The Port Hawkesbury Biomass Project (2010): Concerns related to carbon emissions and impacts of harvesting on soil nutrients & acidification

Comments submitted to the Nova Scotia Utility and Review Board

by

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SUMMARY

The NSP/New Page Biomass Project proposal lacks comprehensive quantitative life cycle modeling that is required to substantiate proponents' claims that the project will reduce GHG emissions and that the resource can be sustainably harvested. Were such models employed, the project and the proposal would likely be quite different. There is ample documentation and discussion in the scientific literature to indicate that (a) forest biomass schemes cannot be assumed to be carbon neutral, and (b) forests and whole watersheds in Nova Scotia are especially susceptible to nutrient limitations and soil acidification over the long term, if not already experienced. Unfortunately FSC Maritime Standards, which to its credit, New Page adheres in its forestry practices, do not address the soil nutrient and acidification issue. Likewise, the proponents' reliance on government documents or government commissioned documents may have led them to overlook these key issues. In both the private and public sectors, there is a need for more critical use of scientific literature and comprehensive modeling in addressing complex environmental issues such as those involved in this project.

1. INTRODUCTION

I am commenting as a taxpayer concerned that we are being asked to cover renewable energy investment costs for NSP in a project that should not qualify as a renewable electricity project. Further I am concerned about the environmental impacts of the project regardless of who covers the investment costs. The proponents have overlooked some key aspects of the project that affect it's status as renewable energy and, at the very least, should be required to revise the project and the proposal accordingly.

The details of my comments reflect my background as a scientist with research experience in the areas of nutrient budgeting and related biological processes in marine and terrestrial ecosystems. (I retired from Dalhousie University as a Professor of Biology in 2008.)

My concerns are that (a) the project may not reduce net carbon emissions, as claimed by the proponents[1], and as required by legislation (at least for the province as a whole), and (b) the scale and intensity of forest harvesting envisaged may not be sustainable because of impacts on soil nutrients and acidification. These issues were highlighted by Trevor Hesselink in an invited presentation to the workshop on *The Scientflc Foundation for Sustainable Forest Biomass Harvesting Guidelines and Policies*, held in Toronto in February of 2008. I raised both concerns at the final Renewable Energy Consultation held at Dalhousie University in the late fall of 2009.[2] However, they did not find their way into the final document (the "Wheeler Report")[3], in spite of assurances that at least the carbon issue would do so. The carbon emissions issue is well

addressed in direct evidence submitted to the URB by the Ecology Action Centre.[4] It appears that the nutrient supply/soil acidification issue has still received little attention in the context of forest biomass policies and technology in N.S.

In both areas, I believe the proponents have essentially acted in good faith and that their assumptions regarding carbon balances and sustainability of the resource were based on common understanding of these issues at the time, e.g., as expressed in the Wheeler Report and in various Nova Scotia Dept. of Natural Resources, Dept. of Environment and Dept. of Energy documents including documents related to the Renewable Energy Standard. Until recently, it has been widely assumed, even by many energy and forest experts, that forest biomass is carbon neutral. Likewise, we have come to expect that FSC (Forest Stewardship Council) certification of forestry operations is sufficient to ensure that the resource is used sustainably.

However, documentation and discussion of these issues in the scientific research literature is sufficient that professional employees and consultants involved in preparing the proposal, as well as government professionals, should have anticipated the need for comprehensive life cycle analyses and modeling to evaluate different configurations of the project for carbon emissions and sustainability of the resource. Had they done so, I believe that the project and the proposal would have looked very different from that presented.

2. CARBON EMISSIONS: IN IT'S PRESENT CONFIGURATION, THE PROJECT MAY INCREASE NET CARBON EMISSIONS

The Direct Evidence submitted by the Ecology Action Centre[4] lays out the key issues with regard to carbon emissions very clearly, with supporting documentation.

This is a case where the proponents relied on common understanding of this issue when scientific research in the area over the last decade or more was indicating that forest biomass, in contrast to some other forms of biomass, should not be considered carbon neutral by default. I referenced some of this literature in a submission to the Nova Scotia Renewable Energy Stakeholder Consultation Process in the fall of 2009[5], noting:

> I suggest that … we need to give careful consideration to the implications of various regimes for net carbon sequestration. Because of the history of forestry in Nova Scotia, our forests are relatively young, averaging perhaps 40 years[1]. Left undisturbed after clearcutting, forests in northeastern North America continue to accumulate carbon and sequester atmospheric carbon dioxide for well over 100 years[2]. If we clearcut our forests for biomass, whether by whole-tree or stem-only harvest, the implications for net carbon sequestration must be taken into account - at least if we want to reduce CO_2 emissions, as well as substitute for petroleum

based energy generation.

Whether or not harvesting biomass for energy is carbon neutral depends very much on site and process specific factors.[3] I suspect that detailed carbon accounting would show that clearcutting forest for biomass would be far from carbon neutral for the typical Nova Scotian scenario; it would in fact reduce net carbon sequestration substantially. The contention that biomass is carbon neutral is based on the assumption that the carbon dioxide released when biomass is burned (or respired) is taken up stoichiometrically when the biomass crop re-grows. For biomass crops such as switchgrass or sugarcane, the CO_2 released on burning can be recaptured within one growing season; if it is grown on degraded land with fertilization, there can even be net carbon sequestration. Harvesting standing forests for biomass is, however, a quite different matter. If we clearcut a 40 year old forest now for biomass energy, all of the harvested biomass carbon is going into the atmosphere now; then it will take a full 40 years to take up an amount of carbon dioxide equivalent to that released, assuming that the forest recovers to its previous state. So, in the short term, e.g., over the ensuing decade at least, burning of the forest biomass will result in net carbon emissions.

