Increasing pressures to use forest biomass: A conservation viewpoint[1]

by Trevor P. Hesselink[2]

ABSTRACT

Various policy, economic, and social drivers are pushing us towards utilizing our forests for a changing mix of products that include returning to them for biomass as a fuel source. While this is a use with some limited merit, it must be considered prudently and with the ecological limits of our forests clearly identified and understood before substantially investing our public resources towards this purpose. There is enough scientific evidence to suggest that caution and restraint is needed so that we can identify key ecological impacts and define sites on which increased fibre harvesting is not appropriate before biomass policies are put in place. Information is needed on monitoring methods, and effects on site productivity, biodiversity, and carbon cycling; full economic analyses and life-cycle carbon accounting is needed. Perverse incentives need to be avoided. A precautionary path is therefore required that makes ecosystem sustainability a priority, that builds confidence in application of current practices, that includes environmental assessment and pilot programs, and that operates under a clear regulatory regime that integrates bioenergy removals within clear forest management plans. The pervasive impacts of climate change are converging with an economic opportunity to set the groundwork for our next forest economy, and biomass utilization policy 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.

Key words: biomass, sustainability, policy, conservation, full-tree harvesting, environmental impacts, intensity, carbon, utilization pressures

RÉSUMÉ

Plusieurs forces politiques, économiques et sociales nous poussent à utiliser nos forêts pour en tirer des produits différents ce qui comprend aussi un retour vers la biomasse en tant que source de carburant. Même s'il s'agit d'une utilisation ayant quelques mérites, elle se doit d'être considérée prudemment et dans les limites écologiques clairement identifiées de nos forêts et comprises avant d'investir substantiellement nos ressources publiques dans cette direction. Il existe suffisamment de preuves scientifiques laissant entendre que des précautions et de la retenue doivent être exercées pour nous permettre d'identifier les impacts écologiques et définir les sites sur lesquels l'exploitation plus poussée de la matière ligneuse n'est pas appropriée avant que les politiques portant sur la biomasse ne soient mises en place. Il nous faut plus d'information sur les méthodes de suivi et les effets sur la productivité, la biodiversité et la production de carbone; il nous faut plus d'analyses économiques complètes et d'exercices de comptabilité du cycle du carbone. Il nous faut éviter d'utiliser de mauvaises mesures d'incitation. Une direction bien établie est donc requise pour faire de la durabilité de l'écosystème une priorité et elle doit s'établir sur l'application des pratiques actuelles et comporter une évaluation environnementale et des programmes d'essai et opérer selon des règlements bien définis qui intègrent l'extraction de la biomasse selon des plans d'aménagement forestiers précis. Les effets négatifs des changements climatiques s'associent à une opportunité économique pour établir les fondations de notre prochaine économie forestière et les politiques d'utilisation de la biomasse joueront un rôle déterminant dans notre choix d'aménagement des ressources forestières dans ce contexte unique. Aller de l'avant avec la maximisation de l'utilisation en tant que priorité de l'aménagement, c'est ignorer un fait tangible que les gestionnaires doivent considérer : nos ressources forestières ont des limites d'exploitation telles qu'advenant leur dépassement, elles ne sont pas en mesure de récupérer facilement. Selon les preuves disponibles, il est temps pour les législateurs de suivre avec précaution la voie de l'allocation de nos biofibres forestières et de s'assurer que nous tirons soigneusement profit des intérêts tirés de nos écosystèmes forestiers sans dilapider le capital.

Mots clés : biomasse, durabilité politiques, conservation, exploitation d'arbres entiers, impacts environnementaux, intensité, carbone, pressions d'utilisation

[1]This paper is based on an invited presentation made at a workshop on *The Scientific Foundation for Sustainable Forest Biomass Harvesting Guidelines and Policies*, Toronto, Ontario, 18–21 Feb. 2008.

