Belledune Coal to Biomass Electricity: Impact on Forests and Emissions

Jamie Simpson and Richelle Martin
Juniper Law & Consulting
Halifax, N.S.

Oct. 31, 2024

Cover Image: Biomass Harvesting in Northern New Brunswick: FPInovations. 2023. *Integrated Biomass Harvesting*. Report No. TR 2023 N17

Table of Contents

1. Executive Summary

NB Power (a Crown corporation of the New Brunswick government) is considering a proposal to convert its Belledune coal-fired electricity generating station to a biomass-fueled electricity generating station in order to stop burning coal at this site, ostensibly to reduce greenhouse gas (GHG) emissions and to promote energy security. Belledune has an annual generation capacity of 467 megawatts, but NB Power predicts the site would have a capacity of 375 megawatts if run as a biomass facility.

The proposed Belledune biomass project would be the largest biomass facility in Canada. New Brunswick currently has four biomass energy facilities for a combined total of 131.7 megawatts. Three of these facilities, totaling 102 megawatts, are located in northern New Brunswick. The proposed Belledune project would mark the fourth such generating station in northern New Brunswick.

NB Power proposes running Belledune on black pellets, which can be burned without significantly changing the existing coal-fired station. Black pellets are produced by several methods, including torrefaction and steam-explosion. Currently, there are no producers of black pellets in New Brunswick, and worldwide supply of black pellets is reportedly limited. NB Power acquired 5,000 tonnes of black pellets to carry out test firing in spring of 2024. NB Power estimates it would require between 500,000 and 1.3 million tonnes of black pellets per year to operate the proposed Belledune biomass facility.

This report assesses the potential impact on New Brunswick's forests of converting the Belledune coal-fired electricity generating station to a biomass-fueled electricity generating station as well as the effect of this conversion on greenhouse gas and particulate emissions. Given there are no suppliers of black pellets in New Brunswick, this report considers the potential impact on New Brunswick's forests under two scenarios:

(a) New Brunswick exports raw biomass to torrefied pellet manufacturers and imports the pellets back;

(b) Domestic producers of torrefied pellets are developed, utilizing fibre from New Brunswick's forests.

Biomass Required to Fuel Belledune:

Assuming black pellets have a moisture content of eight per cent and raw biomass fuel to have a moisture content of 50 per cent, NB Power would require between 920,000 and 2,392,000 tonnes of green biomass per year to satisfy the estimated range of black pellets required by the proposed Belledune biomass facility. A 2012 study at the Université de Moncton found the total potential biomass fuel available in the province (both Crown and private lands) is 4,185,000 tonnes annually. The total biomass available within a reasonable trucking distance of Belledune (approximately 150 kilometres) is estimated in the report to be 392,969 tonnes, assuming NB Power could acquire all biomass from all Crown and private land in this region. Trucking distance can be increased for black pellets due to their reduced weight-to-energy ratio, but the amount of fuel required by NB Power is far more than it could reasonably source within the province, even if black pellets are produced locally. The bottom line is that NB Power would have to rely on imports for the majority of its biomass fuel for the Belledune facility.

Impact on Greenhouse Gas Emissions:

Burning wood to produce energy does not necessarily reduce GHG emissions immediately or even in the next decades. A carbon payback period is required to achieve carbon neutrality, after which net emissions begin to fall relative to the original coal-burning generating method. A number of factors influence the length of this payback period, including:

(a) The type of energy produced (heat, electricity or both);

(b) The type of fuel replaced by biomass (coal, natural gas, etc.);

(c) The forest management used to produce the biomass fuel;

(d) The transportation distance and method for acquiring biomass fuel.

The degree of reality imposed on the carbon modelling also impacts the carbon payback period: Accounting for wildfire and recognizing the dynamic nature of the forest's baseline carbon storage can strongly influence the time required before net emissions begin to decrease. Accounting for these factors, switching to biomass fuel can potentially increase GHG emissions for a period of less than a decade to more than a century.

It is likely that switching the Belledune plant from coal to biomass fuel will increase GHG emissions for decades. Moving away from coal, a particularly heavy emitter, counts in the project's favour. However, more factors count against the project. First, using biomass for electricity is inherently inefficient in that more than 75 per cent of the energy potential of the biomass will be wasted. Second, there is no indication that the biomass fuel will be sourced from anything but conventional forestry operations such as clearcutting, which degrades forest carbon stores relative to not cutting, cutting over longer rotations, and less intensive cutting. Furthermore, biomass harvesting typically reduces forest carbon stores beyond even conventional clearcutting. Deadwood and soil organic matter are typically also taken from the Earth when biomass harvesting, which can exacerbate carbon storage loss as forest productivity degrades. A recent study of New Brunswick's forests indicates that due to contemporary forestry practices, New Brunswick's forests are a net emitter of carbon dioxide, accounting for 32 per cent of the province's greenhouse gas emissions annually. Increased harvest pressure from biomass fuel sourcing would worsen that impact.

While a precise number cannot be provided without knowing from where the biomass fuel will be sourced and the type of harvesting used to produce it, studies of similar scenarios estimate that a biomass conversion at Belledune would increase greenhouse gas emissions for several decades at least.

Impact on Forest Health:

*S*tudies demonstrate a negative impact of biomass harvesting on biodiversity in temperate forests. Biomass harvesting tends to remove woody fibre that is not otherwise taken for use as a commercial product, like small and poorly-formed trees, dead and dying trees as well as non-commercial species. This significantly reduces the amount of structure left after a harvest, which provides essential habitat for forest biodiversity. Amphibians, birds, ground vegetation, mosses and lichens and potentially aquatic ecosystems are negatively impacted by whole-tree harvesting for biomass fuel. A study of the impact of forestry on bird populations in the Maritimes found that increased forestry has degraded forest-bird habitat, causing a decline in bird populations, even where total forest area remains constant. Biomass

harvesting can also increase cutting by making lower-quality product viable, thereby lowering the threshold for a commercial harvest. Increasing biomass harvesting would exacerbate the negative impacts of forestry on biodiversity, both by increasing the amount of woody material removed from status-quo harvesting and by potentially increasing the total area cut per year.

Whole-tree harvesting for biomass fuel may also deplete forest-soil productivity. According to the New Brunswick Department of Natural Resources and Energy Development, most of New Brunswick's forest soils can withstand one biomass harvest. Nonetheless, even nutrient-rich soils may be impacted over multiple biomass harvests, and some forest soils may be depleted after one biomass harvest. A Nova Scotia study found that even conventional clearcutting (without biomass removal) is not sustainable for some of Nova Scotia's soils.

In short, without requirements for post-harvest structural retention, biomass harvesting will exacerbate the negative impacts of forestry on biodiversity. If sourced from New Brunswick, the scale of biomass harvesting required to fuel the Belledune plant would be detrimental for much of New Brunswick's forest biodiversity.

Impact on Particulate Emissions:

There appears to be little research on the particulate emissions of biomass burned in electricity generating stations. Burning biomass releases particulate emissions, but how much relative to coal, especially in the specific context of the Belledune facility is not known. Given that these emissions negatively impact human health, the potential particulate emissions from the proposed Belledune biomass facility should be quantified as part of the project's assessment process.

Recommendations

Large-scale biomass-fueled electricity generation is generally detrimental to forest biodiversity and to efforts to reduce greenhouse gas emissions, even when biomass fuel replaces coal as in the Belledune proposal. The unprecedented scale of the proposed facility risks similarly unprecedented impacts on forest biodiversity and GHG emissions.

Recommendation 1: Given the inefficiency of biomass-fueled electricity generating stations, forgo the Belledune proposal and focus on developing regionally dispersed district heating and small-scale heat-and-power biomass facilities, in addition to other renewable energy sources and energy-conservation methods.

Recommendation 2: Given that New Brunswick does not have a biomass harvesting regulation or policy, create a biomass harvesting regulation applicable to both private and Crown lands that addresses long-term soil productivity and impacts on forest biodiversity. The regulation should establish minimum post-harvest forest and deadwood retention levels.

Recommendation 3: Given that New Brunswick does not have a policy concerning the impacts of forestry on forests' carbon-storage capacity, create a policy that encourages carbon storage in New Brunswick's working forests to increase.

