). These rich sites usually support a suite of rich understory herbs that are rare, such as rare orchids that society values. There is a growing list of organisms whose population viability is being undermined by widespread loss of calcium from forested ecosystems (Jeriorski et al. 2008; Hill and Garbary 2010). The current soil nutrient research sponsored by the Department of Natural Resources continues with the conventional narrow view of timber production, with no consideration of rare herbaceous species and wildlife habitat needs. Can we whole-tree harvest on nutrient-rich sites? Preferably not, as this would bestow significant ecological losses on our children. Must we preserve all nutrient-rich sites? No! The answer is to harvest them in the context of ecosystem-based management, using silvicultural practices that emulate ecological processes (predominantly gap-replacement) and interactions of species composition and structural heterogeneity, and removing only tree boles.

Impacts on flora and fauna

Most of the information written on biomass takes a narrow, utilitarian focus on the amount of wood volume available for fuel, and overlooks the fact that forests are home to many species of dependent flora and fauna. (Hence a committee assigned to thoroughly and objectively examine biomass must be well represented with biologists from a variety of research domains, in addition to foresters and people from economic, and energy backgrounds.) The most common reason for species being designated at risk is habitat loss. The ability of some groups of species to survive and flourish, particularly those requiring late seral stages and continuous canopy conditions, is the summation of all environmental factors. Although forests grow back rapidly after harvest, the composition and structural homogeneity of early successional forests will no longer support the same guild of wildlife (as well as understory herbs, bryophytes and lichens) that existed prior to harvest (Freedman et al. 1994). Species that thrive on early successional forest habitat are, for the most part, not the ones found on endangered species lists. One does not have to be a biologist to deduce that some species populations that require old-growth habitat must be struggling, with old-growth now estimated at 0.6 per cent of the forest land base.

We must adopt a precautionary approach to harvesting forest biomass as well as other forest products since we are inadvertently destroying rare species and their habitat, of ecological importance far beyond the monetary value of wood removed. The slash, or tops and branches of felled trees, provides cover for birds and small mammals, and protects seedlings from deer browsing. While the Forest Panel could write an entire book on harvest impacts on Nova Scotia wildlife, from the extinction of caribou to the struggles of the American marten and brook trout, we present an example of some of the more subtle changes exerted on ecosystems during whole-tree harvesting. Removal of dead wood and coarse woody debris has consequences for wood-inhabiting species, such as saproxylic beetles (wood decomposing beetles) numbering in excess of 780 species in Nova Scotia (Majka 2009), thereby representing a large proportion of the total forest species richness. This saproxylic fauna is responsible for the mechanical breakdown of coarse woody debris and demonstrate considerable sensitivity to timber-harvest practices (Simila et al. 2002). They are critical to various biophysical processes that directly benefit soil structure and nutrient cycling, as well as forming the basis of a considerable component of total forest biodiversity. Over 34 per cent of saproxylic beetles in Nova Scotia were placed in the most vulnerable "may be at risk" category by Majka (2009) based on their limited distribution within the province, and hence potential vulnerability to biomass harvesting. Given the ecological importance of this group, the long history of intensive forest management in Nova Scotia that has left only 0.6 per cent of old-growth stands within its forest base (McMahon 1989), a precautionary approach with respect to forest biomass harvesting is warranted.

A vibrant forest economy stems from an equally vibrant and healthy forest ecology. If forest resources must be directly harvested for biomass, it is essential to maintain/restore a healthy forest ecology. Harvest objectives must shift to placing value on multiple forest resources. Diversifying silvicultural interventions is key. Irregular stands with structural heterogeneity and diverse species compositions and age classes should dominate Nova Scotia forests. Irregular shelterwood silvicultural systems (Raymond et al 2009) and other uneven-aged harvest techniques need to be the default harvest systems, not clearcutting and whole-tree harvesting.

Harvesting forests for biomass: Can it be sustainable?

Dr. Wilfred Creighton, former Deputy Minister, Nova Scotia Department of Natural Resources, stated over 10 years ago that our forest industries were in danger. *"We're overcutting, seriously overcutting,"* he stated, and *"In the past ten years, the crown lands have been raped and Crown land should show other people how forests should be managed"* (Pannozzo and Colman 2008).

The Nova Scotia Government and the Department of Natural Resources are experiencing pressure to increase forest harvesting to meet the new and additional biomass demands. The Forest Panel requests that decision makers adhere to a long-term outlook and not cave to deleterious short-term economic gains. Nova Scotia is already being over-harvested, clearcutting approximately 500 square kilometres per year. The annual allowable cut has been exceeding consumptive capacity for other components that are an essential part of our terrestrial ecology. Old-growth has been nearly wiped out, and old-growth species have been pushed to the margins of existence. There is a resultant predominance of young forests composed of small-diameter trees that are ineligible for sustainable harvest over the next two to three decades because their trunks are too nutrient-rich (due to high bark: stemwood ratios). Biomass facilities are forecasted to require one to two million tonnes of additional wood each year, the bulk of which must be supplied from forests since mill waste wood cannot meet the demand. The annual allowable cut must be reduced, not increased. The people of Nova Scotia are growing very concerned, as they observe signs of our forest industries seemingly in a desperate frenzy to cut the last forests before financial collapse.

The method of harvest is one of the most contentious issues associated with biomass energy. Many of the Forest Panel ideas on types of acceptable harvest practices suitable for the maintenance of Acadian forest biodiversity and health are covered in the clearcutting recommendations. Certainly, whole-tree harvesting lowers costs and increases wood volume per unit area, and so industry will defend the practice. They are unlikely to harvest only stemwood without regulations in place (Salonius 2007). The Department of Natural Resources and government must make an intelligent, science-based, decision to allow stem-only harvests with a minimum top diameter (to be determined). Wood is a renewable resource (as often stated by advocates of biomass energy and the forest industry), but the true Acadian forest is renewable only if harvested responsibly within the range of natural disturbance regimes. Forests grow back, but unless Acadian forest is harvested carefully through partial cuts and small gaps, only early successional or boreal forests will grow back, which leaves a huge suite of species without suitable habitat and results in simplified forest ecosystems with reduced capacity to survive climate change and other stressors.

The Forest Panel heard repeatedly that Nova Scotia has a lot of low-quality wood, like poplar, with no market. Harvesting poplar, white spruce, and other early successional stands using complete canopy removal (even-aged) silviculture does not emulate natural processes and prolongs the ongoing problem of reduced monetary value because later seral stages are not attained, as natural processes would eventually create. While proponents of biomass will advocate that clearcutting these stands is the solution, a series of light, re-entry harvests that create gaps and patches that restore variable age classes and forest structures, and create openings for more valuable species (that may have to be planted) is a wiser investment. Many Nova Scotia forests are currently in need of restoration, not increased harvesting. Biomass proposals are out of step with what is currently needed from an ecological integrity viewpoint.

Forest Stewardship Council certification - good but not a silver bullet

Some believe that we may be able to ensure sustainable biomass harvest practices if carried out under Forest Stewardship Council (FSC) certification. The Maritime FSC Standards can assist in this regard, with a cap of 10 per cent on intensive harvesting. However, FSCWatch points to increasing concerns over large and unabated clearcutting in eastern United States and Canada, herbicide applications, and other issues associated with Forest Stewardship Council-certified forests around the world (www.fsc-watch.org). University of New Brunswick forest faculty have also noted similar concerns with Forest Stewardship Council certification, and recommend that Nova Scotia derive its own forest management/harvesting guidelines rather than rely on Forest Stewardship Council standards (Kershaw 2010). We concur with this viewpoint. Forest Stewardship Council certification cannot be relied on as the silver bullet to resolving a range of long-standing complex issues. Clear guidelines must be put in place to guard against destructive forest harvest practices.

Plantations –Short-rotation woody crops

Forest industry is currently proposing that plantations (areas dedicated to intensive-forest management) can assist with securing sources of fuel for bioenergy production. Plantations generally involve intensive site preparation: herbicide applications, growing genetically superior trees such as hybrid poplar and willow, forest pest control, and fertilization (Kimmins 1997). These practices are often opposed by the public because they are at odds with holistic vision of ecosystem management, in other words, weighing all forest components into the terrestrial ecology. Many native species cannot live within plantations of other types of intensive silivicultural systems. Therefore plantation agriculture would be perceived as a step backwards as we attempt to advance more futuristic thinking that is more respectful of all native species within forest ecosystems.