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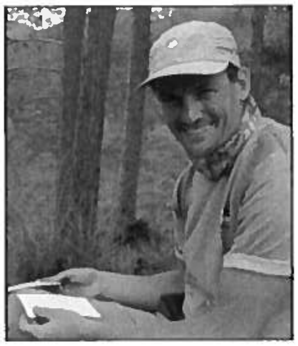

Trevor P. Hesselink

Introduction

Humans have used wood for bioenergy, in the form of fuelwood and charcoal, from time immemorial. Even today, fuelwood is the world's largest single forest product: about 40% of the 3 billion m^3 of wood removed from forests around the world for all uses in 2005 was burned as fuelwood, and an additional 7 million m^3 of fuelwood came from other wooded land (FAO 2006). History reminds us that population pressure and ensuing increased fuelwood extraction can cause localized shortages that lead to over-harvesting, deforestation and other detrimental environmental impacts, which in turn can induce undesirable social and economic problems. Examples of civilization-limiting deforestation caused by biofuels extraction for industrial purposes (e.g., metal smelting) and domestic heating are evident from classical times onwards (e.g., Redman 1999, Williams 2001, Jacobs 2004, Diamond 2005). With the current "green gold rush" for bioenergy in the West, it seems reasonable to be aware of the danger of history repeating itself at the cost of environmental integrity, ecological services, social values, and even alternate economic values.

Most of Canada's forests are publicly owned. Their management for new products, such as biofuels, therefore deserves a transparent public debate of the issues involved. This debate requires a wide spectrum of viewpoints. There are those who can only see forest biomass left after logging as "waste" that humans can or should pick up and remove, as if forests need to be protected from their own ecological processes. For example, the minister of the BC Ministry of Forests and Range, Pat Bell, recently referred to "logging waste" when looking at opportunities for bioenergy, with only economics in mind: "Once the tree hits the ground we should be utilizing every single piece of the tree we can use within the economics of it"[3] (Hamilton 2008). His ministry also devotes a web page[4] to publications on how to assess "logging waste". In the US, removal of "waste" is also seen as a way of reducing fire risk (see comments attributed to Dr. Marcia Patton-Mallory, Biomass and Bioenergy Coordinator, USDA Forest Service, in Koshel and McAllister [2008])[5]. Does being "waste" from commercial processes such as harvesting equate to being "waste" from ecological functions? Not calling it "logging waste" could remove a value-laden term from discussions of forest biomass.

Another viewpoint is to see forests as having evolved over millennia into ecosystems that are usually resistant and resilient to natural disturbances, but which are not necessarily robust in the face of extreme anthropogenic disturbances such as the liberal application of full-tree logging systems, or other increases of harvest intensity to feed bioenergy projects. The objective of this paper is to present a cautionary overview of the potential effects of increased biomass removals on the future of Canada's forests. It is intended to resonate with those engaged in forest science and forest management policy development in Canada and those who have responsibility for safeguarding the public forest resource in the long term.

First, current practices and their effects on site productivity, biodiversity, carbon, and economics will be discussed. While there may be sites and ecosystems in which intensive biomass harvesting will not cause negative short-term impacts, the aim of this section is to point out some unacceptable examples of biomass harvesting that cause concern amongst many in the environmental community and the public, and that should cause the bioenergy and forestry sectors to take a precautionary path (i.e., an abundance of advance caution) in its approaches to harvesting forest-derived feedstock for bioenergy, particularly over the long term. Secondly, Ontario will be used as a case study to highlight practical concerns, using a real-life example. Finally, a precautionary path will be described, highlighting eight universal preconditions for a high likelihood of delivering acceptable bioenergy policies and practices in this time of increasing pressure on our forests.

Current Logging Intensity

Full-tree harvesting (FTH)

Clearcutting with full-tree harvesting (FTH, also sometimes referred to as whole-tree harvesting, or WTH) in which all above-ground material is hauled to roadside or landing for processing (see Pulkki 2008a, b) is the dominant (~90%) approach to logging in Ontario (CCFM 2005), particularly in the boreal forest. This approach also predominates in the interior of BC, across Alberta and the other Prairie Provinces, is used in about 50% of harvesting in Quebec (Campagna 2007), but is less common in some of the Maritime Provinces. The primary driver for current full-tree harvesting instead of "conventional" (CH) or stem-only harvesting is patently economics (Pulkki 2008a, b) and not silviculture. Since its introduction, there have been many scientific concerns about the potential for long-term forest productivity declines associated with its use (e.g., Kimmins 1977; see also symposium on *Impact of Intensive Harvesting on Forest Nutrient Cycling* held in Syracuse, NY, August 13–16, 1979). Some of the commonly cited dangers of using this harvesting method include impacts on nutrients, micro-organisms and biodiversity. The main issue, however, is not so much removing biomass *per se* (as even removing logs as roundwood depletes nutrients and

[3]Pat Bell, BC Minister of Forests and Range, quoted on 17 Sept. 2008 by G. Hamilton in Vancouver Sun.