Recommendation 4: Given the lack of research on the particulate matter emissions of biomass energy, provide funding for independent academic research on particulate

emissions from biomass burning and methods to reduce particulate emissions and their impact on health.

2. Introduction

This report assesses the potential impact on New Brunswick's forests of converting the Belledune coal-fired electricity generating station to a biomass-fueled electricity generating station, and the effect of this conversion on greenhouse gas and particulate emissions.

Specifically, this report addresses the following questions:

1. How will the proposed conversion affect New Brunswick's forests?
2. How will the proposed conversion affect greenhouse gas emissions at the facility?
3. How much biomass fuel is generated from current forestry operations in New Brunswick?
4. Is any of this potential biomass fuel currently used?
5. How much biomass fuel would be required to fuel the Belledune generating station?
6. What impact would the Belledune conversion to biomass fuel have on particulate emissions?

Impact of the Belledune Conversion on Greenhouse Gas Emissions:

The government of New Brunswick is contemplating the conversion of the Belledune coal-fired electricity generating station (current capacity of 467 megawatts) to a biomass electricity generating station with a capacity of 375 megawatts. The proposed biomass plant would burn torrefied pellets, a type of wood pellet with combustion properties similar to coal, thereby negating the need for a costly conversion of the generating station to run on standard wood pellets or chips.[1]

The province's rationale for this proposal is to reduce GHG emissions by transitioning away from burning coal as well as to increase energy security. Belledune currently emits 1.6 million tonnes of GHG per year, which is 13 per cent of New Brunswick's total GHG emissions, second to only the Irving Oil refinery.

At present, there are no commercial suppliers of torrefied pellets in New Brunswick, with most manufactures supplying only sample quantities of pellets for testing purposes. Therefore this report considers the potential impact on New Brunswick's forests under two scenarios:

(a) New Brunswick exports raw biomass to torrefied pellet manufacturers;

(b) Torrefied pellet manufacture is done in-province, using fibre from New Brunswick's forests.

Burning wood to produce energy does not necessarily reduce GHG emissions immediately or even in the coming decades. A carbon payback period is required to achieve carbon neutrality, after which net emissions begin to fall relative to the original coal-burning generating method. A number of factors influence the length of this payback period, including:

(a) The type of energy produced (heat, electricity or both);

(b) The fossil fuel replaced by biomass (coal,natural gas, etc.);

[1] Converting Belledune to run on standard pellets is estimated at $300 million: David Palmer. 2024. Getting to Net Zero. *Atlantic Forestry Review*. Vol 30(5).

(c) The forest management used to produce the biomass fuel.

The degree of reality imposed on the carbon modeling also impacts the carbon payback period: Accounting for wildfire and recognizing the dynamic nature of the forests' baseline carbon storage, for instance, researchers find switching to biomass fuel can increase GHG emissions, even when replacing fossil fuels, for a period ranging from decades to more than a century.

This report recognizes that the "burn-a-tree, grow-a-tree" misconception of carbon neutrality persists in discussions about biomass energy, despite the volume of academic literature to the contrary. This misconception may be explained in part by the fact that in certain circumstances, biomass energy *can* be carbon neutral and *can* reduce GHG emissions when it replaces fossil fuels, but these reductions are not necessarily automatic nor within a reasonable timeframe. Given the need to reduce GHG emissions in the short term, decision makers must account for the potentially lengthy time period required for biomass energy to actually reduce emissions.

With respect to the Belledune proposal, the fact that coal (rather than fossil fuel) will be replaced helps reduce the carbon debt payback period. However, the fact biomass will be burned to produce electricity (rather than heat buildings) will increase the period. The remaining factors influencing the carbon debt are the forestry practices used to secure raw biomass fuel and the distance pellets are shipped. There is little chance that waste sawmill fibre would supply Belledune, as New Brunswick's limited supply appears to be all spoken for. Fuel for the proposed Belledune project would most likely have to come from new forest harvesting, whether in New Brunswick or elsewhere. The prevalence of high-intensity forest cutting in New Brunswick (defined as clearcutting with low retention levels and use of plantations), and the lack of regulation to guide or restrain biomass harvesting, suggests a longer carbon payback period.

The increased cutting and amount of biomass removed per area cut required to fuel Belledune would negatively impact forest biodiversity. If all or most of the biomass fuel required for the Belledune station were to be sourced from New Brunswick's forests, the impact would be devastating for biodiversity and potentially for long-term forest productivity in the province. As reviewed in this report, the fibre targeted in biomass harvesting is critical habitat and an essential part of nutrient cycling in the forest.

Biomass releases particulate emissions when burned. There does not appear to be enough research to determine how much particulate matter a biomass-fired facility such as the one proposed in Belledune would release. Furthermore, the amount ultimately released by the proposed facility would depend on the pollution controls used. Currently, the Belledune coal-fired facility uses technology that significantly reduces particulate emissions but it is unknown whether similar technology would be used for the biomass fuel.

New Brunswick's 2023 Energy Strategy and State of the Forest Reports

New Brunswick's 2023 energy strategy report, *Powering our Economy and the World with Clean Energy,* includes goals of energy security and net-zero GHG emissions by the year 2050. At the time of the strategy report, biomass accounted for three per cent of the province's electricity generation capacity (119 megawatts), and supplied one per cent of actual electricity generation. In 2023, annual electricity demand in the province was 14.5 million megawatt-hours and was anticipated to rise to 23.4 million megawatt-hours by 2035. The report suggests biomass will supply four per cent of the province's

electricity by 2035, and that this increase could be achieved by converting the Belledune coal-fired station to biomass energy (375 megawatts). The report states biomass "is an abundant resource in our province…" and "we are currently assuming a conversion to biomass as the best alternative form of energy for this facility, a decision that will be finalized in 2024."[2]

The province's 2023 state of the forest report, however, does not mention the Belledune biomass energy possibility. The report mentions biomass energy only briefly, stating that "Biomass production is being explored… Tools are now available to accurately estimate biomass availability and feasibility for different areas of the province."[3]

3. Overview of Forestry Management, Policy, and Regulation in New Brunswick

3.1 Forest Ownership

New Brunswick is a largely forested province; of its 73,800 square kilometers of surface area, about 80 per cent (59,300 square kilometres) is covered with forest. New Brunswick has a high proportion of privately-owned land relative to the rest of Canada. Forty-five per cent of New Brunswick is privately owned (28 per cent small private holdings and 17 per cent industrial holdings) and 49 per cent is provincial Crown land licenced to industrial timber companies. The remaining six per cent is federal Crown land (military lands and federal parks) and provincial Crown land used for non-industrial forestry interests.[4]

New Brunswick's provincial industrial-forestry Crown land is divided among 10 forest resource licences which are assigned to six industrial forestry companies (licensees).[5] Each licence has its own annual allowable cut (AAC), though details about these harvest levels and AACs are not publicized. The *Crown Lands and Forests Act*[6] requires licensees to submit 10-year industrial plans, 25-year forest management plans, and one-year operating plans to the Minister of Energy and Resource Development. The Minister reviews the management plans every five years.

The upshot of this ownership pattern is that to be effective, any regulation of biomass harvesting must apply to private as well as Crown forestlands.

---

[2] New Brunswick Government. 2023. *Powering our Economy and the World with Clean Energy: Our path forward to 2035*: https://www2.gnb.ca/content/gnb/en/corporate/promo/clean-energy.html

[3] New Brunswick Government. 2023. *State of the Forest Excellence in Forest Management – Understanding our System*: https://www2.gnb.ca/content/gnb/en/news/news_release.2023.08.0417.html.

[4] Chris Hennigar and Beth Brooks. 2024. *New Brunswick's 2023 Forest Carbon Inventory*. New Brunswick Department of Natural Resources and Energy Development. Report NB-FPSB-2024-1. 24p.

[5] With the exception of Licence 5 (Kent Licence), which is currently managed by the Department of Natural Resources and Energy Development.

[6] *Crown Lands and Forests Act*, SNB 1980, c C-38.1.