The draft biomass guidelines for Nova Scotia (NSDNR 2009) encourage operators to investigate short-rotation wood crops located near biomass facilities, as a potential future source of biomass. It is unclear how economical or ecologically sustainable this endeavour would be at this point. Plantations dedicated to biomass represent a loss of land base that would normally support a wide range of forest ecosystem components, unless they are located on abandoned farmland. However, with increasing fossil fuel prices and pressures to buy local, the agricultural land base may be increasingly dedicated to growing food.

Concerns

1. Nova Scotians do not want biomass energy production. Only 32 per cent of Nova Scotians support biomass for electricity, while they strongly support other renewable energy sources such as tidal, solar, and wind (91, 93, and 99 per cent, respectively) (Adams and Wheeler 2009). The new natural resources strategy process is to be aligned with concerns voiced by Nova Scotians, and they overwhelmingly do not support an increased effort to burn forests and wildlife habitats to produce biomass energy.

2. Forests are already over-harvested and degraded, with serious impacts on ecosystem components, such as late successional, temperate Acadian trees and rare plants (e.g., blue cohosh [Hill and Garbary 2010]), as well as animals like the American marten, mainland moose, lynx, southern flying squirrels and other cavity nesters, as well as many lichen and bryophyte species, that require mature forest structures and forest stand

continuity (i.e., non-fragmented). Proof of over-harvesting is the resultant predominance of young age classes, and relatively small-diameter classes, and an increasing representation of early successional, short-lived boreal trees (NS DNR 2008).

3. The long-term economic viability of the province's forest industry may be further hindered by a shift to biomass for energy since biomass harvesting could direct timber away from more lucrative end uses, such as supplying lumber to foreign markets.

4. Only approximately 30 per cent of the energy released by burning produces electricity (Hughes 2009), leading us to conclude that biomass for energy is a wastefully unacceptable use of our precious forest resources for the 21st century.

5. An increased harvest demand will be placed on forests if the province produces more electricity from wood. Biomass is already predicted to consume between 10 to 12 per cent of the province's average annual harvest to serve a 60 megawatt biomass facility (Hughes 2009).

6. Additional demands on the wood supply for biomass would create hardship for some existing forest industries. There is only so much wood supply available on the landscape. While the Department of Natural Resources stated that the province has sufficient biomass to generate up to 150 megawatts (Adams and Wheeler 2009), we believe the implications are to continue large clearcuts, and increase forest yields by increasing silvicultural intensity. This type of agricultural forestry is not sustainable (Salonius 2007, and others). In an era when pulp and paper industries are already discussing the need to compensate for reduced wood supply because of new protected areas being removed from the working forest, new biomass demands will only exacerbate the problem and cause industries to resort to increasing wood supply through intensive forest management areas (plantations) and nutrient depleting removal of nutrient-rich harvest slash.

7. Draft interim guidelines for biomass retention levels on Crown land (NSDNR 2009) do not address over-harvesting, and would allow a continuation of substantial clearcutting, despite its overuse on the landscape and a wealth of science that indicates this practice is destructive to soils, forest succession, and associated wildlife (Elliot 1999; Freedman et al. 1980, 1994; Betts et al. 2005; Mahendrappa and Salonius 2006). Intensified levels of Crown land clearcutting speak to some of the public's deepest fears concerning biomass harvesting. The proposed guidelines would allow removal of large amounts of nutrient-rich "fines" (tree components, fine branches < 10 cm diameter). For example, 50 per cent of fines on clearcut lands of low productivity and up to 75 per cent of fines removed from clearcuts on more fertile lands in the province. The latter occupies 74 per cent of lands available for forestry activities. While the guidelines acknowledge that the science used in the decisions is new and incomplete, it ignores the productivity losses that have been found in northern Europe, and caters to cheap fuel demands despite the high risks of soil nutrient depletion impacts to forest soils.

8. Biomass harvesting of tree parts other than the main stems risks long-term reduction of forest productivity though depletion of soil of nutrients and renders soils more acidic. A potential conflict with policies that limit harvesting to main stems/boles is that most tree boles have more profitable uses for commodities such as paper and dimension lumber.

9. Soils in Nova Scotia are relatively young with generally low nutrient reserves, and are therefore less well suited than other regions for intensive harvesting of nutrient-rich fines for biomass.

10. Decision support tools and nutrient modeling currently being designed for Nova Scotia by Dr. Arp (University of New Brunswick Department of Forestry and Environmental Science) to help reduce soil impacts from biomass harvesting hold some useful applications (particularly the wet-areas mapping). Predictions about how nutrient cycles will be altered by whole-tree harvesting and removal of fines are reliant on relatively new modeling; untested science that depends on possibly unjustified assumptions concerning soil-nutrient dynamics. For instance, data on the levels of atmospheric deposition of nutrients that may rain down on Nova Scotia forest soils to replace what is harvested are hypothetical.

11. Biomass facilities would rely on a substantial portion of wood procurement from private land owners. Ensuring ecosystem-based harvest practices on private land would be exceedingly difficult. (Witness the harvesting by Northern Pulp site near Upper Musquodoboit, which is legal and being defended by industry). There is a risk that small forest land owners will not understand the long-term importance of retaining nutrient-rich parts of

the tree for the benefit of future forest crops. Assurances that foliage and fine branches are not removed would be challenging once the material is processed. How is this monitored or enforced?

12. There is considerable data gathered under the ENFOR (Energy from Forests) program, which is led by the Canadian Forest Service, to provide significant scientific evidence against the use of harvesting slash biomass for energy (Anderson et al. 2005).

13. Coarse woody debris may not be well maintained on post-harvest biomass sites despite any guidelines that may be put in place. It would be extremely difficult to monitor. A reduction of fallen logs will impact a large suite species that rely on this habitat, such as small-seeded tree species, fungi, and beetles that are confined to coarse dead wood.

14. We do not have data on long-term site impacts of intensive forest harvesting. (We have not been monitoring.) There has been almost no research within Nova Scotia on the capacity of soils to support a range of forest practices. Research needs to be specific to the province's unique geology, soil conditions, and weathering, not adopted from elsewhere with different environmental variables (Keys 2009; Neily 2010).

15. Forests will be prematurely clearcut for biomass since tree size is no longer a critical issue. This harvest of previously unmerchantable small-diameter weed will lower long-term soil productivity since small tree boles have higher, nutrient-rich bark:wood ratios than larger, more-mature tree boles.

16. European thermal stations are currently importing biomass from Nova Scotia, with the province receiving none of the carbon credits. This needs to be renegotiated.

17. Increasing use of clearcutting to produce forest biomass for fuel will necessitate very expensive plantation establishment at significant costs to all components of forest ecosystems and the environment. For example more nutrients will be transported away from harvest sites from repeated short rotations.

18. Biomass harvesting that utilizes only boles will be most beneficial if it is integrated with harvesting for other wood product; biomass offers a profitable use for low-quality timber that has traditionally been an obstacle in forest operations. However, this renders biomass wood vulnerable to market interruptions/downturns experienced in other markets, such as pulp and paper, and softwood lumber.

Recommendations

Two members of the Forest Panel have concluded that under the current context, ecological risks of biomass harvesting far outweigh the energy benefits that could be derived from this material. More research needs to be completed that is specific to the unique aspects of Nova Scotia forests, soils, land ownership, and economic situation. In the interim, there is considerable scientific evidence to lead us to conclude that biomass should either be abandoned, or utilized only as *minor, localized* sources of energy. Forecasted annual harvest demands required for biomass energy are substantial (perhaps an additional 100-square kilometres of clearcutting per year), and come at a time when forest health and biodiversity have been severely compromised through unsustainable clearcut harvesting. The Acadian forest in Nova Scotia requires a period of recovery in many areas on landscape, to restore species diversity, increase representation of late-successional tree species, and to allow forests to attain a more natural range of age classes and greater structural diversity. The long-term health of our forests and their associated wildlife should not be further compromised to produce small amounts of relatively inexpensive energy, as proposed by Adams and Wheeler (2009).

We recommend continued exploration of other more sustainable and less risky alternative-energy sources for Nova Scotia that will not impact long-term productivity of forests. Our vision for Nova Scotia's forests holds that forestry will be involved in more lucrative future markets that demand a greater variety of products, including value-added wood products. Burning wood efficiently for space heating, rather than inefficiently producing electricity, is a better use of forest resources, which ultimately reduces the domestic use of electricity that is derived from fossil fuels.