[4]http://www.for.gov.bc.ca/hva/waste/; accessed on 20 Nov. 2008.

[5]See notes of discussion in Koshel and McAllister (2008): "... Marcia Patton-Mallory (USFS) described a feedstock that is both a forest residue and a waste—the wood that builds up on the forest floor because natural forest fires are often suppressed. This wood buildup raises the likelihood and severity of future forest fires. If it can be collected and used as fuel, it is basically a win-win situation. Since finding ways to **dispose of waste** is also a sustainability challenge, turning waste into an energy source is an attractive option." and "Marcia-Patton [sic] Mallory (USFS) talked about the potential role of forest resources as a source of bioenergy. She noted that almost 50 percent of US renewable energy supplies are from biomass, mostly used for heat and power. Many of these forest resources are **wastes and need to be cleared** as part of a sustainable forest management strategy reducing the potential for forest fires and creating healthier forests."

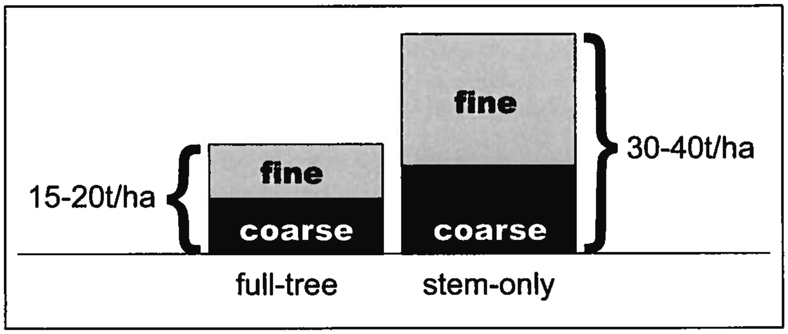

Fig. 1. Relative volumes of material left on site by full-tree (left) and stem-only (right) systems in Ontario. Note that the amount of slash left on site in the full-tree system (FTH), on average, represents only 25% of the pre-harvest total above-ground biomass (D. Morris., personal communication[6]).

affects ecological function to some degree) as defining the threshold of application of practices such as FTH—in other words, defining sites where intensive removals are likely to have a negative impact on sites in the long term and where practices such as FTH that remove high levels of biomass should not be applied. In New Brunswick, for example, these include wetlands, shallows soils with depths of less than 30 cm, rocky and stony areas, and dry and poor soils, which are all defined as "high risk areas" for intensive removals (NBDNR 2008).

Despite targeting the full above-ground biomass of the tree, the process leaves a significant portion of material on-site. In northern Ontario, approximately 25% of harvesting residue is left as standing residuals and on the ground as slash after processing and skidding (Fig. 1; D. Morris personal communication[6]), and 16% (Gibb *et al.* 2005) to 30% (Ericksson 1993 *in* Egnell and Valinger 2003) of the slash is left behind during operational harvesting in Norway spruce stands in Sweden. Even assuming that the current scope of application is appropriate, if roadside slash is considered a source of bioenergy feedstock (particularly if incentives are also provided), then it would be imprudent to assume that slash piles would not grow proportional to demand at the expense of on-site slash. If this on-site material becomes attractive enough that it is also removed, then the threshold of application of the entire system may well change because more sites will be negatively affected, with a reasonable expectation that increasingly productive sites could also become unacceptable for use of this approach—assuming that it is actually monitored and problems recognized. This more intensive removal ought then to be balanced by excluding FTH from more and higher productivity sites to retain ecological integrity but these additional intensity threats appear to be overshadowed by the perceived economic opportunity.