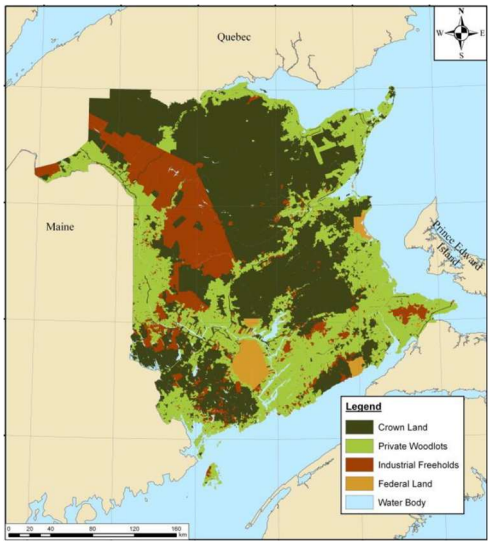

Figure 1: Land ownership in New Brunswick

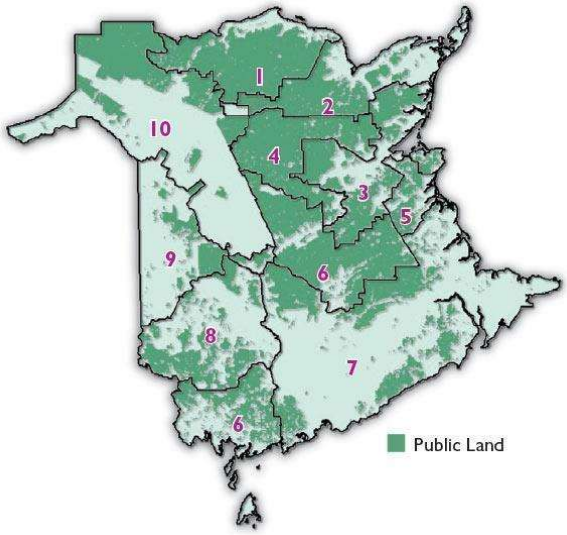

Figure 2: Crown land licence areas in New Brunswick[7]

Company	Licence	Administrative Unit	Area (hectares)
AV Cell Inc.	1 Upsalquitch	Upsalquitch	421,350
Fornebu Lumber Company Inc.	2 Nepisiguit	Nepisiguit-Miramichi	257,024
	3 Lower Miramichi		310,599
	4 Upper Miramichi		381,293
DNR - Kent License Management Team	5 Kent	Kent	70,815
J.D. Irving Ltd.	6 Queens-Charlotte	Queens-Charlotte-Fundy	622,332
	7 Fundy		424,308
AV Nackawic Inc.	8 York	York	257,605
	9 Carleton		130,896

[7] SGS Belgium SA. 2018. Forest sustainability in New Brunswick, Canada. Project No.: 180373.

Twin Rivers Paper Company	10 Restigouche-Tobique	Carleton-Restigouche-Tobique	396,283

Table 1: Crown land timber licences and licensees[8]

3.2 Forest Strategy and Policy: Crown Lands

In 2014, the province released *A Strategy for Crown Lands Forest Management: Putting our Resources to Work,*[9] which stated the primary goal for Crown lands was to "support economic development opportunities." The strategy intended to accomplish this by ensuring that government provides "the atmosphere necessary for companies to attract and secure investment dollars."

The key action to accomplish this goal was to "make more Crown wood available to industry," by increasing the annual allowable cut for softwood by 660,000 cubic metres to 3.9 million cubic metres of wood, and setting an annual allowable cut for hardwood at 1.8 million cubic metres. The strategy noted that finding more fibre would include harvesting on steep slopes and reducing the area of land set aside as exclusive habitat areas.

The province predicted that the 2014 strategy would reduce the amount of mature forest stands on Crown lands from 26 per cent to 10 per cent within 50 years, and increase the land area dedicated to plantations from 12 per cent to 21 per cent. At the time of writing, there is no publicly available update or evaluation of whether these aspirations have been achieved.

Forest Type	**Per cent of Crown Lands under the latest strategy**	**Projected per cent of Crown Lands in 50 years**
Mature Stands	26%	10%
Natural Regeneration	26%	34%
Thinned Regeneration	13%	12%
Silviculture Plantations	12%	21%
Watercourse and Wetland Buffers	8%	8%
Protected Natural Areas	8%	8%
Old Forest Habitats	7%	7%

Table 2: Projected Change in Forest Use due to Forest Strategy

The 2014 strategy also introduced a "results-based" approach to forest management, by which the province intended to "significantly reduce management costs." Licensees would be "held accountable for achieving specified outcomes from their harvest and management activities," and the province intended to "begin working immediately with licensees to develop and implement a more cost-effective and transparent approach to managing our Crown lands."

A 2018 review of the 2014 strategy noted, "it is clear… that many New Brunswickers would like improvements to the government's approach to sustainable forest management on Crown lands" and

[8] NB Department of Natural Resources and Energy Development: https://www2.gnb.ca/content/gnb/en/departments/erd/natural_resources/content/ForestsCrownLands/content/TimberHarvestingScaling.html.

[9] Province of New Brunswick, 2014. *A Strategy for Crown Lands Forest Management: Putting our Resources to Work*: https://www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/en/ForestsCrownLand.s/AStrategyForCrownLandsForestManagement.pdf.

stated the government plans to improve long-term conservation of forest biodiversity.[10] The review committed the province to increasing the amount of "conservation forest" on Crown lands to 28 per cent. Forest cutting is permitted within these areas and it is not clear what constraints "conservation forest" places on licensees. The 2018 review also noted the province will maintain current Crown timber supplies and continue to create favourable conditions for private forest-sector investments.

New Brunswick's 2023 forest strategy states that the province has "prioritized biodiversity" and expresses a goal for New Brunswick's forests to be "healthy and resilient and [to] support the species of flora and fauna we know exist today, those we haven't yet discovered, and those which may naturalize in the future." The strategy recognizes that "old forest has never been more limited, which places even greater importance on the identification, maintenance, and management of critical old forest habitats."

The strategy's objectives include:

> 3.4 The forest will function to moderate water flow throughout the landscape – serving to minimize the impact of extreme weather events.
>
> 4.1 Forest operations will minimize rutting and erosion…
>
> 4.3 The long-term net loss of productive forest area resulting from forest management will be minimized.

The 2023 strategy does not include any quantified analysis of how the 2014 strategy has impacted forests nor do the annual reports released by the Department of Natural Resources and Energy Development.*Licensee Audits*

The Department of Natural Resources and Energy Development conducts audits of licensees according to a set of indicators once every five years.[11] These indicators include:

- Submission of forest operation information
- Effective use of the timber resource
- Compliance with harvest operation standards and submission of a post-audit report
- Proper road location, construction and maintenance
- Establish river and wetland buffers; ensure watercourse degradation, erosion, sedimentation and siltation are minimized during installation; use and removal of watercourse crossings
- Minimize impact on sensitive wildlife habitat
- Protect forest soils from mineral soil exposure and rutting
- Minimize damage to fish and wildlife habitat

The Licensee Performance Evaluation documents were once publicized but are no longer available on the department's website.

---

[10] Province of New Brunswick. 2018. *A Review of the 2014 Forest Management Strategy*. 11872-08-2018: https://www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/en/Publications/forest_management_strategy2014_review.pdf.

[11] New Brunswick Department of Natural Resources. April 2014. *Forest Operations Compliance Audit Performance Indicators*. Reference 867-01: https://www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/en/ForestsCrownLands/AuditPerformanceIndicators.pdf.

Forest Management Manual for New Brunswick Crown Land, 2014

The forest management manual for Crown land was created in 2004 and revised in 2014; it does not appear to have been updated since.[12] The manual provides standards for carrying out silviculture, harvesting, road building, watercourse crossing as well as managing fish and wildlife habitat and old forest. The manual requires licensees to try to maintain at least six per cent of each ecoregion in old-age classes and to maintain the functions of habitats such as bear dens, and bird nests. Licensees must maintain 30-metre buffers around all perennial watercourses and wetlands greater than one hectare (partial harvesting is allowed within buffer zones). The manual is a guideline, not a legal requirement.

Forest Management Agreement with J.D. Irving

In July 2014, the province entered into a forest management agreement with J.D. Irving Ltd. and Irving Pulp & Paper Ltd. regarding the Fundy and Queens-Charlotte Licenses (1,050,000 hectares).[13] The deal extended the forest management agreements for J.D. Irving for 15 years and requires the company continue to submit five-year forest management plans and annual operating plans, per the *Crown Lands and Forests Act*.