Further, in order to realize carbon neutrality over 40 years, we have add to the carbon that needs to be recaptured: (i) losses of soil carbon associated with clearcutting (ii) carbon costs of harvesting and processing the biomass, (iii) the additional carbon that would have been taken up had the forest not been cut. To the extent that these amounts (including the initial biomass carbon) are not recaptured, there will be net emissions of carbon dioxide to the atmosphere.[4]

It is for this reason that biomass energy schemes of this sort are generally considered to cause net emissions of CO_2 unless there is (i) significant carbon capture and storage associated with the combustion of the biomass and/or (ii) conversion of a significant portion of the harvested biomass into a slowly degrading form (carbonization, biochar) and/or (iii) biomass production sites are fertilized to substantially increase productivity over background levels.[5]

In the short term (2015), forest biomass projects in N.S. are not likely to involve any of these three conditions. Further, in considering forest biomass as a substitute for fossil fuels, the lower efficiency of biomass compared to fossil fuels in generating electricity must be taken account. Given the potential of N.S. forests to sequester carbon if they are NOT harvested, a full carbon accounting would likely indicate that we could reduce carbon emissions much more by substantially reducing clearcutting in Nova Scotia than we could by substituting clearcut forest biomass for fossil fuels in power generation.

At the very least, we need to do this sort of carbon accounting before embarking on an ambitious forest biomass cutting to meet 2015 substitution goals.

[See Note & References # 6 for references cited above]

Despite assurances to the contrary, this issue did not make its way into the final Wheeler Report, which I commented on in a letter Dept. of Energy in January, 2010.[7]

> I submitted a referenced document to the Renewable Energy Consultation addressing this issue on Dec. 15th and had some discussion with Dr. Wheeler about it. He commented that "we will be making clear the need for life cycle assessments of the carbon costs and benefits of biomass". However, the only reference to Life Cycle Assessments is on page 42:
>
> > It is also recommended that renewable energy standards be reviewed based on scientific assessments of carbon life cycle considerations and in due course be amended to recognize that co-firing of biomass in NSP coal fired plants could make a significant contribution to renewable energy and climate change mitigation targets.
>
> That statement in fact repeats the erroneous assumptions I refer to above, at least to the extent it refers to forest biomass.
>
> I think that one reason my comments were not taken seriously, perhaps understandably, is that forest biomass has been treated as carbon neutral under the Kyoto Protocol. Indeed, that puzzled me, as the scientific papers cited in my submission were unequivocal in this regard. After submitting my comments to the Renewable Energy Consultation, I discovered that a key paper addressing this issue had recently been published in the Policy Forum of the prestigious journal Science*. This multi-authored paper points out that there is a critical accounting error in the Kyoto Protocol that allows biomass energy to be treated as carbon neutral, regardless of the source. The error is very large for forest biomass. There is no doubt that this error will now be corrected and that the carbon balance for forest biomass will be examined much more critically in future.
>
> *See: T. D. Searchinger et al., 2009. **Fixing a Critical Climate Accounting Error** *Science* 23 October 2009: Vol. 326. no. 5952, pp. 527 – 528

So, it is perhaps understandable, if not excusable, that authors of government documents or government-commissioned documents which NSP/New Page have apparently been relying on for the appropriate criteria were not aware of this issue. Nevertheless, that does not change the reality at this point. We should not knowingly proceed with a project for which there is good reason to suspect that some of the key assumptions are erroneous. Further, this is not a matter of a value judgment for which thresholds are vague or negotiable. It is a quantitative issue that can be addressed though comprehensive life cycle analyses and modeling.

The following points (2.1 to 2.4 below) are intended to complement comments on carbon emissions made by EAC in their Direct Evidence Document[3].

2.1 Role of biomass in silvicultural improvement of forests

Some forest managers maintain that clearcutting is the only way they know to deal with overly dense, mature or dying stands, e.g., that have grown up on some abandoned farmlands, and thus that a market for biomass can aid in silvicultural improvement of such forests.

> Biomass is the biggest and best tool ever offered to the silviculture industry. To improve the health of our forests, we need an economic tool to remove those forest stands we have degraded over the past 300 years so we can establish something closer to what our forefathers found when they arrived.
> Roughly 10 - 20 % of the standing inventory is in decadent stands, ones that are mature or dying. Since most of the stems in these stands are < 9.1 cm they are classed as unmerchantable and don't even show in the inventory totals. Due to their small stem size, the pulp and lumber industry can't afford to harvest them. By building the biomass industry market, we may be able to economically harvest these sites and establish healthy young stands that will be able to absorb carbon while protecting our water and growing fibre for future use.
> (Jim Verboom in "Biomass in Nova Scotia - How much is there?" Comments submitted to the Renewable Energy Stakeholder Consultations, 2009.)

> Many forest stands in Nova Scotia are in such poor condition silviculturally that partial harvests would not work well. Abolition of clearcutting today is not a sensible approach to forest restoration across the province. Where stands have good conditions to support partial harvests, that's what should happen. Where they don't, clearcutting mav be appropriate: but then let's regenerate new forest stands that will be suitable for partial harvests
> (Peter Duinker in the Chronicle Herald, May 13, 2010: "Biomass debate must branch out")

It is not evident from the documents available to the public whether stands of this type would be involved in the additional clearcutting envisaged to support the co-generation project, but it appears they would, based on press reports:

> Bill Stewart, the company's director of woodlands, says its definition of biomass would leave all tops, branches, stumps and roots on the forest floor to return nutrients to the soil. What would qualify as fuel are trees killed by insects and storm damage, rotting hardwood and low-grade hardwood stems too small, deformed or rot-blighted for sawmilling. Mr. Stewart says 85 per cent of Nova Scotia's hardwood is in this unmerchantable condition, so creating a market for it is a chance to replace it with a healthier forest and to give sawmills access to more sawlogs.
> (Chronicle Herald 04/10/2010 in an editorial titled "New page for biomass")