An important question, therefore, needs to be posed regarding application of more intensive slash removals. Given that FTH is currently not recommended on poor sites, based on a popular hypothesis that FTH has a more negative effect on future productivity on low fertility sites (e.g., Weetman and Algar 1983, Lundmark 1983, Hornbeck *et al.* 1990 cited in Jacobson *et al.* 2000), would the removal of additional material (i.e., beyond the ~75% of above-ground biomass that is currently removed) also reduce the system's acceptability on medium-quality sites? This needs to be considered, as it is unrealistic to assume that there will be no pressures to increase the amount of material hauled to roadside once it has economic value as feedstock for bioenergy production.

Productivity after current practices

The science findings are variable with respect to effects of logging and intensive biomass removals on productivity but many concerns are cited, including effects on nutrient levels, availability of cations, acidity, growth and yield, and impacts on critical microbiota, among many others. Although some sites show no impacts yet, a long list of researchers have flagged that loss of forest productivity as a result of increased intensity beyond conventional stemwood harvesting (CH) can occur on other sites, which should register as a significant warning flag when contemplating a regime of additional removals, particularly where FTH is already being practised.

For example, it is clear is that there are growth reductions following FTH or whole-tree harvesting (WTH) on some sites in many parts of the world. Morris and Miller (1994) cite reductions in Sweden (Lundkvist 1988) and in the states of Minnesota (Williams *et al.* 1989) and Washington (Bigger and Cole 1983, Cole 1988); reductions can be found on some sites in the southeastern U.S. (Scott and Dean 2006); Mahendrappa *et al.* (2006) cite reductions in Sweden (Andersson 1991), the UK (Dutch 1994, Proe *et al.* 1996) and New Zealand ([6] Skinner MF, Murphy G, Robertson ED, Firth JG. Deleterious effects of soil disturbance on soil properties and the subsequent early growth of second-rotation radiata pine. In: Dyck WJ, Mees CA, editors. Research strategies for long-term site productivity. Proceedings of IEA/BE A3 workshop, Bulletin No. 152, Seattle New Zealand Forestry Research Institute, 1988. p. 201–12. Skinner *et al.* 1988) and suggest that these works show that "in forested lands where whole-tree harvesting is practised, timber yield during the rotation period following harvest may decline by as much as 20%." It seems to be widely held in the Canadian forestry sector that it is possible to harvest biomass for energy without compromising soil quality and stand productivity because it is done in Nordic countries, but summary statements on Nordic results for tree growth (Lundkvist 1988, Andersson 1991) and more recent summary results from Egnell *et al.* (2006) discussed at the 2008 Toronto workshop by Olsson[7] indicate that spruce growth is generally reduced after whole-tree harvesting—are we prepared to apply the same ameliorative treatments and other actions to correct this loss, and are these treatments adequate to meet more than just growth loss concerns? These

[6]Dr. Dave Morris, Stand Ecology Program Leader, OMNR, Centre for Northern Forest Ecosystem Research, 955 Oliver Road, Thunder Bay, Ontario P7B 5E1.

[7]See presentation by Bengt Olsson (Swedish University of Agricultural Science, Uppsala, Sweden) on *Site productivity lessons from the Nordic countries* given at *The scientific foundation for sustainable forest biomass harvesting guidelines and policy*, Toronto, Ontario, Feb. 18–21, 2008. Available at http://www.sfmnetwork.ca/docs/e/Biomass10Olsson_Nordic siteproductivityreview.pdf

examples from around the world surely challenge the assumption that current and future FTH can be used on all sites in Canada.

Although there is no known published tree growth data following various intensities of harvest in Canada yet, modeling (e.g., Bhatti *et al.* 1998, Morris *et al.* 1997) and other research (e.g., Thiffault *et al.* 2006, Duchesne and Houle 2008) suggest that impacts are indeed likely on some sites. Science-based policies are therefore required to define thresholds and sites on which FTH is acceptable and those on which it is not, as concluded by Burger (2002) in his recent review of the effects of biomass removals on soil and long-term site productivity: "Site-specific management is essential for the maintenance of soil productivity".