The agreement requires J.D. Irving Ltd. to comply with the *Forest Management Manual*, and the minister agrees to amend the manual only with consent of the company.

The agreement prevents the province from removing more than 0.5 per cent, to a maximum of 200 hectares, of the area of the licenses in one year. It also limits the withdrawal from the licenses to five per cent over the life of the agreement (until 2037).

The agreement requires any reduction in land or annual allowable cut available to J.D. Irving must be compensated for by the province. The total annual allowable harvest from the two licenses is set at 1,863,200 cubic metres. The agreement requires the province to pay for silviculture work carried out by J.D. Irving on the licenses.

Other Agreements

The province signed an agreement with Twin Rivers Ltd. (for Licences 9 and 10), providing for guaranteed wood supply, similarly to the agreement with JD Irving.[14] The province also signed agreements with 15 First Nations allocating a total of 203,341 cubic metres of wood per year.[15]

Biomass Harvesting Policy (Now Defunct)

New Brunswick does not have legal requirements for biomass harvesting. However, in 2008 New Brunswick developed a Crown Land Forest Biomass Harvesting Policy (FMB 019 2008) that provided guidance on biomass harvesting on Crown lands in the province. The policy recommended that biomass

[12] Province of New Brunswick. 2014. *Forest Management Manual for New Brunswick Crown Lands: Results-based Forestry Option*: https://www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/en/ForestsCrownLands/ScheduleE_FMM_En.pdf.

[13] https://www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/en/ForestsCrownLands/JDI-ForestmentManagementAgreementJuly2014.pdf.

[14] https://www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/en/ForestsCrownLands/MOA-Twin-Rivers.pdf.

[15] https://www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/en/ForestsCrownLands/FirstNationsAllocationsEnglish.pdf.

harvesting be restricted to the above-ground portion of trees and shrubs, deadwood and flail-chipping residue (i.e., not roots, stumps, or the soil litter-layer).

The policy noted forest biomass is an "important component of a forest ecosystem, vital to nutrient cycling, wildlife habitat, biodiversity and overall forest health. Further research and analysis is necessary to fully understand the impacts of removing forest biomass on both forest growth and ecological values." The policy recognized the importance of tree branches, foliage and tops as important sources of nutrients for forest growth and development. The policy also noted that forest stands harvested for bioenergy purposes "may not provide the full suite of ecological values" identified in *The New Brunswick Public Forest – Our Shared Future*.

The 2008 policy recommended that a geographic information system (GIS)-based decision support model be used to help identify Crown forestlands that are eligible for biomass removal. The model was to "incorporate information relating to soil types, bedrock types, atmospheric nutrient deposition and tree nutrient content in calculating the total nutrient supply for a forest stand. … The impact of removing forest biomass on forest growth is determined by assessing the total available supply of nutrients minus the nutrient demand to sustain a predefined growth rate of any given forest stand."

Finally, the policy recommended biomass harvesting should minimize nutrient loss and result in no reduction in predicted growth of future forest stands. The policy suggested the department would audit biomass eligibility and biomass harvest operations to ensure standards and guidelines are followed.

The 2008 policy was to be reviewed in 2012. The Department of Natural Resources and Energy Development indicates that the policy has not been updated and is no longer used by the department. No replacement biomass policy has been developed.[16]

3.3 Private Forestland Management

There are seven woodlot product marketing boards in New Brunswick, representing the interests of woodlot owners, and providing services such as training and information on woodlot management (Figure 3).

These marketing boards, as follows, are empowered by specific regulations under the *Natural Products Act*:[17] Office de vente des produits forestier du madawaska (MAD), North Shore Forest Products Marketing Board (N-S), Northumberland Woodlot Owners Association (NTH), South Eastern NB Forest Products Marketing Board (SENB), Southern New Brunswick Forest Products Marketing Board (SNB), York Sunbury Charlotte Forest Products Marketing Board (YSC), and Carleton-Victoria Wood Producers Association (C-V).

The *Natural Products Act* enables the boards to collect levies on wood sold through the boards, thereby providing funds for the boards. The New Brunswick Federation of Woodlot Owners serves as an umbrella organization for the seven regional marketing boards.

[16] Comm. from Shawn Morehouse, NB Depart. of Natural Resources and Energy Development, June 7, 2024.
[17] *Natural Products Act*, SNB 1999, c N-1.2.

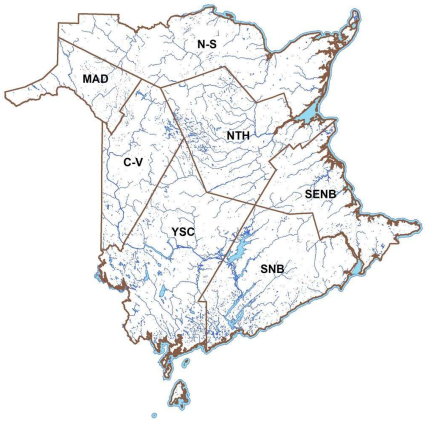

Figure 3: NB Woodlot Marketing Boards

The only regulation of private forestland management is through the *Clean Water Act*. The New Brunswick Department of Natural Resources and Energy Development also provides funding for certain silviculture activities on private forestland, for the purpose of growing higher quality wood and reducing time to harvest[18] such as creating plantations, herbicide spraying and thinning.

3.4 Forest Management Legislation

Crown Lands and Forests Act

The *Crown Lands and Forests Act*[19] enables the Minister of Energy and Resource Development to issue Crown timber licenses to entities that own, operate, or intend to own/operate a wood processing facility in the province and enter into a forest management agreement with the minister (section 28). As described above, the province created 10 Crown land licences, and granted these to six forestry companies.

The forest management agreements must include a one-year operating plan, a 10-year industrial plan, and a 25-year management plan (section 29). These plans must describe the aspects of wood processing, long-term forest management and short-term forestry activities for the licenced Crown land. The management and operating plans are subject to approval by the Minister of Energy and Resource Development. Management plans are to be reviewed by the minister every five years (section 31). The act empowers the minister to carry out compliance audits of licensees (sections 31.1 – 31.3).

Clean Water Act

The *Clean Water Act*[20] is administered by the Minister of Environment and Local Government. The act requires anyone wishing to either alter a watercourse or a wetland (except those less than one hectare and not contiguous to a watercourse), such as by building a bridge or installing a culvert, or to cut trees within 30 metres of a watercourse or wetland, to obtain a permit and to abide by the conditions of the

[18] NB Private Woodlot Silviculture Program, 2023-2024. Dept. of Natural Resources and Energy Development: https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://senb.ca/images/2023-24_Private_Woodlot_Silviculture_Manual_EN.pdf&ved=2ahUKEwijl660sveHAxUJFlkFHVPeDtMQFnoECBgQAQ&usg=AOvVaw1CfNp2LZoyzsUlvfXzbISH

[19] *Crown Lands and Forests Act*, SNB 1980, c C-38.1.

[20] *Clean Water Act*, SNB 1989, c C-6.1.

permit (section 15). The permitting process is detailed in the *Watercourse and Wetland Alteration Regulation*[21] under the *Clean Water Act*.

3.5 Forestry Certification

The only forestry certification system in use in New Brunswick is the Sustainable Forestry Initiative (SFI). As of 2016, all Crown lands and industrial freehold lands controlled or harvested by licensees were certified under the SFI program (4.2 million hectares). SFI has been criticized as a rubber-stamping of status-quo forestry and is currently being investigated by the Competition Bureau of Canada for making false or misleading statements.[22] There is no evidence that the SFI certification provides any meaningful protection for biodiversity.

Forestland under the SFI program in New Brunswick is certified under the SFI 2022 Forest Management Standard, which is a generic standard for all forestland in North America.[23] The SFI standard purports to promote forest management that protects biological diversity; however, it does not require forestlands to be evaluated on-the-ground for compliance. Rather, the standard requires forest managers to have their own policies and to be considerate of biodiversity. For example, the standard expects forest managers to develop criteria to retain wildlife habitat such as snags and coarse woody debris, and expects forest managers to consider the environmental impact of harvesting residue. The SFI standard does not otherwise directly address biomass harvesting.