Should the government authorize biomass energy production, even on a small-scale, two members of the Forest Panel recommend the following caveats:

1. Adopt a precautionary approach to biomass energy using only low-nutrient stem wood:
   a) Start small-scale > Monitor forest impacts > Adapt to limitations > Re-evaluate.
   b) Do not implement biomass on a larger-scale in the future unless biomass-burning facilities can also make economic use of waste heat for district heating.
2. Biomass energy should not be supported beyond the large 60 megawatt facility already authorized for NewPage.
3. Provincial goals and regulations need to be in place prior to undertaking additional biomass agreements.
4. Ensure that biomass harvests will not contribute additional degradation to Nova Scotia forests and soil productivity, and will not increase clearcut harvest practices under any circumstances. A reduction in the total amount of cutting throughout Nova Scotia is essential to restoring healthy and diverse forest ecology.
5. Consider capping wood volumes harvested by reducing the annual allowable cut to take other ecosystem components and ecosystem services into account.
6. Small-scale, local-biomass pellet and chip production facilities may partially meet future heating needs (and rural employment) in local communities.
7. Ensure where possible that major sources of biomass are from waste wood. Sources of waste wood are from sawmills and pulp and paper mills, scrap lumber from residential and construction sites, and other wood products (e.g., Christmas trees, chips from roadside brush clearances and power corridors). Landfills could have a biomass pick-up service. (Most of these sources of waste wood biomass are now being utilized so new sources of biomass must come from standing forest.)
8. Biomass exports to foreign markets need to be re-allocated to our domestic energy production. We are currently exporting green energy and importing coal. Furthermore, we can little afford to export our wood to foreign markets, when we are in need of reducing harvest volumes in order to restore forest health and biodiversity.
9. Prior to commitment to any increased use of forest biomass, establish a strong regulatory and monitoring system to safe-guard forest ecosystems. Establish a cross-functional biomass working group, comprised of soil scientists, biologists, forest ecologists, foresters, and private land owner groups to elucidate and attain the highest possible standards for biomass harvesting. This entails applying lessons learned from the previous Forest Biomass Working Group and long-term site productivity research results from northern Europe to build more ecologically sound guidelines, grounded in science and common sense, for sustainable forest practices.
10. Enact legislation to ensure that whole-tree harvesting does not take place under any circumstances or site conditions. The science is clear enough on this issue to proceed with legislation. This should also include regulations to prevent buyers from purchasing biomass containing branches, foliage, tops, etc. Regulations must be clear, easily applied by harvest operators, and easy to enforce by Conservation Officers. Consultations with both forest technicians and enforcement officers in the field will ensure that new regulations to protect forests are practical.
11. Biomass harvest will adopt uneven-aged silviculture techniques. Harvest systems that are both economically and ecologically viable are outlined in: Salonius (2007); York et al. (2004); Raymond et al. (2009); Seymour et al. (2002); Seymour (2005). Harvests should focus on low-grade hardwood. (Clearcutting will occur only under extenuating circumstances, or within Cape Breton Highlands, where it approximates natural stand-replacement disturbance.)
12. Biomass harvesting will begin long-term incremental restoration of more natural-age classes and species composition to even-aged stands that are middle-aged by harvesting in strips or patches that are less than two tree-lengths wide.
13. Biomass operations will not harvest immature stands since this would contribute to soil nutrient depletion.

14. Harvest practices that produce uneven-aged stand structures will require a system of both incentives and regulations in order to encourage the transition away from slightly less expensive conventional clearcuts. Incentives may entail changes in stumpage rates on Crown land, additional silvicultural subsidies on private land, higher prices received for wood chips/pellets obtained through uneven-aged silviculture, etc.

15. Provincial regulations on sustainable harvesting for biomass and other forest products will need to be substantially re-worked in order to transition away from clearcutting, ensure only stem wood is removed from the forest, and to protect soils, biodiversity, and aquatic resources.

16. Ensure that high-quality timber is not harvested for biomass. (Since operations will utilize patch or strip cutting techniques, it should be easy to leave high-quality timber in the woods.) Sorting yards would assist in assuring that buyers for value-added industries have first opportunity to purchase the higher-quality wood.

17. Provide programs that encourage Nova Scotia homeowners to adopt energy-efficient practices to reduce energy demands. Such programs will indirectly lower demands on forest resources for electricity.

18. Continue to explore new energy technologies, such as ocean and photovoltaic, as they become available. It may be better to embark upon proven technologies that we are more certain of than commit to ones that may be neither economically nor ecologically viable.

19. Consider biomass for space heating rather than electricity generation, since high-efficiency wood-burning units, such as pellet furnaces, extract over 80 per cent of the biomass energy contained within the wood (versus 30 per cent efficiency estimated for electricity generation from biomass).

20. Conduct more thorough research on carbon accounting prior to any commitment to harvest larger volumes of forest biomass for the goal of reducing carbon dioxide emissions from the burning of petroleum-based biomass for electrical generation.

Conclusions

Two members of the Forest Panel conclude that it would be irresponsible forest management to adopt the scale of forest biomass proposed to the Nova Scotia Government by Adams and Wheeler (2009). We have already surpassed the threshold of ecologically sustainable harvesting, and are faced with resolving some major restoration issues to sustain viable populations of many forest components. As green-energy technology evolves and forests recover, Nova Scotia will be better-positioned to make wise choices on energy production and immerging forest industries.

Biomass exports from Nova Scotia

(Computed from Statistics Canada, International Trade Division)

Year	Code	Description	Country	QTY (tonnes)	Value
2009	**44013090**	**Wood waste and scrap, nes**	United States	19,958	4,423
2009	44013090	Wood waste and scrap, nes	United Kingdom	657,072	17,2512
2009	44013090	Wood waste and scrap, nes	Saint Pierre and Miquelon	95	29
2009	44013090	Wood waste and scrap, nes	Netherlands	36,750,000	7,304,414
2009	44013090	Wood waste and scrap, nes	Iceland	21,818	6,784
2009	44013090	Wood waste and scrap, nes	Germany	5,000,000	1,009,900
2009	44013090	Wood waste and scrap, nes	Denmark	10,613,388	2,067,076
2009	44013030	Wood shavings	United Kingdom	553,230	210,228
2009	44013030	Wood shavings	Saint Pierre and Miquelon	37	14
2009	44013030	Wood shavings	Malta	10,695	4,064
2009	44013030	Wood shavings	France	3,293	1,251
2009		**Total**		**53,629,586**	**10,780,695**
2008	44013090	Wood waste and scrap, nes	United States	678,706	156,079
2008	44013090	Wood waste and scrap, nes	United Kingdom	43,350,191	8,679,422
2008	44013090	Wood waste and scrap, nes	Netherlands	27,186,000	4,713,678
2008	44013090	Wood waste and scrap, nes	Iceland	173,117	53,008
2008	44013030	Wood shavings	United Kingdom	868,121	284,649
2008	44013030	Wood shavings	Saint Pierre and Miquelon	144	45
2008	44013030	Wood shavings	France	533	186
2008		**Total**		**72,256,812**	**13,887,067**
2007	44013090	Wood waste and scrap, nes	United States	561,594	97,205
2007	44013090	Wood waste and scrap, nes	United Kingdom	623,999	156,763
2007	44013090	Wood waste and scrap, nes	Sweden	15,000,000	2,095,293
2007	44013090	Wood waste and scrap, nes	Republic of Ireland (Eire)	4,257,162	887,984
2007	44013090	Wood waste and scrap, nes	Netherlands	99,693,608	12,646,786
2007	44013090	Wood waste and scrap, nes	Italy	132,252	32,021
2007	44013090	Wood waste and scrap, nes	Iceland	305,452	82,016
2007	44013090	Wood waste and scrap, nes	Belgium	75,038	20,672
2007	44013030	Wood shavings	United Kingdom	122,663	27,618
2007	44013030	Wood shavings	United Arab Emirates	104,320	31,568
2007	44013030	Wood shavings	France	225	64
2007	44013030	Wood shavings	Barbados	3,227	1,226
2007		**Total**		**120,879,540**	**16,079,216**