Do we actually understand enough about the impacts of FTH on sites in Canada to be able to confidently continue to remove these levels of biomass, let alone increase them further—if this is the direction that our energy policies take us? It is perhaps telling that FTH is generally differentiated from what is commonly referred to as "conventional harvesting" (CH), codifying in industrial terms that FTH already pushes the limits of convention.

Feedback from the extensive use of current intensive practices across Canada—including widespread application of FTH is still not clear, due in large part to poor silvicultural monitoring, but also due to the significant delays of the impacts likely to be experienced (e.g., Morris *et al.* 1997). Does subsequent growth following current practices approach the same composition and productivity as the natural forest condition? Will it continue to after multiple rotations? How rigorous are our definitions of "success"? Are we collecting the right information to assess long-term sustainability? How, in fact, do we define sustainability? These are all questions that deserve careful consideration before additional fibre removal pressures are contemplated or encouraged.

Modeling and monitoring concerns

Predicting and monitoring impacts is therefore a theme of critical concern with broad application required at several levels with respect to forest biomass policy development. Unfortunately, silvicultural effectiveness is not generally well monitored, and is inordinately obsessed with a one-rotation rather than an ongoing-rotation horizon. When silvicultural effectiveness monitoring is less than ideal, it is difficult to have high confidence in the effectiveness of forestry practices. With weak criteria for what constitutes success, and when the state of total and available site nutrients is ignored as a criterion, claims of "sustainability" of the system cannot be assured. That there is a potentially substantial delay before nutrient issues become apparent should be well-understood by forest managers. While farmers with seasonal crops have much tighter feedback loops, no land manager can ignore the needs of successive crops, and management of these crops relies upon sound information about the land that sustains them.

Available modeling efforts are useful for examining this problem in more detail. For example, Morris *et al.* (1997) modeled six successive short rotations of intensive FTH and found that significant negative impacts are not likely to occur until after the second rotation, once the nutrient reserves are extracted from the forest soils, at which point their modeling identified a 59% drop in productivity. Similarly, Bhatti *et al.* (1998) found that with FTH, most of their 17 Canadian jack pine sites were simulated to have sustainable annual increment (SAI) values substantially below their field-estimated mean annual increment values. In these cases, reduced availability of both N and base cations would have limited growth because the estimated nutrient replenishment rates would not be able to compensate for the nutrient export from FTH.

To increase biomass removals further, without respect for available cautionary signs, elevates a known risk and pushes the potential impacts onto future generations. This highlights the need for employing a significant amount of precaution to this endeavour, proceeding in an experimental manner, and with a sound monitoring plan to address how potential impacts of biomass harvesting will be monitored effectively over time. Without a monitoring plan, and adequate capacity to oversee this new suite of pressures, it would clearly be unwise to promote additional harvesting of more biomass, given the potential risks involved. A plan must be established that includes adequate on-going experimental monitoring of net forest floor contributions for various harvest intensities both with and without additional biomass pressures before such activities are normalized.

Biodiversity

Forest floor biodiversity

The biodiversity of the forest floor is poorly understood, but widely acknowledged as a potentially critical limiting factor for overall ecosystem function and nutrient balance. For example, it is understood that the long-term activity of decomposer populations depends on a consistent supply of fresh C (Fontaine and Barot 2005) and that the soil C pool is determined by the balance between C input by litterfall and rhizodeposition on the one hand and the release of C during decomposition on the other (Jandl *et al.* 2007). Researchers have cited concerns that intense logging such as FTH systems might result in long-term decreases in the abundance of many soil animal groups, upsetting these evolved balances (e.g., Bengtsson *et al.* 1997).

The effects of additional biomass use on biodiversity and hence ecosystem function must be a key focus of policy development. This line of inquiry should include questions such as: how will additional biomass removal affect forest floor biodiversity and, by extension, what productivity losses are likely to be associated with any loss of this biotic function?

Standing residual biomass

Current guidelines in some provinces (e.g., Ontario) require "emulation of natural disturbance" at harvesting by leaving a prescribed amount of standing residual trees and snags for habitat structure. Beyond broader concerns regarding whether or not this structure is adequate, it is important to honestly evaluate the extent to which additional biomass removal pressures might impact the quality and quantity of this residual structure, as well as the effects of further slash removal from the forest floor on the habitat and biodiversity assumptions being employed in such guidance.