There is no evidence of certification of non-industrial private lands in New Brunswick. However, the New Brunswick Federation of Woodlot Owners is working on a program to offer Forest Stewardship Council (FSC) certification to woodlot owners.[24]

3.6 Forest Harvesting and Products

The 2022-2023 Annual Report from New Brunswick's Department of Natural Resources and Energy explains the harvest target of 90 per cent of annual allowable cut was met.[25] The actual AAC is not provided in the report. Another report noted the harvest from New Brunswick Crown lands in 2016 was 5,813,640 cubic metres, but again did not provide the annual allowable cut.[26]

Natural Resources Canada publishes limited statistics on forestry activities for each province. The most recent harvest data for New Brunswick are for 2021. In that year, 79,047 hectares were harvested, with a harvest volume of 9,341,187 cubic metres, and 12,384 hectares were planted.[27]

---

[21] *Watercourse and Wetland Alteration Regulation*, NB Reg 90-80, under section 40 of the *Clean Water Act*.

[22] Ecojustice. 2023. *Competition Bureau lunches investigation into greenwashing complaint against North America's largest forest certification scheme*: https://ecojustice.ca/news/competition-bureau-launches-investigation-into-greenwashing-complaint-against-north-americas-largest-forest-certification-scheme/

[23] https://forests.org/forestmanagementstandard/

[24] Personal communication, NB Federation of Woodlot Owners, August 2024.

[25] New Brunswick Department of Natural Resources and Energy Development. 2023. Annual Report: https://www2.gnb.ca/content/gnb/en/departments/erd/Publications.html

[26] New Brunswick Department of Natural Resources and Energy Development. 2016. Annual Report: https://www2.gnb.ca/content/gnb/en/departments/erd/Publications.html

[27] Government of Canada: Natural Resources Canada. Statistical data: https://cfs.nrcan.gc.ca/statsprofile/forest/NB.

The most recent data for primary wood product exports are for 2021. That year, 97,981 tonnes of wood chips were exported from New Brunswick, worth $9,378,969. In that same year New Brunswick imported 342,935 tonnes of wood chips, worth $20,754,201.[28] The net trade deficit of chips may be a function of lower prices outside of the province, but the high cost of transportation suggests the actual supply in New Brunswick is low enough to require this importation.

The New Brunswick Department of Natural Resources and Energy Development reported that between 2020 and 2023, the province's average annual export of mill residues was approximately 643,000 tonnes (comprising of 185,000 cubic metres of sawdust and shavings, 369,000 cubic metres of chips, and 109,000 tonnes of hog fuel and bark). Communications from the department confirmed that there is no excess supply of waste fibre from mills and that the province imports more biomass fibre than it exports.

The department notes forest residue biomass is not fully "accessed", but they believe future demand for forest residue biomass exceeds the supply. The department notes that the three-year average harvest of forest residue biomass from Crown land is 55,000 cubic metres or approximately 55,000 green metric tonnes (GMT), the annual harvest from industrial freehold land is 41,000 cubic metres and the annual harvest from non-industrial private woodlands is 48,000 cubic metres, for a provincial average annual total of 144,000 cubic metres (roughly 144,000 GMT).[29]

In a 2023 promotional flyer, the Wood Pellet Association of Canada notes that New Brunswick has five wood pellet plants, producing a total of 350,000 tonnes of pellets per year. The flyer also notes that more than 90 per cent of this pellet production was exported.[30]

4. New Brunswick's Supply of Biomass Fuel and Amount Required for Belledune

It is estimated NB Power will need 660,000 tonnes of biomass (non-torrefied) per year just to operate Belledune for winter peak electricity usage only. That amount shoots up to between 1.5 and 2.2 million tonnes to run at full capacity (375 megawatts). As noted, NB Power is requesting proposals to supply between 500,000 to 1.3 million tonnes of black pellets per year.

If raw biomass fuel is assumed to have 50 per cent moisture content, and torrefied pellets to have eight per cent moisture content, then a tonne of torrefied pellets requires 1.84 tonnes of green biomass, assuming a 100 per cent conversion ratio of green biomass to torrefied pellets. Thus, NB Power's estimates of 500,000 to 1.3 million tonnes of back pellets annually equates to 920,000 to 2,392,000 tonnes of green biomass per year.

For perspective, the proposed Belledune biomass project would be the largest biomass facility in North America.[31] The current largest capacity biomass electricity facility in Canada is the Atikokan facility, at 215-megawatt capacity. However, as noted below, this facility runs at only eight per cent capacity.

---

[28] *Ibid*: https://cfs.nrcan.gc.ca/statsprofile/trade/NB.

[29] *Ibid*.

[30] Wood Pellet Association of Canada. 2023. *Local Wood Pellets: A Sensible Solution for New Brunswick's Energy Needs*: https://pellet.org/resources/local-wood-pellets-a-sensible-solution-for-new-brunswicks-energy-needs/

[31] Database Earth. Biomass Power Plants in Canada. Accessed June 19, 2024: https://database.earth/energy/power-plants/biomass-power/canada.

New Brunswick currently has four biomass energy facilities, for a combined total of 131.7 megawatts. Of these, three facilities (102 megawatts) are located in northern New Brunswick.[32]

Review of Sample Biomass Electricity Facilities in Canada

The following brief review of several biomass electricity facilities in Canada shows the estimated amount of fuel required for the proposed Belledune biomass facility is similar to the fuel consumption of other biomass electricity facilities in Canada, accounting for the differences in energy content between green biomass chips,white pellets and black pellets.

- The Port Tupper 60-megawatt biomass facility in Cape Breton, Nova Scotia, was estimated to require 705,000 tonnes of green biomass per year when running at full capacity.[33] Information about the amount of time it operates at capacity is not known; however, the Nova Scotia government has resorted to creating a regulation under the *Electricity Act* to force Nova Scotia Power to operate the facility at as close to capacity as possible.[34] This regulation has since been repealed in order to allow Nova Scotia Power to operate the facility on an as-needed basis. Nova Scotia Power remarked in the media that being forced to run the biomass facility at capacity rather than on an as-needed basis cost Nova Scotian rate payers an extra $9 million per year.[35]

- The Atikokan Generating Station in Ontario was a coal-fired generating station converted to biomass fuel in 2014 (at a cost of $170 million). At 215 megawatts, Atikokan is reportedly the largest 100 per cent biomass-fired electricity generating station in North America and the highest consumer of industrial white pellets in Canada. However, it is reported to run at only eight per cent capacity, and consumes 90,000 metric tons of white pellets annually.[36]

- The Thunder Bay Generating Station in Ontario was a 326-megawatt coal-fired electricity generating station converted to burn black pellets in 2015. With a capacity to operate at 306 megawatts, the station was only planned to operate at two per cent of this capacity (which would require 15,000 tonnes of pellets per year).[37] The station was shut down in 2018 due to a leaking boiler and demolition of the station began in 2021, having operated for only 10 days in total on the new biomass fuel.[38]

Biomass Availability in New Brunswick

---

[32] *Ibid*.

[33] Nova Scotia Power Incorporated (Re), 2010 NSUARB 196, at para 41.

[34] *Renewable Electricity Regulations*, NS Reg 155/2010, s5(2A), since amended; under *Electricity Act*, SNS 2004, c25

[35] For example: Jean Laroche. 2016. Nova Scotia biomass plant will no longer run 24/7. CBC News April 8: https://www.cbc.ca/news/canada/nova-scotia/biomass-nova-scotia-power-nsp-electricity-rates-wood-1.3527202.

[36] IEA Bioenergy. 2018. *Bioenergy Success Stories: Ontario Power Generation, Canada: Coal to biomass journey furnace*.

[37] Ian Ross. Pellet solution will save on power plant conversion costs. *Northern Ontario Business* Jan 7, 2014: https://www.northernontariobusiness.com/industry-news/design-build/pellet-solution-will-save-on-power-plant-conversion-costs-370110.

[38] Lindsay Kelly. High cost, lack of use shutters Thunder Bay Generating Station. *Northern Ontario Business*. Jul 27, 2018: https://www.northernontariobusiness.com/regional-news/thunder-bay/high-cost-lack-of-use-shutters-thunder-bay-generating-station-998952.