2006	44013090	Wood waste and scrap, nes	United States	2,394,734	346,615
2006	44013090	Wood waste and scrap, nes	United Kingdom	370,906	85,424
2006	44013090	Wood waste and scrap, nes	Sweden	62,495,830	8,333,417
2006	44013090	Wood waste and scrap, nes	Republic of Ireland (Eire)	2,288,550	448,842
2006	44013090	Wood waste and scrap, nes	Netherlands	59,801,111	8,263,816
2006	44013090	Wood waste and scrap, nes	Italy	5,082,297	794,326
2006	44013090	Wood waste and scrap, nes	Iceland	21,818	4,992
2006	44013090	Wood waste and scrap, nes	Belgium	215,412	59,427
2006	44013030	Wood shavings	United States	19,958	3,330
2006	44013030	Wood shavings	United Kingdom	3,207,575	490,542
2006	44013030	Wood shavings	United Arab Emirates	43,500	17,016
2006	44013030	Wood shavings	Iceland	9,582	3,641
2006	44013030	Wood shavings	Barbados	42,526	6,753
2006		**Total**		**135,993,799**	**18,858,141**
2005	44013090	Wood waste and scrap, nes	United States	2,836,973	591,759
2005	44013090	Wood waste and scrap, nes	United Kingdom	392,906	89,280
2005	44013090	Wood waste and scrap, nes	Sweden	42,718,443	5,144,927
2005	44013090	Wood waste and scrap, nes	Republic of Ireland (Eire)	518,759	116,139
2005	44013090	Wood waste and scrap, nes	Netherlands	55,433,980	6,692,988
2005	44013090	Wood waste and scrap, nes	Iceland	87,272	20,096
2005	44013030	Wood shavings	United States	57,493	18,619
2005	44013030	Wood shavings	United Kingdom	1,050,240	177,256
2005	44013030	Wood shavings	United Arab Emirates	406,535	88,426
2005	44013030	Wood shavings	South Korea	79,510	17,856
2005	44013030	Wood shavings	Malta	6,092	2,315
2005	44013030	Wood shavings	Iceland	167,580	16,708
2005	44013030	Wood shavings	Hong Kong	79,112	9,466
2005	44013030	Wood shavings	France	1,320	278
2005	44013030	Wood shavings	Barbados	14,000	1,249
2005	44013030	Wood shavings	Bahrain	13,129	4,989
2005		**Total**		**103,863,344**	**12,992,351**
2004	44013090	Wood waste and scrap, nes	United States	3,647,946	826,468
2004	44013090	Wood waste and scrap, nes	United Kingdom	448,724	136,210
2004	44013090	Wood waste and scrap, nes	Sweden	15,380,630	1,630,365
2004	44013090	Wood waste and scrap, nes	Netherlands	62,150,003	6,317,328
2004	44013090	Wood waste and scrap, nes	Iceland	46,363	7,752
2004	44013030	Wood shavings	United Kingdom	1,471,370	149,028
2004	44013030	Wood shavings	United Arab Emirates	128,000	11,458
2004	44013030	Wood shavings	Turkey	14,500	1,887
2004	44013030	Wood shavings	Malta	86,000	6,681
2004	44013030	Wood shavings	Iceland	482	214
2004	44013030	Wood shavings	Hong Kong	616,355	61,061
2004	44013030	Wood shavings	France	880	196
2004	44013030	Wood shavings	Barbados	14,720	1,956
2004	44013010	Firelogs of agglomerated sawdust	Sweden	14,660,602	1,554,042
2004		**Total**		**98,666,575**	**10,704,646**

2003	44013090	Wood waste and scrap, nes	United States	3,654,772	915,991
2003	44013090	Wood waste and scrap, nes	United Kingdom	327,052	70,800
2003	44013090	Wood waste and scrap, nes	Sweden	42,041,961	4,445,920
2003	44013090	Wood waste and scrap, nes	Iceland	22,636	3,320
2003	44013030	Wood shavings	United Kingdom	2,663,192	346,656
2003	44013030	Wood shavings	United Arab Emirates	70,800	7,320
2003	44013030	Wood shavings	Republic of Ireland (Eire)	14,500	1,415
2003	44013030	Wood shavings	Malta	12,701	6,604
2003	44013030	Wood shavings	Iceland	58,000	5,322
2003	44013030	Wood shavings	Hong Kong	23,651	6,504
2003	44013030	Wood shavings	France	14,500	2,236
2003	44013010	Firelogs of agglomerated sawdust	United Kingdom	7,353	8,481
2003		**Total**		**48,911,118**	**5,820,569**
2002	44013090	Wood waste and scrap, nes	United States	358,966	105,696
2002	44013090	Wood waste and scrap, nes	United Kingdom	143,267	32,275
2002	44013090	Wood waste and scrap, nes	Sweden	72,917,855	7,516,346
2002	44013090	Wood waste and scrap, nes	Malaysia	16,400	9,504
2002	44013090	Wood waste and scrap, nes	Iceland	23,130	3,400
2002	44013090	Wood waste and scrap, nes	Denmark	6,616,209	701,336
2002	44013030	Wood shavings	United States	21,000	3,516
2002	44013030	Wood shavings	United Kingdom	276,725	45,026
2002	44013030	Wood shavings	United Arab Emirates	30,000	4,572
2002	44013030	Wood shavings	Cuba	68,207	34,516
2002		**Total**		**80,471,759**	**8,456,187**
2001	44013090	Wood waste and scrap, nes	United States	5,242,549	663,339
2001	44013090	Wood waste and scrap, nes	Sweden	48,764,744	5,169,117
2001	44013090	Wood waste and scrap, nes	Spain	209,610	25,700
2001	44013090	Wood waste and scrap, nes	Netherlands	7,131,660	770,239
2001	44013020	Sawdust not agglomerated	United States	18,574	6,845
2001		**Total**		**61,367,137**	**6,635,240**
2000	44013090	Wood waste and scrap, nes	United States	435,185	59,344
2000	44013090	Wood waste and scrap, nes	Sweden	58,949,006	6,248,605
2000	44013090	Wood waste and scrap, nes	Spain	895,679	121,616
2000	44013030	Wood shavings	United States	405,000	32,517
2000	44013030	Wood shavings	United Kingdom	46,319	8,707
2000		**Total**		**60,731,189**	**6,470,789**
1999	44013090	Wood waste and scrap, nes	United States	19,958	3,897
1999	44013090	Wood waste and scrap, nes	Sweden	31,706,310	3,360,905
1999	44013030	Wood shavings	United Kingdom	40,824	13,472
1999		**Total**		**31,767,092**	**3,378,274**

1998	**44013090**	**Total**	**United States**	**855,929**	**137,041**
1997	**44013090**	**Total**	**United States**	**3,335,715**	**485,926**
1996	44013090	Wood waste and scrap, nes	United States	1,342,729	203,927
1996	44013020	Sawdust not agglomerated	United States	478,626	87,580
1996		**Total**		**1,821,355**	**291,507**
1995	44013090	Wood waste and scrap, nes	United States	14,515	13,968
1995	44013030	Wood shavings	United States	37,268	10,428
1995		**Total**		**51,783**	**24,396**
1994	**44013090**	**Total**	**United States**	**20,865**	**12,171**
1991	**44013020**	**Total**	**South Korea**	**39,278**	**7,929**
1990	**44013020**	**Total**	**South Korea**	**21,000**	**3,800**
1989	44013090	Wood waste and scrap, nes	United States	20,455	4,056
1989	44013030	Wood shavings	Italy	43,996	33,985
1989	44013030	Wood shavings	Bermuda	5,000	2,732
1989	44013020	Sawdust not agglomerated	South Korea	69,673	10,031
1989		**Total**		**139,124**	**50,804**
1988	44013090	Wood waste and scrap, nes	United States	760	3,800
1988	44013090	Wood waste and scrap, nes	South Korea	20,412	3,105
1988	44013020	Sawdust not agglomerated	South Korea	64,457	9,747
1988	44013010	Firelogs of agglomerated sawdust	Iceland	14,970	3,300
1988		**Total**		**100,599**	**19,952**

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2.3 Special Management Zones (Riparian Zones)

There is a need to incorporate more missing features of original Acadian forests into today's managed forest landscapes. Many of these features can be located in riparian zones, which are lands beside waterways that have a disproportionately high amount of use by wildlife. Riparian zones are a potential means to connect the landscape for wildlife. Riparian zones should not only protect aquatic habitats; they need to offer terrestrial habitats, in consideration of the massive habitat altercations with forest clearcutting.

The Importance of Riparian Zones

Areas bordering water have been called greenbelts, buffer strips, special management zones, and riparian zones. The term used here will be riparian.

About three-quarters of our wild animal species either depend upon, or prefer, habitats near water. Brinson et al. (1981), in a review paper on riparian (near water) ecosystems, state that the area of riparian vegetation most heavily used by wildlife is the zone within 200 metres (660 ft) of a stream or open water. These long, relatively narrow ribbons can contribute a relatively small amount to the total available habitat, but their wildlife value far outweighs their size.

DiBello (1984) found that 85 per cent of the locations of radio-collared furbearers in Maine occurred within 100 metres (330 ft) of a waterway. Coyotes and bobcats frequently move along frozen streams in winter, when traveling their home ranges, while red fox and fisher use the vegetation within 100 metres of the waterway (Stocek, 1994). Red fox use lake edges, while coyotes frequently avoid them. Small mammals and birds also travel through riparian zones in dispersing from their original or natal habitats.