Carbon

Logging impacts the carbon cycle

Logging removes biomass, disturbs the forest floor and soil, and changes the stand microclimate. After logging and replanting, soil C losses may exceed C gains in aboveground biomass (Jandl *et al.* 2007). The long-term balance depends on the extent of soil disturbance.

Morrison *et al.* (1993) showed that, for the boreal forest in Ontario, CH would result in about 20% to 33% C loss from sites, with more intensive harvesting regimes (such as FTH) removing up to 35% to 44% of the carbon. Jiang *et al.* (2002) suggested that, for the boreal forest in China, FTH with a 100-year rotation would result in an 81% reduction in biomass and 49% reduction in litter relative to a no-harvest reference. With respect to soil C in a central Canadian boreal context, Peng *et al.* (2002) report an additional 32% loss of soil C when FTH is employed versus stem-only harvesting. With net C differentials of these magnitudes, the use of carbon-inefficient logging choices must be carefully evaluated in an increasingly carbon-conscious world.

Sound carbon accounting

Forest-derived bioenergy is often assumed to be a "carbon-neutral" energy source. However, it needs to be remembered that this concept is premised on the successful recapture of the same amount of carbon in the renewing forest, raising at least two critical points: the assumption of silvicultural success that is often omitted, and the fact that renewal to the same storage level in the forest can take a very long time to occur. The use of fossil fuels in its harvesting, transportation and processing impose a carbon cost on these activities that also needs to be considered, particularly when haul distances are long, forest productivity is low, and when energy-intensive products are produced. Add to this the opportunity costs—such as the carbon storage lost to renewal delays and the reduction in carbon residence time in various forest floor and soil pools because of harvesting impacts (as compared to intact stands), any permanent lost capacity of the forest to process and store carbon, and the carbon profile of energy sources that bioenergy is replacing (e.g., natural gas versus coal), to name just a few critical variables—and claims of "carbon neutrality" for forest bioenergy are rendered highly suspect. It is necessary for all variables to be taken into account when determining cost-benefit ratios for carbon in biomass-derived energy and other biomass project assessments (e.g., White *et al.* 2005). Eriksson *et al.* (2007) specifically flag the need for this: "The complex flows between standing and harvested carbon stocks, and the linkage between harvested biomass and fossil fuel substitution, call for a holistic, system-wide analysis in a life-cycle perspective to evaluate the impacts of forest management and forest product use on carbon balances." It is also important for this to include the rotation length needed to take up the atmospheric CO_2 released by burning the previous stand for energy.

Economics

Efficiency is a critical ingredient

Sustainability aside, for a forest biomass project to be able to make up for these built-in carbon debts, its displacement factor will have to be exceedingly high, as substitution strategies are reliant upon high efficiency displacement (e.g., Marland and Schlamadinger 1997). Unfortunately, the low productivity and long haul distances in landscapes such as Canada's boreal forests are substantial challenges to a viable carbon balance in energy-from-biomass projects. Application matters as well. The best applications are generally small or medium in scale, located close to sustainably derived feedstock (particularly industrial by-product waste streams) and are used for the most efficient applications, such as process or district heating. Conversely, large, centralized projects that require long hauling distances and produce electricity are generally less efficient applications. It is important to appreciate these realities before instituting policies of public incentives and subsidies; otherwise, an unviable sector may emerge as an ongoing public burden but without providing the desired social or environmental benefits.

Product value

It is important to recognize the (arguably marginal) appropriate place of most currently contemplated bioenergy products in the value chain. Its best opportunities are likely in integrated product chains, rather than stand-alone operations. Where biomass projects such as energy generation are proposed, for example, any negative impacts on fibre supply to higher-value products that provide more benefits to the jurisdiction and/or shift carbon-containing fibre into longer-lasting products would be preferable scenarios. Understanding the implications and monitoring simple metrics (such as value, jobs, and carbon-years per unit of harvested volume) are going to be critical to building our next forest economy.