A 2012 report by researchers at Université de Moncton found that the potential harvest of residue forest biomass of the entire province (Crown and private lands) is 4.185 million green metric tonnes.[39] The report broke down potential biomass harvest by region as well. The Belledune facility site is on the border of two regions: The Dalhousie and Bathurst procurement areas. The total residue biomass harvest potential was 143,634 GMT for the Dalhousie area and 249,335 GMT for the Bathurst area, for a total of 392,969 GMT. There is no indication in the report that sites with soils unsuitable for biomass harvest were removed, or that any concessions for leaving some residue for biodiversity reasons were made. Furthermore, there is no information on the degree of willingness of private forest owners to have all of their biomass harvested.

Nonetheless, even if the study's figures were reasonable, and if NB Power were able to purchase all residue biomass within the Dalhousie and Bathurst procurement areas, NB Power would still be significantly short of the projected need: 392,969 GMT of residue biomass equates to 213,570 tonnes of torrefied pellets, which is approximately nine to 23 per cent of the projected requirements. NB Power would have to acquire more than half of all estimated residue biomass for the entire province to meet its projected upper-end fuel requirement.

It is apparent that NB Power would be able to source only a fraction of its total fuel needs from New Brunswick biomass, all economic and forest-health considerations aside.

5. Impact of Belledune Biomass Conversion on GHG Emissions

Burning biomass for energy is often wrongly assumed to be automatically carbon neutral, the belief being that growing trees capture the same amount of carbon as is released by burning of an equal amount of biomass. In other words: burn a tree, grow a tree. If this accounting were correct, then replacing fossil fuels with biofuels would eliminate most of the GHG emissions associated with that fossil fuel.

This simplified accounting, however, does not account for the impacts that biomass harvesting has on forest structure and productivity, differing efficiencies of converting biomass to energy, and the time-lag for carbon capture in forests. Assumptions in the model used to measure forest carbon, such as whether wildfire is accounted for and whether a dynamic baseline in forest carbon storage is allowed for, significantly alter this accounting. When these impacts are accounted for, forest biomass energy may put more carbon into the atmosphere than the fossil fuels it replaces for a time frame of decades to more than a century.

5.1 Changing Land Use

[39] Stephan Bouchard, Mathieu Landry & Yves Gagnon. 2012. *Forest Biomass to Energy Atlas of New Brunswick*. Université de Moncton.

In 2009, a paper in the journal *Science* addressed the failure to account for changing land use in biomass carbon accounting.[40] Land that is used for biomass production, it noted, may store far less carbon than land not used for biomass production.

For example, the paper considered an old-growth forest that stores 300 tonnes of carbon per hectare. Minor cutting and natural disturbance events do not significantly alter the amount of carbon stored in this forest over time.[41] However, if management of this forest is changed to short-rotation forestry to supply biomass, pulp and studwood, then the total carbon stored in this forest is much reduced.[42] Although technically still supporting a forest (of sorts), the land will store much less carbon until it is allowed a prolonged regrowth. This increased harvesting thus results in a net transfer of carbon stored in forests to the atmosphere.

5.2 Impacts of Harvesting Method, Efficiency of Biomass Use, and Type of Fossil Fuel Replaced

The conversion of old-growth forest to intensively managed forest for biomass is an extreme example, given that old-growth forest is rare in New Brunswick.[43 Still], introducing biomass harvesting to forests that are already under short-rotation, intensive management still reduces the amount of carbon stored in those forests. Biomass harvesting removes woody material that would otherwise remain in the forest as lower-quality living trees and shrubs, standing and fallen snags, and coarse woody debris. Dead wood eventually decomposes, with some carbon entering the soil carbon pool and some released to the atmosphere.

This was documented by researchers in Vermont who carried out tests to quantify the impact of biomass harvesting on forest carbon storage over time in eastern hardwood forests.[44] The researchers found that increasing intensity of harvesting corresponds with less carbon stored in the forest over time. According to their work, carbon storage over time is highest in non-managed forests. Increasing harvest intensity results in depleted forest carbon storage and a corresponding net increase in atmospheric carbon.

Similar research for New Brunswick's forests found that from 1985 to 2020, the forests' net carbon dioxide emissions were 4.02 megatons per year, which is equivalent to 32 per cent of the province's entire carbon dioxide emissions for the year 2020, due to forest degradation.[45] These net emissions account for carbon stored in forest products and in landfills. Adding harvest pressure for biomass fuel will only exacerbate this trend.

---

[40] Timothy D. Searchinger et al. 2009. Fixing a Critical Climate Accounting Error. *Science*. 326: 527.

[41] Mark E Harmon, W.K. Ferrell & J.F. Franklin. 1990. Effects on Carbon Storage of Conversion of Old-Growth Forests to Young Forests. *Science* 247: 699.

[42] D.N. Scott. 2000. Carbon sinks and the preservation of old-growth forests under the Kyoto Protocol. *J of Environmental Law and Practice* 10: 105.

[43] A. Mosseler, J.A. Lynds & J.E. Major. 2003. Old-growth forests of the Acadian Forest Region. *Environmental Reviews* 11: S47.

[44] J. Nunnery & W.S. Keeton. 2010. Forest carbon storage in the northeastern United States: Net effects of harvesting frequency, post-harvest retention, and wood products. *Forest Ecology and Management* 259: 1363.

[45] M. G. Betts, et al. Congruent Long-Term Declines in Carbon and Biodiversity Are a Signature of Forest Degradation. Global Change Biology, 2024; 0:e17541 (https://www.google.com/url?q=https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.17541&source=gmail&ust=1730468336016000&usg=AOvVaw05wzpINjoJXq6BlRkkPBU7)

The New Brunswick 2023 Forest Carbon Inventory, based on permanent sample plots arranged in a grid pattern throughout the province, found that carbon stored in live trees was highest on lands not subject to industrial forestry. Crown lands used for non-industrial timber purposes was found to store on average 74.3 tonnes of carbon per hectare in live trees. This is 23.5 per cent more carbon than the 60.2 tonnes of carbon per hectare stored on Crown land subject to industrial timber licences. Non-industrial private lands store 63.7 tonnes of carbon per hectare, which is seven per cent more than industrial forestry private lands (59.6 tonnes of carbon per hectare).[46] Given the New Brunswick Forest Carbon Inventory did not account for deadwood or soil organic matter, it is likely that the differences between lands subject to industrial versus non-industrial forestry would be higher in reality. As well, the Forest Carbon Inventory found that carbon storage levels were relatively constant over the timeframe of the study (2016 to 2023) except for Crown lands with no industrial forestry, which increased over the timeframe of the study.

Aside from the impact on sites already scheduled for cutting, adding biomass as a harvesting product can make forest stands more economical to harvest, potentially expanding the area cut or decreasing the time until a particular stand is cut. Any incentive that results in cutting stands earlier or in cutting additional stands will reduce the overall carbon stores in New Brunswick's working forests.

The Vermont study was based on stand-level impacts of harvesting on forest carbon storage. A study in Massachusetts, however, looked at the landscape-level impacts of forest harvesting on forest carbon.[47] Under status-quo forestry management, the researchers estimated the state's forests would store an additional 1.9 million tonnes of carbon over the next 50 years. When biomass harvesting was introduced, however, the result was a net loss of carbon to the atmosphere, estimated at 7.3 to 9.9 million tonnes. The authors conclude that pursuing forest biomass energy at a large scale would likely result in a net increase in atmospheric carbon.

Manomet Study

The State of Massachusetts commissioned the Manomet Center for Conservation Studies to complete a life-cycle analysis of carbon emissions from forest biomass harvesting. The centre considered (a) the efficiency at which biomass is burned, (b) the intensity of forest harvesting, (c) management of biomass-harvested sites post-harvest, and (d) the type of fossil fuel replaced by the biomass fuel.[48]

The analysis found that the best-case scenario for forest biomass energy is when (a) biomass is burned at high efficiency (that is, used to heat buildings), (b) low-intensity harvesting is used (non-clearcut with structural diversity maintained), and (c) biomass replaces fossil fuels with relatively high emissions. Under best-case scenarios, the carbon debt incurred by burning biomass can be repaid within one to two decades, after which net GHG emissions begin to decrease. However, under less-than-ideal

[46] Hennigar and Brooks, *supra* note 4.