I suggest three points to be considered in regard to the role of such clearcuts in the co-generation project scenario: (i) Regardless of the siliviculural benefits, clearcutting such stands for biomass will still increase CO_2 emissions over the

short to intermediate term if not longer. (ii) As envisaged, the silvicultural strategy is to replace useful-only-for-biomass stands with healthier forests that would primarily serve other purposes in the future. Thus harvesting them for biomass is a one time event (or at least that it how it is rationalized) and it cannot be assumed repeat harvests will be available. (iii) If the silvicultural arguments are accepted, there should be legal provisions to ensure appropriate follow-up management.

2.2 Mixed Biomass Sources

I realize that the NSP/New Page project involves a mix of sources and, considered on their own, some could result in net reduction of carbon emissions compared to present practices. However, a significant component involves clearcutting above current levels which, with burning of the biomass, would clearly increase carbon emissions. The mix of resources involved underscores the need for comprehensive, fully quantitative life cycle accounting of carbon emissions under different scenarios.

2.3 Mixed products: what are the implications of a variable market for paper?

Arguments are made that the project has high efficiency because it is a co-generation project, with steam being used in the manufacture of paper and wastes from paper manufacture being used in generation of electricity and steam. What are the implications of a possible loss in the market for paper, reflecting worldwide trends? Would the operation reduce its electricity output to NSP or would it still operate to full capacity but divert more of the output towards electricity exported to NSP? Doing the latter would increase net carbon emissions because carbon storage in paper is replaced by direct emissions. As above, this question underscores the need for comprehensive, fully quantitative life cycle accounting of carbon emissions under different scenarios.

2.4 Towards a carbon-neutral project

The project might be reconfigured in various ways to make it carbon neutral and or even carbon sequestering.

For example, on the processing end, the proponents could incorporate carbon capture &/or conversion of some of the biomass to a slowly degraded form. There are a number of options for increasing carbon capture and reducing carbon losses on the forest production end, e.g., recycling of nutrients recovered from burnt biomass and/or net fertilization to increase productivity. I note that the proposal by NSP/new Page states:

> The ash that is produced from the combustion process is land filled in the existing offsite ash management site.

Many or most of the on-site losses of carbon and the loss of ongoing carbon sequestration can be avoided in harvesting systems which involve thinnings or partial cuts rather than clear-cutting, Such systems may even enhance existing levels of carbon sequestration. A 2008 report on *Silvicultural and Ecological Considerations of Forest Biomass Harvesting In Massachusetts*[8] recommends harvesting for biomass only if "if partial harvests rather than clearcut harvests are used, leaving healthy, vigorous, residual stands that will continue to grow and sequester carbon at high rates after the harvest."

Such measures might not be economically feasible at this time. In such a case, natural gas or oil could be utilized as an alternative to the component that involves new clearcutting until such time that carbon-conserving measures are economic.

3. SOIL NUTRIENTS & ACIDIFICATION: A KEY SUSTAINABILITY ISSUE NOT ADDRESSED IN FSC MARITIME STANDARDS

New Page deserves credit for its efforts to ensure that forestry operations supplying biomass are FSC certified. FSC Certification is widely regarded as the most rigorous amongst the various sustainable forest certification systems, and takes into account a variety of ecosystem and social services that forests provide, as well as sustainable yield based on conservative growth and yield data.

However, FSC Maritimes standards[9] are seriously deficient in at least one regard: there are no criteria for assessing sustainability of the resource in relation to soil nutrient supply and soil acidification. These are significant issues for Nova Scotia because of the initially nutrient-poor status and poor buffering capacity of soils over much of the province (including some soils in or close to the Port Hawkesbury region) and because of the influx of acid rain from heavily industrialized areas of the USA and Canada. Clearcutting exacerbates the stresses through direct removal of basic cations and through increased losses of nutrients by erosion and leaching. The danger is that with each harvest, more nutrients are removed directly or lost indirectly through enhanced erosion and leaching; although there may not be immediate or noticeable effects, at some point critical thresholds for nutrient uptake and soil pH could be crossed. Then growth rates could drop precipitously, some species might be lost, pest and diseases increase etc., but it will be too late and/or too expensive to attempt to rectify the underlying conditions. Calcium has been identified as a particular concern.

While the FSC standards in principle cover these concerns, there is no explicit recognition of the soil nutrient & acidification issue in the standards documents. This reflects the same sort of lag between the scientific understanding of the issue at the research level and the common understanding of the issue that

applies to the biomass carbon emissions issue. Regardless, the issue is real and well documented in the scientific literature, and well understood in certain sectors of government, e.g., in relation to poor survival of Atlantic salmon fry in once salmon-rich rivers. Susceptibility of some Nova Scotian lakes and rivers to enhanced acidification by acid rain was first documented in the 1970s. While discussion of the issue has focused primarily on effects on aquatic organisms, the susceptibility relates to the base-poor status of soil and bedrock underlying certain largely forested watersheds, with representation throughout most of Nova Scotia, including parts of eastern N.S. However, with a few notable exceptions, the issue is rarely discussed in the context of the intermediate to long term effects of intensive forest harvesting in Nova Scotia.

Like the carbon emissions issue, the effects of forest harvesting on soil nutrients and acidification are amenable to quantitative assessment. The proponents should be required to employ the best current techniques and data to model different configurations of the project for their effects on soil nutrients and soil acidification and, in turn, consider how those effects impact longer term forest productivity and health of aquatic systems.