Avoidance of perverse incentives

When developing forest bioenergy policies, we need to be extremely wary about scenarios in which we create unwarranted competitive advantages for bioenergy projects over higher-value products, products with a better carbon fate, or products from better-integrated product chains, for example. Incentives such as zero-costing of the resource, or providing artificial haul subsidies (especially where haul distances are long) to make it economical are likely detrimental to rebuilding a sound forest economy, and can also unduly impact the long-term ecological health of our forests, including its carbon balance. If it is necessary to provide baseline subsidies to bioenergy projects, is this a promising sign for an effective new forestry paradigm? Are they likely to represent a long-term public burden instead?

Case study: Policy development in Ontario

With the province of Ontario recently issuing a new "biofibre" policy direction, it is timely to consider the potential conservation challenges associated with its development. While this commentary focuses on an Ontario perspective, many of the concerns illustrated are transferable to other jurisdictions. Six themes of concern regarding conservation—from policy to economics—have been explored. The conclusion is clear — we must be cautious in the development of forest biomass policy for our public forests.

Biofibre policy

To date, the only apparent adjustment to the status quo in considering biomass utilization in Ontario has been the development of a "biofibre policy". One draft of this proposed policy was posted for public comment. With an overt focus on stimulating economic development, the draft was critiqued by the conservation community for a lack of content that would suggest that ecological sustainability issues are being reasonably considered. Other jurisdictions have more appropriately anticipated these issues and taken steps to examine them more comprehensively. For example, increased incentives to remove slash through the recent Biofibre Policy for Ontario (OMNR 2008) will arguably result in both additional reliance on the FTH system, and additional pressure to leave even less slash behind on sites than is left at the moment (~25%). Based on current science, both of these effects carry reasonable potential for significant additional impacts to long-term forest health, yet the public policy tools remain silent on their assessment. Although plenty of room existed for subsequent revisions of this Ontario policy, the final policy was posted in August 2008 (OMNR 2008) essentially unchanged from its original draft form of July 2007 (OMNR 2007), despite submission of significant stakeholder concerns. Further changes to the Forest Management Planning Manual are currently underway to codify biomass removal into practice. Hopefully, these efforts will more adequately reflect the precautionary path needed to oversee this new emphasis.

The "undertaking"

The current "undertaking" for logging in Crown forests in Ontario, including the environmental assessment, legislation, and policy regime, was not established with significant bioenergy utilization in mind. This means that the original environmental assessment was granted without consideration of the additional pressures and potential environmental impacts of bioenergy harvesting. As the entire policy framework from the Crown Forest Sustainability Act (CFSA) through to the various guidelines and silvicultural prescriptions stems from this original environmental assessment, it follows that additional bioenergy harvesting was also not contemplated in their development. Given this, there is a strong case for revisiting this environmental approval in a regime of proposed increased biomass pressures.

Crown Forest Sustainability Act (CFSA)

In Ontario, under the CFSA, sustainability is defined as "long-term forest health". This is appropriately interpreted as meaning that the act has an ecosystem health priority, and that long-term impacts *must* be consistently considered in subservient policy. Unfortunately, many policy processes falling under the jurisdiction of the Act, including the Biofibre Policy, are apparently blind to this long-term ecosystem priority. Instead, they tend to focus upon economic priorities, in a "balancing act" approach perhaps drawn from an in appropriate use of a "sustainable development" or three-legged stool model, and at times even reverting back to an industrial "sustained yield" focus on consistent delivery of fibre. The first assumes that rather than social and economic systems being contingent on the ecosystem priority, that they are equal in policy weight; the second further subordinates the environment to industrial expediency. These approaches do not fit the ecosystem health primacy embodied in the Act, and therefore are not appropriate public policy models for this application. The fact that "long-term" is explicitly emphasized in this over-arching purpose of the Act should, for example, exclude scenarios that can only achieve one rotation of renewal by mining soil nutrients. Unfortunately long-term risk assessment has not been a significant element of bioenergy discussions in Ontario to date.