Migration routes along rivers and streams are consistently used by birds, bats, and deer. Migrating songbirds probably use riparian forests disproportionately because of the abundance of food and dense cover. Some areas are major resting places for many north-south migrating birds, and may contain up to ten times the number of spring migrants than are found in adjacent, non-riparian areas.

The microclimate of riparian zones is different from that of the surrounding forest. There is generally more shade, higher humidity, and increased air movement. The increased humidity is important to plant and lichen growth and tends to make the habitat more favourable for many amphibians and some small mammals. Dense stands of conifers along waterways, with their milder microclimate, provide protective cover for tree swallows in cold, wet springs. Such stands in sheltered river valleys are commonly selected as deer-wintering areas in Nova Scotia and New Brunswick. Riparian zones are also favourite moose habitat at various times of the year.

Research by Elliott and others in the State of Maine has demonstrated that many forest songbirds' territorial requirements necessitate a riparian zone that is at least 100-metres (330 feet) wide, on each side of a river or stream. Within that zone, dead trees (snags) are retained, as well as den sites, perch and other wildlife trees, while a variety of harvest techniques such as single-tree, small-group selection, patch, shelterwood and seed-tree cuts can be employed to create diverse vegetation both horizontally and vertically. In Maine, taking this approach has been calculated to encompass about 15 per cent of the land base. A few bird species may require a 200-metre-wide (660 ft) riparian strip on both sides of the waterway. Bird use of riparian habitat is often related to snag (dead tree) occurrences coupled with plant species diversity (richness) and the vertical stratification (varying elevation) of vegetation.

In boreal mixed wood of Alberta, Machtans et al. (1996) found that 100-metre-wide buffers enhanced the movement of juvenile songbirds. The buffers had significantly more movement of birds than did clearcuts, showing the value of buffers as wildlife corridors. Focusing on ovenbirds, a forest-interior species, Lambert and Hannon (2000) found birds did significantly better with a 100-metre-wide buffer than they did with a 20-metre-wide lakeshore buffer.

In eastern Maine (Meiklejohn and Hughes 1999), the bird community differed greatly among buffer types. Riparian reference sites were dominated by forest-interior species, whereas buffer strips along rivers (averaging 76-metres wide) were inhabited by equal numbers of forest-interior and edge species. Tributary buffers (averaging 32-metres wide) were largely inhabited by edge species.

Also in Maine, harvest intensity in lakeshore buffers had negative effects on forest-interior species (Johnson and Brown 1990). In Quebec (Larue et al. 1995), riparian forest had higher abundance and richness than non-riparian forest, because it contained forest-interior species, shrub, and water-edge species.

In boreal balsam fir mixed-wood in Newfoundland and Labrador (Whitaker and Montevecchi 1999), riparian buffers of black spruce and alder 20- and 50-metres wide both proved to be poor habitat for birds; only three of six forest interior species were present and they were rare; a 50-metre buffer was not significantly better than a 20-metre buffer.

Several species of forest-interior passerines are sensitive to buffer width (Darveau et al. 1995) and harvesting of adjacent forest (Hanowski et al. 2002). Species that have declined where buffers were small (15 to 30 metres) include the yellow-bellied flycatcher, golden-crowned kinglet, hermit thrush, Swainson's thrush, bay-breasted warbler, blackburnian warbler, black-throated green warbler, northern parula, and ovenbird.

Pearson and Manuwal (2001) found higher species turnover in narrower buffers. Residents were displaced by generalists that tolerate open, shrubby vegetation. This study also shows that avian richness or diversity is not indicative of ecosystem health.

Hodges and Krementz (1996) reported a rapid increase in bird species occurrence and species richness with increasing corridor width. They found a 100-metre buffer was sufficient to maintain functional assemblages of six common species and recommended a 100-metre riparian buffer strip for conserving breeding populations of neotropical migrant birds.

In Nova Scotia, Bill Freedman of Dalhousie University and others have studied changes in bird species associated with intense disturbances as a result of forestry operations. Cindy Staicer of Dalhousie University has studied bird use of various forest habitats, including riparian, in Nova Scotia. Her students found lower abundance and fewer species of conservation concern in riparian buffers less than 40-metres wide or subject to harvesting or blowdown (Akerman 2007). Buffers lacked certain species (yellow-bellied flycatcher, black-throated blue warbler) and had fewer occurrences of other species (red-breasted nuthatch, Swainson's thrush, ovenbird, blackburnian warbler, black-throated green warbler) than either riparian or upland reference sites. On the other hand, species typical of young, regenerating forest were abundant in buffers.

As vegetation on a site passes through successional sequences after a clearcut, so do trends in wildlife occurrence. The edge effect created between a residual stand (e.g., riparian zone) and a cutover area, for example, may attract more edge species of wildlife and reduce the number of forest interior birds such as ovenbirds. A 100-metre width on each side of the waterway is the kind of distance required to minimize some of these undesirable impacts. A typical forest songbird territory is about a hectare (100 m x 100 m) in size, so this width has potential benefits for wildlife.

It should be noted that most of this riparian research is based on the industry standard-harvest method: the clearcut. Healthy Acadian forests are transformed and degraded by repeated clearcuts. Tree species such as original sugar maples, yellow birches, hemlocks, red spruces, and white pines that can grow in shade are gradually replaced with tree species such as poplar, grey birch, and white spruce that grow readily on bare, open ground. Where an area is harvested by more gentle methods such as selection or patch cuts, wildlife is generally better served.

Many forested areas are imperfectly drained. These areas often contain small, spring-fed pools, seeps, or ponds where frogs and salamanders can lay their eggs without having them eaten by fish. Humans build these, but call them woodland fire ponds. *Seeps, small ponds and other perennially wet sites located in forests that are scheduled for any form of cutting should be flagged out of the harvest zone and categorized as a riparian zone.* Occasionally these sites grow excellent trees (such as spruce) on hummocks within the wet area. With the appropriate equipment, and during a dry or frozen time period, it may be possible to harvest a few of these trees without causing undue drying or destruction of wetland habitat. This might be planned and economically accomplished when a crew is scheduled to conduct a partial harvest in nearby riparian zones.

Small brooks that are less than 50-centimetres (20 in) wide (as defined in Nova Scotia's *Wildlife Habitat and Watercourses Protection Regulations)* can be traditional rearing sites for young speckled (brook) trout. These places often have sources of cool water, and are too small to be occupied by larger fish that might eat the young trout. Even small brooks that dry up in the summer can host spawning adult trout after fall rains. Eggs overwinter in bottom gravels, and hatch in the spring. Some young-of-the-year trout will move downstream if drought sets in later in the summer.

A healthy forest environment can offset drought conditions. Forest environments tend to be moist, whereas large-scale forest cutting generally leads to warmer air temperatures and drier soil conditions. Bogs and wet forest areas normally feed their water into small brooks. Two forest bird species that nest in such wet areas are the Canada warbler and veery. Populations of both species are declining across North America. This downturn has been linked to reductions in their available habitat.

Small brooks supply water to larger rivers, in addition to the specific in-stream habitat needs of young-of-the-year speckled trout. Riparian zones on brooks should have a substantial buffer from the drying effects of clearcut operations.

Any harvests in riparian zones should be light enough overall to maintain riparian dampness and shade conditions.

Weaknesses of Riparian Zone

Leaving thin ribbons of trees across clearcut landscapes on certain soil types and with topographic exposure to strong winds can prove very unstable when riparian and travel corridors are populated by even-aged, shallow-rooted and/or pioneer trees. Perhaps the most vulnerable period occurs when adjacent contiguous forests are clearcut harvested on a large scale, leaving riparian zones and wildlife corridors with bared edges for the first time, and open to blowdown. More gradual adjacent harvests might help, by "feathering" the cutting edges. Nevertheless, some sites windthrow with a minor opening as a trigger. The challenge with inherently unstable riparian and wildlife corridors lies in gradually converting them to more stable, uneven-aged stands with a variety of site-suited tree species. Shallow soils may make this conversion impossible on some sites.

Riparian zones and wildlife travel corridors should be joined with the uneven-aged, shade-tolerant stands and other special areas set aside to provide connectivity at a landscape level for wild animals and plants.

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2.4 Ecologically Based Multi-Aged Silviculture in the Acadian Forest

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Silviculture – the science and art of managing forest vegetation to meet human needs – can take many forms, and the options are especially broad in a forest as diverse as the Acadian. Historically, silviculture in the Canadian Maritimes has focused on timber production, following essentially an agricultural model. Production silviculture tends to focus on a few, fast-growing and relatively short-lived conifer species. Under production forestry, all trees in a stand are the same age and are harvested at the same time, under what foresters call "even-aged" or "single-cohort" silvicultural systems. Stands are often planted and later treated with cultural practices such as herbicide release and precommercial thinning to create optimum growing conditions for the timber crop.