[47] J Thompson et al. 2009. Biomass energy and a changing forest landscape: Simulating the effects of intensified timber harvest for biomass energy. Poster presentation at 2009 LTER All Scientists Meeting, Sept. 14-16th, 2009, Estes Park Colorado: http://asm.lternet.edu/2009/posters/biomass-energy-and-changing-forest-landscape-simulating-effects-intensified-timber-harv.

[48] Thomas Walker et al. 2010. *Biomass Sustainability and Carbon Policy Study*. Brunswick, Maine: Manomet Center for Conservation Sciences. http://www.manomet.org/manomet-study-woody-biomass-energy.

scenarios, such as where intensive forest harvesting is used and where biomass is burned to produce electricity, the carbon debt may persist for over a century..

The authors of the study provided a 40-year snapshot of net carbon emissions under various scenarios. They predicted that replacing a coal-fired electricity plant with a biomass-fired plant would result in a three per cent net increase in emissions during the 40-year period. Replacing a natural gas power plant would result in a 110 per cent increase in emissions during the period. Replacing oil-fired heating with biomass fuel, on the other hand, was predicted to decrease net emissions by 25 per cent during the 40-year period.

A questionable assumption in the Manomet study is that forests subjected to biomass harvesting will regrow to the pre-harvest level of carbon. The study does not contemplate scenarios in which biomass harvesting either depletes the capacity of the forest soils to regain baseline carbon levels, or biomass harvesting brings about shorter-rotation harvesting. Both of these situations would significantly increase the carbon debt payback time.

Note, the Manomet study used a business-as-usual baseline for forest carbon storage, meaning it considered current forest carbon stores and forest harvesting as the baseline from which to add or deduct carbon. This baseline does not recognize the potential for depleted forests to store additional carbon if forest management was improved.

McKechnie Study

Researchers from the University of Toronto and the Ontario Forest Research Institute conducted a study of the Great Lakes-St. Lawrence Forest region, similar to the Manomet study.[49] They too noted that assuming carbon-neutrality of biofuels fails to account for delays in the mitigation of carbon emissions. They note that bioenergy policies that fail to address carbon flows in the forest may achieve emissions reductions on paper but not in reality. McKechnie et al. found that for the Great Lakes-St. Lawrence Forest, burning biomass for electricity would increase emissions relative to coal-fired electricity for between 16 and 35 years.

Holtsmark Study

Holtsmark, a Norwegian researcher, conducted research similar to the Manomet and McKechnie studies but included the impact of multiple biomass harvests as well as the impact of harvest occurring at economic maturity rather than carbon-storage maturity.[50] By his model, Holtsmark found that an increased harvest level in forests leads to a permanent transfer of carbon from the forest to the atmosphere. His model did not include the impact of replacing fossil fuels on net GHG emissions, but nonetheless his results suggest that the Manomet and McKechnie studies underestimate the carbon debt payback period.

---

[49] J. McKechnie, et al. 2011. Forest Bioenergy or Forest Carbon? Assessing Trade-Offs in Greenhouse Gas Mitigation with Wood-based Fuels. *Environ Sci Technol* 45: 789. SEE ALSO: M.T. Ter-Mikaelian, et al. 2011. The Carbon neutrality assumption for forest bioenergy: A case study for northwestern Ontario. *The Forestry Chronicle* 87: 5. AND SEE ALSO: M.T. Ter-Mikaelian, et al. 2014. Carbon debt repayment or carbon sequestration parity? Lessons from a bioenergy case study in Ontario, Canada. *GCB Bioenergy* doi:10.1111/gcbb.12198.

[50] B. Holtsmark. 2012. The outcome is in the assumptions: analyzing the effects on atmospheric CO2 levels of increased use of bioenergy from forest biomass. *GCB Bioenergy* doi: 10.111/gcbb.12015.

5.3 Emissions from Black (Torrefied) Pellets

Torrefaction and steam-treatment are two processes by which white pellets, wood chips, forest residues or agricultural wastes are reduced in water content (from approximately 50 per cent to eight per cent moisture content), made resistant to moisture uptake, and made more energy dense (approximately 15 per cent more energy by weight). The resulting pellets, known as black pellets, are less expensive to transport per unit of energy potential, can be stored outside and have a combustion quality similar to coal. They are, however, more expensive than white pellets or wood chips due to additional processing.

The actual energy content of torrefied pellets varies according to the heat at which they are torrefied. In a 2024 study (carried out in Fredericton, N.B.), Fuwape and Opara found that torrefaction at 225 Celsius resulted in pellets with 22.02 megajoules per kilogram (MJ/kg), while torrefaction at 300 Celsius resulted in pellets with 29.86 MJ/kg. Un-torrefied pellets, meanwhile, have an energy content of 18.9 MJ/kg.[51]

Black pellets are not yet widely available on a commercial scale. A 2021 report claims that no company had yet achieved ongoing commercial-scale production of black pellets to meet commercial contracts.[52] A 2020 report noted one plant in Estonia producing 157,000 tons of black pellets per year, and a plant in Portugal producing 120,000 tons of black pellets per year.[53] Blackwood, a Dutch company, is currently supplying torrefied pellets for testing purposes.

NB Power has issued a request for proposals to supply between 500,000 and 1.3 million tonnes of torrefied pellets per year, which appears to be significantly more than the total world production of torrefied pellets, at least as of 2020.

NB Power was asked for an interview about the proposed biomass project but declined, offering the following statement instead:

> "Finding an alternative fuel source for Belledune is part of our long-term strategy to drive New Brunswick to a cleaner, greener future and be more environmentally sustainable for generations to come. We are excited to share that on March 25 [2024], Belledune began burning biomass (pellets) to test its viability as a fuel source. The test wrapped up on April 2 [2024] and the results are very encouraging. … Right now, we are analyzing the results and further testing the pellets to determine the long-term viability of burning biomass."[54]
>
> - Monica McKendy, Business Development Advisor, NB Power

Mr. Denis Caron, CEO of the Port of Belledune noted in an interview that for its test firing in April 2024, NB Power acquired 5,000 tonnes of black pellets from a combination of two sources, one in Quebec and

[51] J.A. Fuwape and E.U. Opara. 2024. Emissions and combustion characteristics of torrefied wood *pellets*. *BioResources* 19(1), 134-145.

[52] Almuth Ernsting. 2021. *The Multiple Failures of Black Pellet Technologies – A recent history of false promises, company bankruptcies and mothballed plants*. Biofuelwatch.

[53] European Technology and Innovation Platform. 2020. *Torrefied Pellets*: https://www.etipbioenergy.eu/value-chains/products-end-use/intermediates/torrefied-pellets

[54] Comm from Monica McKendy, Business Development Advisor, NB Power; June 5, 2024.

one in Norway.[55] Mr. Caron also noted that NB Power will need to acquire 1.2 million tonnes of black pellets annually to supply the proposed Belledune biomass plant.

GHG Emissions

In theory, gases released during the torrefaction process can be burned to help generate the heat required for torrefaction. As a result, it is possible for the life-cycle GHG emissions of torrefied pellets to be not significantly greater than the life-cycle GHG emissions of white pellets. A 2023 study by Alizadeh *et al*., found that steam-treated pellets, on the other hand, result in four times the GHG emissions compared to white pellets.[56] At this time, it is not known what treatment process would be used for Belledune's fuel supply. NB Power is engaged in test-firing black pellets at the Belledune station, using torrefied pellets from a Quebec supplier (Airex Energy), and steam-treated pellets from a company in Norway.[57]

A 2020 study, Yun *et al*. states that replacing coal in Asian power stations with torrefied pellets from British Columbia will reduce GHG emissions by 85 per cent.[58] However, this study assumes immediate and full carbon neutrality for the forest side of the carbon equation, and so does not accurately reflect the true GHG emissions of black pellets. This study shows that transporting black pellets significant distances (British Columbia to Asia) results in a significant increase in gross GHG emissions.