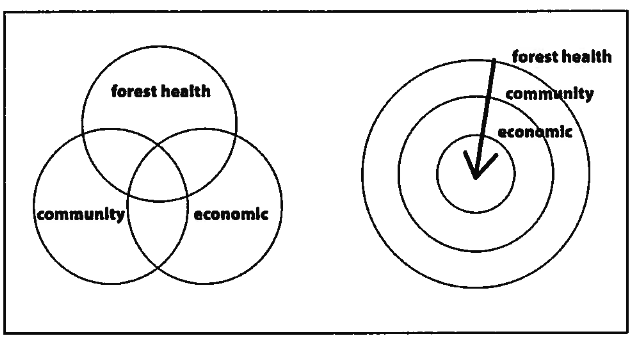

Fig. 2. Contrasting sustainability interpretations: incorrect "balancing act" interpretation (left), and the appropriate policy priority embodied in Ontario's Crown Forest Sustainability Act (right).

The Precautionary Path

Regardless of jurisdiction, success in this new undertaking of additional biomass utilization will be determined by how well we can anticipate the potential effects of our policy development and implementation on the long-term health of our public forests. The need to emphasize precaution, given the amount of uncertainty and the high potential for additional impacts of this undertaking on the system, cannot be overstated. Our forests deserve the following preconditions before additional industrial pressures are applied under a blanket policy (such as that recently established by Ontario):

1. **Ecosystem priority:** Biomass collection must be centred overtly upon long-term forest health objectives.
2. **Confidence in current practices:** The long-term impacts of our current practices must be known, with a high degree of confidence, before biomass collection practices and demands are established. This must include the dimensions of soil productivity, biodiversity, and silvicultural effectiveness—all directly compared to a natural forest ecosystem baseline for each area of application.
3. **Environmental assessment:** An environmental assessment of the life-cycle impacts of various scenarios of biomass collection must be undertaken.
4. **Pilot program:** The collection of biofibre must be sufficiently tested in a pilot program that will comprehensively monitor and evaluate its environmental impacts.
5. **Clear regulatory regime:** Implementation must be clearly regulated, including stand-level retention targets for logged areas, downed wood retention targets, and site- and soil-disturbance thresholds. Legacy residual stock (healthy individuals of representative species) also deserves additional consideration. These requirements must be designed to be easily demonstrated at an operational level for ease of implementation, monitoring, and enforcement.
   (a) **Removal thresholds:** Thresholds for above-ground biomass removal, by site type and species, must be regulated, using a precautionary approach, and with the ability to adjust the thresholds through adaptive management as better information becomes available. Implementation must be supported by appropriate performance monitoring of adherence to such thresholds.

(b) **Downed wood targets:** Additional biomass removal must not negatively impact forest floor biodiversity, or biotic function. To achieve this, downed wood retention targets, as well as site- and soil-disturbance thresholds, must be clearly regulated.

(c) **Residual retention targets:** Additional biomass removal must not negatively affect the quality and quantity of current residual material left for habitat provision. Stand-level retention targets for logged areas must be clearly regulated.

6. **Forest management integration:** Biomass collection sites must be regulated within forest management plans, including identification of each site, an estimation of the nutrient budget for each site, and mandatory monitoring and reporting provisions.
7. **Carbon assessment:** The impact of biomass use for energy on greenhouse gas production must be assessed through a life-cycle analysis of likely scenarios, paying attention to, for example, the relative role of carbon sequestration in forest floor and forest soil pools, and carbon emissions incurred during logging, transportation, and production, and with a regional efficiency analysis that includes the productivity and geography of the particular forests being considered, including rotation length and hence time for carbon uptake by growth of the next stand.
8. **Avoidance of perverse incentives:** The role of baseline subsidies, such as zero-pricing of the resource and haul distance compensation, must be carefully considered against long-term forest ecosystem health, a sustainable forest economy, and its carbon footprint.

Conclusion

Various policy, economic, and social drivers are moving us towards utilizing our forests for a changing mix of products that include returning to them for a fuel source. While this is a use with some limited merit, it must be considered prudently and with the ecological limits of our forests clearly identified and understood before substantially investing our public resources for this purpose. It is perhaps useful to remember that moving beyond using their forests for fuel was considered a right of passage for advancing nations not that long ago, for many good reasons, and that today a suite of non-fossil fuel energy options are available, of which bioenergy from traditional forest management is just one choice.

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.

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