Widespread application of production silviculture can increase wood supplies substantially, but over time, will create a forest that is very different from the "presettlement" Acadian forest first experienced by European colonists. Studies of the few remaining old-growth forests, along with scientific analyses of early surveyors' records, reveal that that natural disturbances such as wildfires or hurricanes that killed all trees over large areas – what ecologists call "stand-replacing" disturbances – were quite rare. In northern Maine, for example, forest ecologists Craig Lorimer (1977) and Alan White (these proceedings) found that single-cohort stands of the sort maintained under production forestry occupied less than 20 per cent of the presettlement landscape. Most presettlement forests in the Acadian region were dominated by long-lived or "late-successional" tree species that develop best when young in partially shaded environments resulting from small-scale or "gap" disturbances that kill only single large trees or small patches at one time. Because forests affected by chronic gap disturbances are never completely killed, they typically contain trees of nearly all ages, from 5-year-old seedlings to 400-year-old veterans, and form what foresters call "multi-aged" stands.

Studies of natural Acadian forests reveal two key characteristics of disturbances that can be used to design ecologically based silvicultural systems:

about 1 per cent of any given stand is killed and regenerated every year (i.e., the same point on the landscape is affected on the average every 100 years), and regenerating gaps are quite small, mostly under 0.1 ha.

To emulate these dynamics with silviculture, partial harvests can be employed to regenerate 10-to-20 per cent of the stand at 10-to-20-year intervals in small, partially shaded gaps, thereby maintaining or restoring multi-aged stands with a diverse species composition. To accelerate recovery of mature forest conditions, a few large trees or rare individuals of formerly common species –- so-called "legacy trees" --- are retained in the gaps as they are harvested.

The Acadian Femelschlag

In 1994 scientists at the University of Maine established the Acadian Forest Ecosystem Research Program (AFERP) to study two ecologically based silvicultural systems based largely on natural disturbance dynamics:

The Irregular Group Shelterwood with Reserves ("large gap") treatment – The first harvest regenerates 20 per cent of the stand in gaps averaging 0.2 ha. Subsequent harvests at 10-year intervals each regenerate another 20 per cent of the stand, mainly by expanding the original gaps. Permanent legacy trees comprising a basal area of about 4 m^2 ha^{1} (= 10 per cent of the original stand basal area) are reserved in the gaps as they are regenerated. After the fifth entry, the stand is entirely regenerated, then is allowed to grow another 60 years with only tending treatments, at which point the regeneration process would begin anew. This system "front-loads" the regeneration process at 2 per cent per year for 50 years, then none for the next 50, thereby averaging 1 per cent per year over the entire 100-year rotation. Where patches of well-developed advance regeneration exist, the initial gap harvests are effectively localized overstory removal cuttings, with all trees except the reserves harvested. Where the stand is still in stem exclusion, additional overwood is left for a 10-year period to provide seed and partially shaded conditions. In the following gap-expansion entry, these "extra" overwood trees are harvested, leaving only the final reserve trees.

The Group Selection with Reserves ("small gap") treatment – The first and all subsequent harvests, done perpetually at 10-year intervals, each regenerate 10 per cent of the stand area, in gaps averaging 0.1 ha. Legacy trees are left identically to the group shelterwood treatment. The gaps are not expanded until 20 years after their creation; the first and second harvests thus both establish new gaps, and the initial gaps are not expanded until the third harvest. In effect, this treatment is a "half-speed" version of the Group Shelterwood treatment, continually regenerating 1 per cent of the stand per year.

Several features of these systems—the expanding-gap nature of the harvests under both systems, the irregular vertical structure created, and the shelterwood regeneration process—are quite similar to the old European Femelschlag system, long used in Germany to convert single-cohort stands to more irregular structures.

There are three replicates of both treatments, plus paired untreated control blocks, on the Penobscot Experimental Forest near the University of Maine campus. Vegetation development, dead wood, and a host of biodiversity indicators are all monitored using both remeasured permanent plots and specially designed studies.

Biological and operational advantages of area-based gap regeneration systems over uniformly applied systems based on a size (e.g., diameter) structure:

Ecological sustainability is assured as long as the regeneration rate does not exceed 1 per cent (i.e., a complete turnover requires at least 100 years).

Regeneration is managed deliberately by controlling gap size and total area, rather than simply assuming ingrowth into merchantable diameter classes.

There is no need to assume any problematic relationship between tree size and age.

Pre-harvest layout, logging, and tending operations are concentrated on 10-20 per cent of the stand, not dispersed throughout.

There is no need for a pre-harvest diameter distribution or other structural information.

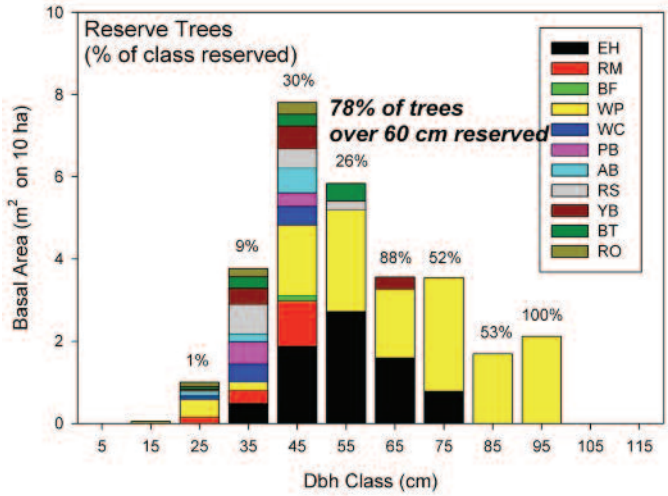
Yields can be predicted using conventional models for even-aged stands.

Light harvests (<25%) are feasible because they are concentrated, not dispersed.

Trees maintain or restore mature forest conditions

Legacy trees are typically the oldest individuals in any forest stand. They may be remnants of the presettlement forest, or simply representatives of cohorts older than the main stand. Cavity or nest trees with definite wildlife use are obvious candidates. Any tree of an uncommon species, regardless of age, is also a desirable candidate. Legacy trees are selected at the time the gap is marked for harvest, protected from logging damage, and retained indefinitely until they succumb from natural causes. After death, the boles fall and decay, replenishing the pool of coarse woody material on the forest floor. The following chart shows the distribution of legacy trees by species and 10-cm dbh class in one research area of the AFERP experiment.

Large white pine legacy tree with multiple cavities



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A long-term, multi-disciplinary experiment studying the effects of expanding-gap silviculture on the Acadian Forest ecosystem (the AFERP Web Site) http://www.forest.umaine.edu/facstaff/facstaff_pages/wagner/FERP/default.html

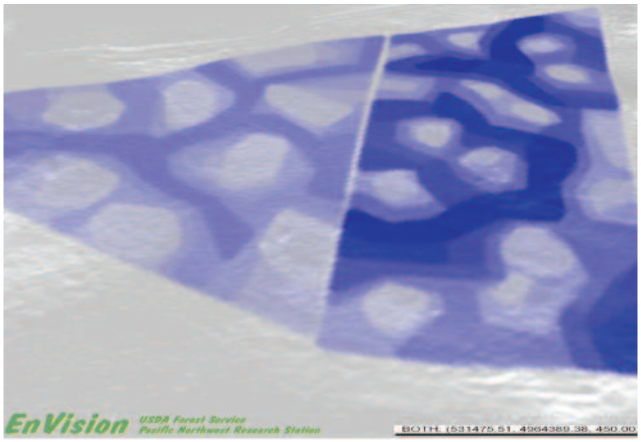

Figure 1. Schematic view of gap creation and expansion over time in group shelterwood (left) and group selection (right). Harvest timing ranges from light (earliest) to dark (latest). Based on actual GPS locations of the first two harvests, with further expansions simulated.

Figure 2. Large gap after final harvest, showing tall advance regeneration and several legacy trees reserved from harvest.

Figure 3. Recently expanded large gap showing newly released regeneration on the right (the expansion zone), regeneration from 10 years before on the left, and a narrow extraction trail dividing the two zones in the left-center of the photo.