3.1 The scientific literature

The following annotated references illustrate that issues of soil nutrient depletion, particularly calcium, and soil acidification are well documented in the scientific literature and that Nova Scotia is an area of particular susceptibility to these stresses. Many more could be cited. The notes highlight some of the content that is relevant to forest management.

Goldsmith, F.B. 1980. **An Evaluation of a forest resource: a case study from Nova Scotia**. *Journal of Environmental Management* 10:83-100
Goldsmith reviewed the history of forest exploitation in Nova Scotia and highlighted the issue of nutrient supply as a possible limitation to continued intensive harvesting of forests, including use of biomass as a major energy source. “The construction of nutrient budgets is time-consuming and difficult, but it may nevertheless be considered surprising that no budgets have been prepared for any of the major nutrients in Nova Scotia. The province has one of the longest histories of logging in North America and some of the most nutrient-deficient soils. If any region is likely to experience a serious nutrient depletion problem, it is Nova Scotia.

Freedman, B. et al. 1986. **Biomass and nutrients in Nova Scotia forests, and implications of intensive harvesting for future site productivity.** *Forest Ecology and Management* 15, 103-127.
The authors examined direct nutrient removals by whole tree harvesting on four conifer and four hardwood stands in central Nova Scotia. Calcium removals were highest relative to soil stocks, averaging 29% per rotation for whole tree

harvesting, and approx. ½ of that for bole-only harvests. They commented: “This may be a cause for concern, and warrants further investigation.” They did not examine possibly substnatial indirect removals through enhanced erosion and leaching, as illustrated by the well known Hubbard Brook experiments.[10]

Howell, G. & A. H. El-Shaarawi. 1991 **An overview of the acidification of lakes in Atlantic Canada**. *Environmental Monitoring and Assessment* 17: 323-338.
Figure 2 shows the distribution of acid-sensitive geology in Nova Scotia

Huntington, T.G. 2005. **Assessment of calcium status in Maine forests: review and future projection**. *Canadian Journal of Forest Research* 35: 1109–1121
“Forest soils in Maine are currently at lesser risk of Ca depletion compared with many forest soils in the central and southeastern United States, because levels of acidic deposition and rates of Ca accumulation in trees are lower in Maine. The rate of Ca accumulation in trees is reduced in Maine as a result of lower growth rates and a higher proportion of conifer trees that require less Ca than hardwoods. However, field-scale biogeochemical studies in Maine and New Hampshire, and regional estimates of harvest removals and soil inventories coupled with low weathering estimates, indicate that Ca depletion is a realistic concern in Maine. The synthesis of site specific and regional data for Maine in conjunction with the depletion measured directly in surrounding areas indicates that the Ca status of many forest soils in Maine is likely declining. Ca status could decrease further in the future if forest growth rates increase in response to climate trends and recovery from insect-induced mortality and excessive harvesting in recent years. Proposed climate change induced reductions in spruce and fir and increases in hardwoods would also increase the risk of Ca depletion.” Most of these considerations apply to Nova Scotia as well.

Juice SM, et al. 2006. **Response of sugar maple to calcium addition to northern hardwood forest.** *Ecology* 87(5): 1267-80.
The results of this study “reinforce and extend other regional observations that sugar maple decline in the northeastern United States and southern Canada is caused in part by anthropogenic effects on soil calcium status.” Also noted by these authors: evidence that decline of red spruce (Picea rubens Sarg.) in the northeastern U.S. mountains is tied to disruption of plant calcium nutrition by acid deposition.

Clair, T.A. et al. 2007. **Freshwater acidification research in Atlantic Canada: a review of results and predictions for the future.** *Environmental Reviews* 15: 153-167.
“The granite and shale bedrock found in large parts of the Atlantic region contain little buffering material…Soils that are from this apparent material and the waters draining them this contain low base cation (C_b) concentrations and are thus vulnerable to acidification, even under low acid deposotion… Much of southwestern NS, the eastern shore of NS, the Cape Breton highlands…showed

low CSI [calcite saturation index] values." The authors note an additional cause of base removal: "Seasalt generated acid pulses have not been reported in Atlantic Canada, but are probably occurrung, especially in catchments on windward coasts."

Jeziorski, A. et al. 2008. **The widespread threat of calcium decline in fresh waters**. *Science* 322, 1374

"Lake-water calcium concentrations are currently falling in softwater lakes in many boreal regions (1–3). Declining calcium is part of an expected concentration trajectory (4) that is linked to a reduction in the exchangeable calcium concentration of catchment soils (5). Although such reduction is part of the natural, long term process of soil acidification, it is accelerated by other factors that vary regionally in importance [for example, acidic deposition (1, 6), reduction in atmospheric calcium inputs (7), calcium loss from forest biomass harvesting, and regrowth after multiple timber harvesting cycles (2, 8)]."

Joseph, A.A. 2009. **The development of spatiotemporal simulation methods for the strategic assessment of ecologically sustainable bioenergy supplies** PhD thesis, Dalhousie University, Halifax, Nova Scotia

From the Abstract:

"This thesis uses systems analysis techniques to develop models and simulation software capable of providing strategic information on sustainable biomass supplies from forest and agricultural systems… An example case was analyzed to demonstrate the functionality of the methods using the province of Nova Scotia, Canada. A series of scenario tests indicate that bioenergy could meet a modest portion of the region's primary energy requirements, but aggressive targets result in forest depletion within 100 years. Land-use constraints, moderately productive forests, and a lack of agricultural bioenergy production combined to limit supply potential in the case study example. Nutrient measurement capability was added to the simulation tool to provide an additional measure of bioenergy system performance. Over time, bioenergy related nutrient removal, specifically soil base cation depletion can threaten to limit forest productivity. However, the extent of this effect on long-term bioenergy supply remains poorly understood. The methods and software described in the thesis provide scientists, resource managers, and policy-experts useful techniques for exploring strategic-level bioenergy supply questions using a transparent, reproducible, and empirically-based approach."

3.2 Impacts of climatic change on soil nutrients

Reliance on growth and yield data to calculate sustainable harvest levels could be especially misleading in an era of climatic change. A recent study suggests that that forest growth is being enhanced by longer seasons and higher temperatures[11]. Combined with harvesting based on empirical growth and yield data, this phenomenon could accelerate nutrient removal and soil acidification while giving the impression that the harvests are sustainable.

Huntingdon's comments on impacts of climate change on forests and soil Ca status in Maine[12] likely apply also to Nova Scotia:

> Additionally, a variety of circumstances could result in large increases in the rate of net Ca depletion in Maine forests, putting them at greater risk in the future. Maine's forests have experienced exceptionally low growth rates in recent decades but growth rates are expected to return to more typical levels. Climate change, including warming and lengthening of the growing season, will likely accelerate the rate of Ca accumulation into merchantable wood. There is also concern that changes in forest species composition may result in higher rates of Ca accumulation. Together, these trends could lead to accumulation rates that are more comparable with those currently observed in the southeastern United States, which would increase the risk of Ca depletion in Maine. Continued monitoring of acidic deposition, forest growth and composition, stream chemistry, and, over the longer term, soil chemistry, is needed to monitor Ca status and ecosystem health.

4. CLEARCUTTING IN N.S. FOR BIOMASS VERSUS OTHER PRODUCTS

It is worth noting that the concerns related to soil nutrients & acidification apply to intensive forest harvesting regardless of how the products are being used.
In contrast, the effects of clearcutting for fiber and timber products on carbon emissions are less than those from clearcutting for biomass because fiber and wood products continue to store carbon. Many reasons to rein in the extent of clearcutting in this province are cited in the Forests Panel of Expertise Report by R. Bancroft & D. Crossland.[13]

5. CONCLUSION

I trust that these concerns will be addressed in the URB hearings. In key areas pertaining to carbon emissions and sustainable forest management there is a significant gap between the research literature and "the common understanding" of the science in these areas, as reflected in the Wheeler Report, various government documents, FSC standards and in text posted by New Page on a website promoting the co-generation project. Regardless, the issues are real and there is considerable documentation of them in scientific literature going back at least 10 or more years in the case of carbon emissions and 20 or more years in relation to soil nutrients/soil acidification. In both the private and public sectors, there is an obvious need for more critical use of scientific literature and comprehensive modeling in addressing complex environmental issues such as those involved in this project.

Biomass utilization policy currently sits at the converging points between the pervasive impacts of climate change and the economic opportunity to set the groundwork for our next forest economy, and will play a key role in how well we choose to manage our forest resources in this unique context. To proceed with maximization of use as the dominant management priority is to ignore the critical obligation that managers must appreciate: that our forest resources have limits to their exploitation from which, once exceeded, they do not easily recover. On the evidence available, this is a time for government policy-makers to take the precautionary path in allocating our forest biomass and to ensure that we are comfortably living on the interest from our forest ecosystems but not tapping into its capital.

- From Hesselink, T. 2010. **Increasing pressures to use forest biomass: A conservation v1iewpoint.** An invited presentation made at a workshop on The ScientfIc Foundation for Sustainable Forest Biomass Harvesting Guidelines and Policies, Toronto, Ontario, 18—21 Feb. 2008, Published in *The Forestry Chronicle* 86(1): 28-35.

6. NOTES & REFERENCES

1. There is no direct mention of carbon emissions in the proponents' application to the URB, it being noting instead that "The facility will be fueled by biomass, and as confirmed by the Province's RES Administrator, be eligible for inclusion in the Company's RES portfolio."
(http://www.nspower.ca/en/home/aboutnspi/ratesandregulations/regulatoryinitiatives/biomass.aspx).
However, the New Page website **Biomass Benefits Nova Scotia** (http://www.biomassbenefitsns.ca/) is replete with explicit claims that carbon emissions will be reduced and that harvesting will be fully sustainable.

2. Hesselink,T. 2010. **Increasing pressures to use forest biomass: A conservation viewpoint.** An invited presentation made at a workshop on The Scientflc Foundation for Sustainable Forest Biomass Harvesting Guidelines and Policies, Toronto, Ontario, 18—21 Feb. 2008, Published in *The Forestry Chronicle* 86(1): 28-35.

3. Adams, Michelle, and David Wheeler. **Stakeholder Consultation Process For: A New Renewable Energy Strategy For Nova Scotia, Final Report To The Government Of Nova Scotia**, December 28, 2009.
http://www.gov.ns.ca/energy/resources/EM/renewable/Wheeler-Renewable-Stakeholder-Consultation-Report.pdf

4 **EAC Direct Evidence for UARB Hearing CI 39029** submitted by Jamie Simpson with support from Brennan Vogel, Kevin Chisholm and Max Raissi on behalf of Ecology Action Centre June 16, 2010
Document N-17 on URB website
http://www.nsuarb.ca/NSUARB_Exhibits_JOOMLA/get_document.php?doc=N-17&no=1315

5. **Clearcutting Nova Scotian Forests for Biomass: Implications for Carbon Sequestration and Sustainability.** Comments submitted to the Nova Scotia Renewable Energy Stakeholder Consultation Process in response to the Interim Report To Stakeholders by David G. Patriquin. December 15th 2009.
http://eco-efficiency.management.dal.ca/Files/NSREC/Clearcutting_Biomass_in_NS.pdf