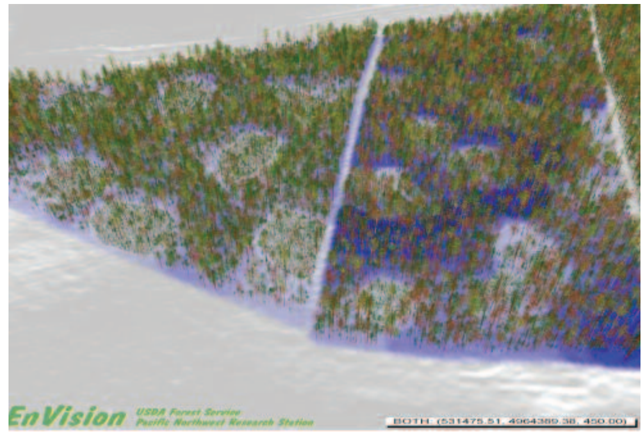

Figure 4. Simulated view of actual research areas 1 and 2 in year 11, after second harvest and first expansion in the group shelterwood treatment at the left.

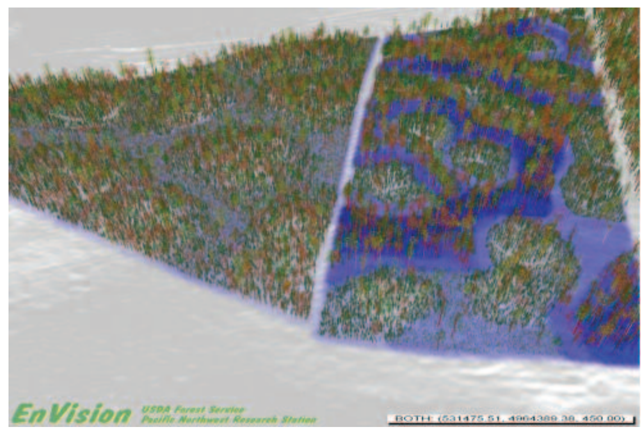

Figure 5. Simulated view of actual research areas 1 and 2 in year 51, after completion of harvests in group shelterwood area (left). Matrix is still only 50 per cent harvested in group selection treatment on the right.

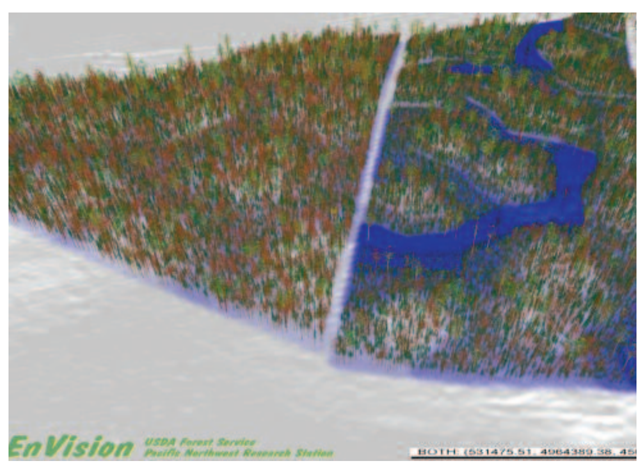

Figure 6. Simulated view of actual research areas 1 and 2 in year 100, just after completion of last harvest in group selection treatment (right) and 50 years after the last harvest in the group shelterwood treatment (left).

Figure 7. Isolated red spruce reserve trees in harvested gaps have remained quite windfirm after 12 years of monitoring.

2.5 Forestry: A New Policy for Nova Scotia

The 1986 *Forestry - A new policy for Nova Scotia* strategy document contained solid, high-level recommendations for turning industrial forest practices onto a more ecologically sustainable path. Since many of these recommendations were never implemented but remain applicable today, some of the original concepts find themselves being reiterated 24 years later.

These include:

Wildlife & Environmental Considerations: Protection of significant wildlife habitats and maintenance of the long-term productivity, diversity, and stability of the forest ecosystems. (p.6)

Forest Management Planning: (Comment from strategy) Full consideration of wildlife conservation requirements, potential ecological impacts, and outdoor recreation opportunities and needs. (p.7)

Forest Management Practices: Forest management techniques to be used on Crown land and recommended on private land will be designed to facilitate suitable natural regeneration wherever practical. This will involve selection cutting, or the harvesting of individual trees or groups of trees within a stand, and the shelterwood harvest system, involving one or more partial cuts carried out a decade or two before the final harvest. (p.8)

Private Land Forestry: Arrange for suitable financial incentives.......the Government of Nova Scotia will further explore forms of income tax incentives with the Government of Canada and continue to support and assist group management venture organizations......This concept will be expanded. (p.8)

"Forestry - A new policy for Nova Scotia" 1986 published by the Province of Nova Scotia, Ken Streatch, Minister of Lands and Forests.

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3.0 PARKS PANEL OF EXPERTISE ADDENDUM

3.1 The Evolution of Nova Scotia's System of Parks, Protected Areas and Outdoor Recreation Opportunities

1926 The Province of Nova Scotia set aside 1,212 hectares near Waverley for the use of Boys Scouts. In time this area was enlarged to 5,698 hectares and became the Waverley Game Sanctuary.

1927 The province set aside over 51,800 hectares as the Tobeatic Game Sanctuary.

1928 The province set aside another 51,800 hectares as the Liscomb Game Sanctuary.

1929 The Department of Lands and Forests' annual report makes it clear that the newly created Wildlife Sanctuaries were established not only to preserve wildlife, "but also to create provincial parks where people can enjoy the beautiful scenery and fishing, and greatest hunting of all, camera hunting."

1936 Cape Breton Highlands National Park became the first national park in Nova Scotia. This was followed by Kejimkujik National Park (1968) and Kejimkujik's Seaside Adjunct (1988).

1937 The last of the large game sanctuaries, Chignecto Game Sanctuary, was established when 22,275 hectares of Crown land were set aside.

1944 The Royal Commission on Provincial Development and Rehabilitation, established to examine post-war economic development in Nova Scotia, identified the tourism industry as having potential for growth. In order to attract out-of-province visitors, the commission recommended that a system of provincial parks be established to meet the anticipated needs of the traveling public.

1958 The Governments of Nova Scotia and Canada signed the Trans-Canada Agreement, which enabled the province to recover half the total cost of developing seven picnic and four camping parks situated along the Trans-Canada Highway. This agreement marked the beginning of an active program to develop provincial parks. Previously, only a small number of roadside table sites operated by the Department of Highways and a few provincial parks operated by the Department of Lands and Forests had been developed.

1959 Nova Scotia's *Provincial Parks Act* became law. Existing parks, park reserves, and other park properties designated under the act contribute to Nova Scotia's parks and protected areas system as representative examples of our landscapes and ecosystems, as well as safeguarding outstanding natural features and providing quality opportunities for outdoor recreation, education, and tourism.

1974 Biologists working in Nova Scotia under the International Biological Program (IBP) of the United Nations recommended 69 sites of ecological significance for protection. This led to the adoption of the *Special Places Protection Act.*

1975 Local community representatives from the eastern shore of Nova Scotia approve in principle the concept of an Eastern Shore Seaside Park System. The province's first major attempt at public consultation in park planning led to the creation of several natural environment and outdoor recreation parks along Nova Scotia's Atlantic Coast.

The *Beaches Act* was proclaimed. The act provides for the protection of beaches and associated dune systems as significant and sensitive environmental and recreational resources.

1976 "The Boggs Report" provided the Nova Scotia Department of Lands and Forests with a comprehensive vision for completing a provincial park and recreation system, incorporating wildland parks and natural heritage reserves, in addition to recreational lands.

1980 The *Special Places Protection Act* was passed in the Nova Scotia Legislature and assigned to the Museum of Natural History, Department of Education. The act provides, in part, for the designation of nature reserves to protect and regulate ecological sites (or nature reserves) that are considered important elements of the natural heritage of the province. Responsibilities for nature reserves subsequently were moved to the Department of Natural Resources in 1994 and the Department of Environment in 1999.

1983 The Department of Lands and Forests submission to the Royal Commission on Forestry contained a number of recommendations on the provincial parks program. These included: continued emphasis on land acquisition; provision of public access to privately owned recreational lands through such means as the *Trails Act*; the planned integration of uses on all Crown-owned resource lands; continued emphasis on larger resource-based parks; the anticipated implementation of an Ecological Reserves Program; the continuation of resource inventory and demand analysis; a proposal to amend the *Lands and Forests Act* to provide control of backcountry recreational use; a proposal to determine the extent and impact of non-resident ownership in Nova Scotia; allocation of sufficient quantity and quality of resource lands to meet the outdoor recreation, heritage appreciation and scientific research needs of present and future generations, both within and outside dedicated provincial park lands; management of lands both within and outside provincial parks to maintain environments that will yield high-quality opportunities for those activities; and, to recognize the Parks and Outdoor Recreation Program as a land use and to ensure that it is placed in the proper perspective relative to other uses of resource lands.

1984 The *Natural History of Nova Scotia* was published. The two-volume report provided the first major synthesis of knowledge about the natural history of Nova Scotia and established a theme-region framework for evaluating and protecting both representative and unique natural areas and features.

1987 The first nature reserve was established under Nova Scotia's *Special Places Protection Act*, at Tusket River in Yarmouth County. The site had been acquired by the Nature Conservancy of Canada and transferred to the province for designation.

The World Commission on Environment and Development (The Brundtland Commission) recommended that conservation be treated as an integral part of the planning and implementation of development activities. The commission also recommended that each country should protect 12 per cent of its landbase by the year 2000.

1988 MacFarlane Woods Nature Reserve was designated to protect an old growth stand of yellow birch, sugar maple, and American beech typical of the original Acadian tolerant hardwood forest. The land owner, Jim St. Clair, became the first individual to permit private lands to be protected under the *Special Places Protection Act.*

The Government of Nova Scotia adopted a Provincial Parks Policy following extensive provincewide consultations. The policy was designed to "provide the land base, infrastructure, and services to meet the outdoor recreation and heritage protection needs of Nova Scotians well into the 21st century." To implement the new policy, the province also passed a new *Parks Act*, a new *Trails Act* and a revised *Beaches Act*.

1989 Prompted in part by the Brundtland Commission, the World Wildlife Fund Canada and the Canadian Parks and Wilderness Society (CPAWS) launched an ambitious "Endangered Spaces" campaign to underscore the need to protect Canada's rapidly disappearing wilderness area. The campaign embraced the commission's call for 12 per cent protection of Canada's landbase.

1990 The inaugural meeting of the Federation of Nova Scotia Naturalists (now Nature Nova Scotia) included an announcement of the provincial government's intent to develop a *Systems Plan for Parks and Protected Areas.* This led to the identification of the best and largest remaining wilderness areas on Crown land in Nova Scotia, and to their eventual designation for protection.

1991 Representatives of various universities and government agencies based in Nova Scotia brought together 200 participants from 15 countries at the first conference on Science and the Management of Protected Areas (SAMPA), to discuss how to improve links between scientists and managers in the selection and management of protected areas.

1992 The *Conservation Easement Act* came into effect in Nova Scotia. This legislation allows designated conservation organizations to enter into easements with the owner of significant natural areas on private lands for conservation purposes.

Bowater-Mersey Paper Company became the first corporation to contribute land for the creation of a Nature Reserve under the *Special Places Protection Act.* Panuke Lake Nature Reserve on Bowater-owned land protects an old growth red spruce - eastern hemlock forest.

Nova Scotia was a signatory to the "A Statement of Commitment to Complete Canada's Network of Protected Areas."

1993 The Government of Nova Scotia declared a moratorium on resource development in 31 areas of Crown land that had been identified as candidate protected areas. Interim protection was provided pending the outcome of a public review process.

1994 The Nova Scotia Nature Trust was officially incorporated. The Trust works to promote conservation of private lands by identifying those lands with significant natural value, educating and co-operating with land owners to protect the natural values on their lands, and holding purchased or donated lands and conservation easements in trust.

The Government of Nova Scotia released its proposed Systems Plan for Parks and Protected Areas for public review and comment. The primary criterion for new proposals to add to existing protected areas was that sites provided representative examples of the province's typical landscapes and ecosystems.

Voluntary Planning released *A Review of Nova Scotia's Provincial Parks and Campgrounds.* Undertaken at the request of the Department of Natural Resources, Voluntary Planning examined how Nova Scotia's provincial parks and campgrounds could be made more flexible and less costly to taxpayers. The study, which included extensive public consultation, made several key recommendations on higher user fees, development of a comprehensive marketing plan, enhanced facilities and services, changes to park seasons, and giving consideration to partnerships with individuals and communities for delivery of park services and programs.

1995 The Government of Nova Scotia accepted in principle the recommendations of the report of a Public Review Committee, to protect 31 wilderness areas on Crown land. Strong support in favour of protection of the candidate areas was expressed during public meetings around the province in 1994-95.

1997 The Nova Scotia Department of Natural Resources released *"Nova Scotia's Protected Areas Strategy,"* which confirmed government's intent to protect 30 wilderness areas (Jim Campbells Barren had been removed but was later added again), provided an action plan and interim management guidelines to guide the implementation of the strategy.

At its annual meeting, the Canadian Council of Ecological Areas presented an award to the Nova Scotia Department of Natural Resources for its commitment to the province's Parks and Protected Areas Systems Plan.

The Department of Natural Resources completed a report entitled *Park Operating System Review*, which provided an in-depth analysis of provincial park operations and led to improvements in operational efficiencies.

1998 The Federal-Provincial Park Council presented the Nova Scotia Department of Natural Resources with an award for "excellence in the advancement of parks programs," in recognition of the department's work in developing a Parks and Protected Areas Systems Plan.

Cape Chignecto Provincial Park officially opened as a new Natural Environment Park. Nova Scotia's largest provincial park at 4,200 hectares, Cape Chignecto is operated and managed by a board from the local community according to standards set out in a management agreement with the Department of Natural Resources.

The *Wilderness Areas Protection Act* was adopted by the Province of Nova Scotia. The act officially protects 31 new Wilderness Areas, totaling 285,650 hectares across Nova Scotia. Combined with existing parks and nature reserves, wilderness areas protect representative examples of 26 of the province's 80 natural landscapes, as well as many outstanding natural values and features, and opportunities for wilderness recreation and nature tourism.

Responsibility for Wilderness Areas, Nature Reserves, and the Canadian Heritage Rivers Program was transferred from the Department of Natural Resources to the Department of Environment.

1999 The *Endangered Species Act* is proclaimed in Nova Scotia. The act establishes a process of listing species at risk and permits development of recovery plans for habitat on public and private lands.

2001 The Voluntary Planning Task Force on Non-Resident Land owners releases its final report. The report recommends a number of initiatives that could impact Nova Scotia's parks and protected areas system including development of a specific coastal access strategy, protection of traditional coastal access ways, public acquisition of key properties, improved use of Crown lands and a provincial interest statement on coastal utilization.

2003 Nova Scotia released *"Towards a Sustainable Environment"* (Nova Scotia's Green Plan), which included a commitment to continue to work towards a comprehensive system of protected areas.

2004 The final report of the Voluntary Planning Off-highway Vehicle Task Force is released. The report recommendations include calls for better enforcement of OHV regulations, development of additional OHV infrastructure, a renewed emphasis on public safety, more efforts directed towards environmental protection, and stricter vehicle standards.

2005 The Colin Stewart Forest Forum (CSFF) was established through a Memorandum of Understanding signed by the Ecology Action Centre, Canadian Parks and Wilderness Society, Bowater Mersey, JD Irving Ltd., Neenah Paper (now Northern Pulp), and StoraEnso Port Hawksbury (now NewPage Port Hawksbury), and later by the Nova Scotia Nature Trust and Nature Conservancy of Canada. Forum partners pledged to "work together in good faith to develop a mutually agreeable proposal toward completion of the protected areas network ...."

2006 The Government of Nova Scotia releases *Opportunities for Sustainable Prosperity 2006: An Updated Economic Growth Strategy for Nova Scotia.* The report identifies a number of government priorities including, under Sustainable Competitiveness, a commitment to complete new strategies for forestry, minerals, parks, and biodiversity and begin implementation.

"*Our Heritage Future: A Shared Responsibility*" is released by the Voluntary Planning Heritage Strategy Task Force. The report provides important recommendations on a range of issues affecting Nova Scotia's cultural and natural heritage. Several of these recommendations impact on the province's parks and protected areas system.

2007 Nova Scotia adopts the *Environmental Goals and Sustainable Prosperity Act* (EGSPA). The act contains a wide range of environmental goals, including two commitments involving the province's parks and protected areas system. EGSPA included a commitment to legally protect 12 per cent of the total land mass of the province by 2015 and to adopt strategies to ensure sustainability of the province's natural capital in the areas of forestry, mining, parks, and biodiversity by the year 2010.

In response to the *Environmental Goals and Sustainability Act,* the Department of Natural Resources announced that a new natural resources strategy would be developed over a three-year period. The new strategy would replace existing policies for forests, minerals, and parks that had been in place since the 1980s and would also include a new biodiversity strategy.

2009 The Colin Stewart Forest Forum submitted its final report to the Government of Nova Scotia. The report includes a number of key recommendations with respect to the identification and designation of new protected areas; mitigation of impacts on wood supply; interim protection for Crown lands recommended for protection by the forum; additional land acquisition; consultation with First Nations; public and stakeholder consultations; future initiatives; private land conservation; biodiversity conservation on unprotected lands; and implementation of the forum's recommendations.