6. These references are cited in the document immediately above (#5):

1. Pannozzo, L. & Colman, R. 2008. ***GPI forest headline indicators for Nova Scotia*** Haifax: GPI Atlantic. For the history of forest harvesting in N.S., see Goldsmith, F.B. 1980. **An Evaluation of a forest resource a case study from Nova Scotia.** *Journal of Environmental Management* 10:83-100

2. Wofsy, S. 2004. **The Harvard Forest and understanding the global carbon budget.** Chapter 19 in Forests in time; *The environmental consequences of 1000 years of change in New England* (D.R. Foster & J.D. Aber, eds). New Haven: Yale University Press. For data pertinebts to N.S, see Diochon, A et al. 2009. **Looking deeper: An investigation of soil carbon losses following harvesting from a**

managed northeastern red spruce (*Picea rubens* Sarg.) forest chronosequence. *Forest Ecology and Management* 257: 413-420.

3. Schlamadinger, Bet al., 2001, ***Carbon sinks and biomass energy production. A study of linkages, options and implications***. Climate strategies Network, London. Available at www.climate-strategies.org

4. Ornstein, L. 2009. **Replacing coal with wood: sustainable, eco-neutral, conservation harvest of natural tree-fall in old-growth forests An editorial essay.** *Climatic Change* 97:439-447

5. Christian, A. et al. 2006. **Carbon capture and storage from fossil fuels and biomass: Costs and potential role in stabilizing the atmosphere.** *Climatic Change* 74: 47-79.

7 **Forest biomass will not reduce carbon dioxide emissions.** Comments on the final Energy Consultation Document by David G. Patriquin, submitted to Nova Scotia Department of Energy, January 27, 2010. Available at http://versicolor.ca/biomass/docs/NSEsubmission.html

8. Kelty, M.J. et al. 2008. **Silvicultural and ecological considerations of forest biomass harvesting in Massachusetts**. Prepared for the Massachusetts Division of Energy Resources & Massachusetts Department of Conservation & Recreation. http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/bio-silviculture.pdf

9. **FSC Maritime Forest Management Standard (2008)** http://www.fsccanada.org/docs/4362246B2B61578A.pdf

10. **The Hubbard Brook Ecosystem Study** http://www.hubbardbrook.org/

11. McMahon, S.M. et al. 2010, **Evidence for a recent increase in forest growth**. *Proceedings of the National Academy of Sciences USA* 107 (21) E88-E89.

12. Huntington, T.G. 2005. **Assessment of calcium status in Maine forests: review and future projection**. *Canadian Journal of Forest Research* 35: 1109–1121

13: **Restoring the Health of Nova Scotia's Forests. A panel of expertise report on forests to the steering panel** by Bob Bancroft and D, Crossland , February 2010. http://www.gov.ns.ca/natr/strategy2010/pdf/phase2-reports/Forests-Health.pdf

Forest biomass will not reduce carbon dioxide emissions

Comments on the final Energy Consultation Document

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The final Energy Consultation Document (the "Wheeler Report") recommends use of forest biomass as a component of Nova Scotia's renewable energy strategy, subject to harvesting standards. Unfortunately the report does not examine the issue of the carbon emissions associated with forest biomass.

Energy generation from forest biomass is commonly assumed to be "carbon neutral" and therefore, it is argued or assumed, substituting forest biomass for fossil fuels reduces carbon dioxide emissions. However, that is true only if there is some carbon capture involved or forests are fertilized to increase productivity. These are not components of forest biomass harvesting envisaged for N.S., at least not in the short term (2015).

I submitted a referenced document to the Renewable Energy Consultation addressing this issue on Dec. 15th and had some discussion with Dr. Wheeler about it. He commented that "we will be making clear the need for life cycle assessments of the carbon costs and benefits of biomass". However, the only reference to Life Cycle Assessments is on page 42:

> It is also recommended that renewable energy standards be reviewed based on scientific assessments of carbon life cycle considerations and in due course be amended to recognize that co-firing of biomass in NSP coal fired plants could make a significant contribution to renewable energy and climate change mitigation targets.

That statement in fact repeats the erroneous assumptions I refer to above, at least to the extent it refers to forest biomass.

I think that one reason my comments were not taken seriously, perhaps understandably, is that forest biomass has been treated as carbon neutral under the Kyoto Protocol. Indeed, that puzzled me, as the scientific papers cited in my submission were unequivocal in this regard. After submitting my comments to the Renewable Energy Consultation, I discovered that a key paper addressing this issue had recently been published in the Policy Forum of the prestigious journal Science*. This multi-authored paper points out that there is a critical accounting error in the Kyoto Protocol that allows biomass energy to be treated as carbon neutral, regardless of the source. The error is very large for forest biomass. There is no doubt that this error will now be corrected and that the carbon balance for forest biomass will be examined much more critically in future.

***Fixing a Critical Climate Accounting Error**", by T. D. Searchinger et al., Science, Vol. 326. no. 5952, pp. 527- 528 (23 October 2009).

I urge the Government of Nova Scotia to give serious attention to this issue in relation to possible forest biomass initiatives. The carbon emissions issue, combined with biodiversity, environmental and sustainability concerns associated with clearcutting in N.S., could garner forest biomass a reputation as “dirty energy”. On the other hand, we could reduce our carbon footprint by cutting back on clearcutting to allow increased sequestartion of carbon by forests. Further, there are biomass schemes cited in the Wheeler Report that would be carbon neutral or even result in some net sequestration of carbon, e.g., use of grass or fast growing trees grown on otherwise unused agricultural lands, and such schemes should be pursued.

I have appended two documents that elaborate further on this topic.

- **Clearcutting N.S. Forests for Biomass: Implications for Carbon Sequestration and Sustainability.** (My submission to REC at Dalhousie University)

- **The Biomass Issue: We should pay woodlot owners to store carbon, not to burn it!** (A perspective published in a recent WRWEO newsletter.)

Thank you for receiving these comments.

David G. Patriquin

Clearcutting N.S. Forests for Biomass: Implications for Carbon Sequestration and Sustainability

Comments submitted to the Nova Scotia Renewable Energy Stakeholder Consultation Process in response to the Interim Report To Stakeholders (December 15th 2009)

David Patriquin
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Dec 15, 2009.

From the Report to Stakeholders (Dec. 15, 2009):

> There is an emerging consensus between the various parties (DNR, forest managers, academics and industry) that there is sufficient forest biomass to support up to 150 MW of electricity generation. But more discussion regarding forestry management standards and the assurance of ecological integrity of Nova Scotia's forests is required.

I suggest that in addition, we need to give careful consideration to the implications of various regimes for net carbon sequestration. Because of the history of forestry in Nova Scotia, our forests are relatively young, averaging perhaps 40 years[1]. Left undisturbed after clearcutting, forests in the northeastern North America continue to accumulate carbon and sequester atmospheric carbon dioxide for well over 100 years[2]. If we clearcut our forests for biomass, whether by whole-tree or stem-only harvest, the implications for net carbon sequestration must be taken into account – at least if we want to reduce CO_2 emissions, as well as substitute for petroleum based energy generation.

Whether or not harvesting biomass for energy is carbon neutral depends very much on site and process specific factors.[3] I suspect that detailed carbon accounting would show that clearcutting forest for biomass would be far from carbon neutral for the typical Nova Scotian scenario; it would in fact reduce net carbon sequestration substantially. The contention that biomass is carbon neutral is based on the assumption that the carbon dioxide released when biomass is burned (or respired) is taken up stoichiometrically when the biomass crop re-grows. For biomass crops such as switchgrass or sugarcane, the CO_2 released on burning can be recaptured within one growing season; if it is grown on degraded land with fertilization, there can even be net carbon sequestration. Harvesting standing forests for biomass is, however, a quite different matter. If we clearcut a 40 year old forest now for biomass energy, all of the harvested biomass carbon is going into the atmosphere now; then it will take a full 40 years to take up an amount of carbon dioxide equivalent to that released, assuming that the forest recovers to its previous state. So, in the short term, e.g., over the ensuing decade at least, burning of the forest biomass will result in net carbon emissions.

Further, in order to realize carbon neutrality over 40 years, we have add to the carbon that needs to be recaptured: (i) losses of soil carbon associated with clearcutting (ii) carbon costs of harvesting and processing the biomass, (iii) the additional carbon that would have been taken up had the forest not been cut. To the extent that these amounts (including the initial biomass carbon) are not recaptured, there will be net emissions of carbon dioxide to the atmosphere.[4]

It is for this reason that biomass energy schemes of this sort are generally considered to cause net emissions of CO_2 unless there is (i) significant carbon capture and storage

associated with the combustion of the biomass and/or (ii) conversion of a significant portion of the harvested biomass into a slowly degrading form (carbonization, biochar) and/or (iii) biomass production sites are fertilized to substantially increase productivity over background levels.[5]

In the short term (2015), forest biomass projects in N.S. are not likely to involve any of these three conditions. Further, in considering forest biomass as a substitute for fossil fuels, the lower efficiency of biomass compared to fossil fuels in generating electricity must be taken account. Given the potential of N.S. forests to sequester carbon if they are NOT harvested, a full carbon accounting would likely indicate that we could reduce carbon emissions much more by substantially reducing clearcutting in Nova Scotia than we could by substituting clearcut forest biomass for fossil fuels in power generation.

At the very least, we need to do this sort of carbon accounting before embarking on an ambitious forest biomass cutting to meet 2015 substitution goals.

Recent studies/modeling by forest and ecology scientists in relation to using forest biomass in the well-studied Massachusetts forests provide an example. Thompson et al.[6] modeled the implications of potential future demand for biomass electricity of around 165 MW, which would require up to 2 million Mg of woody biomass annually from Massachusetts forests:

> Changes in species composition were small, but present, under the biomass energy scenarios, with white pine and red oak increasing relative to the baseline scenario, and black birch, beech, and hemlock decreasing. Living aboveground biomass increased by 2.0%, from 225 to 229 Mg/ha under the baseline scenario, while decreasing to 207 Mg/ha (-7.9%) and 201 Mg/ha (-10.7%) in the two biomass scenarios. The difference in standing biomass translates to a net carbon sequestration of 1.9Tg over 50 years under current trends, compared to a 7.3 and 9.9Tg of net emissions in the biomass energy scenarios. In spite of this, the amount of biomass feedstock harvested in the biomass future scenarios was only enough to generate 90 and 100 MW of power, well short of potential future demand. These results indicate that demand for biomass energy is likely to greatly increase the importance of harvesting as a disturbance on the forest landscape. Furthermore, pursuing a renewable energy policy that relies heavily on biomass power is likely to come at the cost of a diminished forest carbon sink.

The Massachusetts forests occur on better soils than in Nova Scotia and have been subject to much less clearcutting. We could expect equivalent or larger effects on carbon sequestration in N.S. forests.

Sustainability

As emphasized by Goldmsith in 1980[1], an important factor to be considered in relation to repeated clearcutting, whatever the use, is loss of nutrient capital in the harvested forest biomass and through enhanced erosion and leaching: at some time in the future, that will result in lower forest productivity and reduced uptake of carbon dioxide. Susceptibility of N.S. forests to this type of degradation is especially high in SW Nova Scotia because of acid rain and the poor buffering capacity of soils on granitic bedrock.[7] Loss of calcium is a key concern for both forests[8] and the downstream riparian and aquatic systems.[9] Other regions of N.S. might be able to withstand repeated clearcuts for a longer period, but that is only a matter of degree and, as illustrated by the Massachusetts study, clearcutting for biomass even on better sites is likely to increase carbon emissions, not reduce them.

Conclusion

There is a role for forest biomass in energy production in N.S., e.g., using processing wastes, selective cutting for firewood, growing fast growing trees coupled with use of biosolids as fertilizers, especially when combined with energy efficient conversion technologies and/or carbon capture/biochar production. However, clearcutting forests for biomass energy is a questionable strategy. Indeed, given the generally degraded state of Nova Scotia's forests and evidence that our forests go on accumulating carbon for well over 100 years after a clearcut, a case could likely be made for gaining carbon credits by substantially reducing the current annual cut in Nova Scotia, even with ongoing use of fossil fuel to generate energy (where we might otherwise substitute clearcut forest biomass).

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WRWEO WATCH (Vol. 7, No. 1)
January 2010
Newsletter for the Woodens River Watershed Environmental Organization (WRWEO)

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PERSPECTIVES

We invite WRWEO members to share their perspectives on issues that relate to the Woodens River Watershed, The Bluff Wilderness Hiking Trail and the Five Bridge Lakes Wilderness Area. Below, WRWEO Co-chair David Patriquin expresses the position of the WRWEO Board on the forest biomass issue that has been much in the news recently.

The Biomass Issue: We should pay woodlot owners to store carbon, not to burn it!

Clearcutting and watershed integrity can be uncomfortable partners. There has been at least one bad experience associated with clearcutting on the Woodens Watershed: in 2004, a flash storm after a poorly executed clearcut washed silt into Brines Little Lake and from there into the Woodens River, turning it chocolate brown for five days. New pressures to clearcut for a minimum of financial return (and hence minimum incentive to do it with care) could develop if the province allows large scale clearcutting for biomass energy. In December, 2009, WRWEO Co-chair Richmond Campbell and I wrote a letter to Premier Dexter on behalf of the WRWEO Board, cc'd to WRWEO members, expressing concerns about the environmental impacts, sustainability and CO_2 (carbon dioxide) emissions that would be associated with large scale forest biomass projects. The topic was much in the press during the fall, concurrent with the Renewable Energy Consultation process at Dalhousie University. (See: http://eco-efficiency.management.dal.ca/Events/Special_Events/.) The Renewable Energy Strategy coming out of that process recommends that large-scale forest biomass energy could provide up to 70 megawatts by 2015 and a further 70 MW by 2020. The authors suggest that it could be done in an ecologically compatible fashion by setting appropriate regulations, e.g., that management be certified.

Area by Brines Little Lake that was clearcut in 2004. (Photo in spring of 2009)

Much of the discussion about sustainability of forest biomass has focused on whole tree versus stem-only harvesting. A clear-cut near Caribou Mines provides a particularly

upsetting example of what can result from a whole tree clearcut, apparently SFI (Sustainable Forestry Initiative) certified. (See photos and story at http://halifax.mediacoop.ca/story/2241). Regardless of whether a clearcut for biomass involves stem-only or whole tree harvesting and regardless of the provisions to ensure it is conducted according to the highest possible standards, however, there is an important reason that it shouldn't be part of our green energy strategy: it would entail CO_2 emissions at least equivalent to those associated with coal.

The common assumption has been that forest biomass is "carbon neutral", i.e. that because the forest regrows, it takes up the carbon dioxide that was released when the biomass was burned. True, but if a 40 year old forest is burned, it takes 40 years to take it up again and there are additional CO_2 emissions associated with enhanced breakdown of soil organic matter following a clearcut, loss of forest productivity, energy used in processing, and the lower efficiency of biomass to generate electricity compared to petroleum products. Further, if the forest were not cut, it would go on sequestering carbon dioxide (taking it out of the atmosphere). So a clearcut for biomass takes a site that helps to reduce carbon dioxide in the atmosphere and turns it into a source of more carbon dioxide! (Cutting for timber is a different matter because much of the carbon continues to be stored in wood products. It should be noted as well that there are biomass schemes that are carbon neutral or even help to sequester CO_2 - generally these involve fast growing trees or perennial crops grown on fertilized land. Also, use of thinnings or selectively harvested trees for firewood are probably carbon neutral practices.)

We may wonder why this issue has not been raised within the context of the Kyoto Protocol. A recent paper in the prestigious journal Science* has pointed out that there is a critical accounting error in the Kyoto Protocol that allows biomass energy to be treated as carbon neutral, regardless of the source. The error is very large for forest biomass and, the authors say, is leading to inappropriate pressures on the world's forests, most of which will go on accumulating CO_2 if not harvested. Let's hope Nova Scotia's energy wizards take notice and that our green energy strategy will NOT include large scale clearcuts for biomass energy!

In fact, sparing forests from clearcutting and allowing them to accumulate more carbon, as well as aforestation (establishing forests on non-forest land), are considered critical to global efforts to reduce CO_2 emissions. Really, we should be looking at schemes such as carbon offsets that pay woodlot owners for storing carbon, not for burning it (by selling to biomass energy producers). That does not have to exclude harvesting: for example, selective harvesting of a forest managed to promote natural age structure and species diversity would be a win-win for all, including the wildlife.

* "Fixing a Critical Climate Accounting Error", by T. D. Searchinger et al., *Science,* Vol. 326. no. 5952, pp. 527 - 528 (23 October 2009).