6. Impact of Belledune Conversion to Biomass on Particulate Matter Emissions

"Particulate matter" or "particulates" are airborne solid particles and liquid droplets, which can be composed of many different chemicals. Some particulates are emitted directly from a source, such as a construction site, while the majority form in the atmosphere from chemical reactions of gases emitted from sources such as power plants.[59] Particulate pollution comes from a variety of sources but burning fossil fuels and biomass forms the largest.[60]

Particulate matter is classified based on its diameter. Three different classifications are used: TSP (Total suspended particulates), PM_{10}, and $PM_{2.5}$. TSP consists of all particulate matter with a diameter of less than 100 micrometres and includes PM_{10} and $PM_{2.5}$. PM_{10} consists of particulate matter that is less than 10 micrometers in diameter and includes $PM_{2.5}$. $PM_{2.5}$, also known as "fine particulate", is particulate

[55] Alexander Johnson. 2024. Belledune Hydrogen Plan Balloons to $8B Megaproject. *AllNovaScotia*, June 20, 2024.
[56] Peyman Alizadeh et al. 2023. Life cycle assessment of bioenergy production from wood sawdust. *J of Cleaner Production*. Vol 427: November 15.
[57] David Palmer. 2024. Getting to Net Zero. *Atlantic Forestry Review*. Vol 30(5).
[58] Huimin Yun, Roland Clift & Xiaotao Bi. 2020. Environmental and economic assessment of torrefied wood pellets from British Columbia. *Energy Conservation and Management*. 208: March 15.
[59] United States Environmental Protection Agency (USEPA). July 11, 2023. *Particulate Matter (PM) Basics*: https://www.epa.gov/pm-pollution/particulate-matter-pm-basics.
[60] Simone Amaral, et al. 2016. *Particulate Matter Emission Factors for Biomass Combustion*. *Atmosphere* 7(11), 141: https://www.mdpi.com/2073-4433/7/11/141.

matter with a diameter of less than 2.5 micrometers.[61] Examples of PM_{10} include dust from roads, quarries, and tire wear. The most common source of fine particulate is fuel combustion.. [62]

Health Canada has estimated that air pollution contributes to around 15,300 deaths in Canada annually, as well as an increase in emergency room visits. The economic cost of the negative health impacts is estimated to be around $120 billion annually.[63] Particulate matter is a major source of air pollution. PM_{10} and $PM_{2.5}$ are small enough they can be easily inhaled and can end up deep in the lungs or the bloodstream, increasing the risk of asthma attacks, chronic bronchitis and heart attacks.[64] Due to this health risk, PM_{10} and $PM_{2.5}$ are the most problematic of the three categories of particulates.[65]

In addition to human health risks, particulate matter pollution can also reduce visibility in the form of smog, and can cause changes to water and soil chemistry which can adversely affect biodiversity.[66]

6.1 Regulation of Particulate Matter Emissions

New Brunswick's *Clean Air Act* "aims to protect and improve the quality of air we breathe, and to encourage the wise use of resources across the province."[67] The act regulates air pollution through a system of air quality approvals. The *Air Quality Regulation*, NB Reg 97-133 under the act, divides approvals for pollution sources into four different classes based on the amount of anticipated pollution generated Section 21(1) and Schedule B of the *Regulation* prohibit anyone from releasing or permitting the release of total suspended particulate above an average of 120 milligrams particulate per cubic metre of air (mg/m^3) over a 24-hour period and an average concentration of 70 mg/m^3 per year.[68]

The regulation includes a maximum concentration of total suspended particulate matter but does not specify limits for fine particulates. The Council of Canadian Ministers of the Environment has developed Canadian Ambient Air Quality Standards which recommend limiting fine particulate matter ($PM_{2.5}$) to a 27 mg/m^3 average over a 24-hour period and 8.8 mg/m^3 average over a year.[69]

6.2 Historical Particulate Matter Emissions from Belledune Coal-fired Generating Station

Pollution control equipment has been installed at the Belledune Thermal Generating Station to reduce particulate matter emissions from the facility. This equipment includes an electrostatic precipitator that is designed to remove 99.5 per cent of the particulates generated by coal combustion.[70]

---

[61] USEPA, *supra* note 58.

[62] Government of New Brunswick, Department of Environment and Local Government. 2022. *An Introduction to Air Quality in New Brunswick*: https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Air-Lair/AirQuality-QualiteDeLair/IntroductionAirQuality.pdf.

[63] Canadian Council of Ministers of the Environment. *Canada's Air*: https://ccme.ca/en/air-quality-report.

[64] *Ibid*.

[65] USEPA, *supra* note 58.

[66] USEPA, *supra* note 58; Canadian Council of Ministers of the Environment, *supra* note 62.

[67] Government of New Brunswick. *About the Clean Air Act*: https://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/air_quality/clean_air/act.html.

[68] *Clean Air Act*, SNB 1997, c. C-5.2.

[69] Canadian Council of Ministers of the Environment, *supra* note 62.

[70] *Ibid.*

Guidelines established by *Thermal Power Generation Emissions – National Guidelines for New Stationary Sources* that were in place at the time the plant was constructed, published under the federal *Environmental Protection Act,* established particulate emission limits and required continuous monitoring.[71]

According to the Department of Environment's Belledune Thermal Generating Station Facility Profile, historical particulate matter emissions at Belledune ranged from 22 to 690 tonnes of particulate per year for the 450-megawatt facility. The facility's Approval to Operate sets a limit on total particulate matter emissions at 160 mg/m^3. The New Brunswick Department of Environment reports that annual testing between 2014 and 2018 revealed particulate matter concentrations ranging from 1.77 to 23.8 mg/m^3.[72]

6.3 Particulate Emissions after Biomass Conversion

During biomass combustion, PM_{10} and $PM_{2.5}$ can be generated and emitted into the air.[73] The amount generated and emitted depends on several factors including the type of biomass used, the combustion temperature, and the technology that is in place to filter particulate matter, such as the electrostatic precipitator used at the Belledune facility.

Without more detail on the specific plans for the Belledune biomass project, it is difficult to predict the potential change in particulate matter emissions of coal-fired versus biomass-fired power generation at the Belledune facility. Due to the significance of particulate emissions on air quality, this change should be quantified during the project-assessment process.

The Partnership for Policy Integrity, a think-tank focused on forest protection policies, reported in its analysis of power plants' air pollution permits in seven states that biomass burners emit equal or more particulate matter compared to coal. The report does not provide the methodology used to reach this conclusion.[74] According to the report, documents for a proposed 100-megawatt biomass plant in Florida predicted the plant would emit 249.8 tons of particulate matter per year (0.26kg/megawatt-hour). The report also includes data from the proposed 35-megawatt Palmer Renewable Energy biomass plant in Massachusetts, which anticipates emitting 42.4 tons of PM_{10} per year.

British Columbia's William's Lake Power Plant is a 66-megawatt biomass-fuelled electricity generating station with a primary fuel source of wood residue from local sawmills. According to a technical

---

[71] Government of New Brunswick, Department of Environment and Local Government. 2019. *Facility Profile: New Brunswick Power Corporation for the Belledune Thermal Generating Station*: https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Air-Lair/Class-Categorie1/NBPowerBelledune/FacilityProfile.pdf.

[72] *Ibid*.

[73] IEA Bioenergy. 2017. *Aerosols from Biomass Combustion*: https://www.ieabioenergy.com/wp-content/uploads/2017/10/Two-page-summary- per centE2 per cent80 per cent93-Aerosols-from-Biomass-Combustion.pdf.

[74] *Partnership for Policy Integrity. Burning Wood is not Clean!:* https://www.pfpi.net/air-pollution-2/.

assessment, the William's Lake Power Plant's total particulate emissions averaged 6.3mg/m^3 per year over 13 years of testing. This is lower than the permitted limits of 50 mg/m^3.[75]

7. Biomass Harvesting: Impact on Biodiversity and Forest Productivity

A significant increase in demand for forest biomass will increase the amount of biomass removed per unit of land cut and may increase the overall amount of land cut by making economically marginal stands commercially viable to cut.

Biomass product is intended to be woody material that is otherwise unmerchantable, including tree tops and branches, woody shrubs, and trees that are a non-commercial species or otherwise too small, crooked, damaged or decayed to be sold as lumber. This material includes standing and fallen dead trees as well as coarse woody debris: Much of which would eventually decompose and augment soil organic matter. All of this material has ecological roles in the forest. As discussed in more detail below, academic literature shows that biomass harvesting (or specifically the reduction of coarse woody debris and/or standing dead trees) in eastern North American forests reduces abundances of species of amphibians, herbaceous vascular plants, bryophytes(mosses and liverworts), lichens, trees, insects, soil fauna and birds.

Researchers note the reduced coarse woody material habitat, reduced abundance of sang and cavity trees, loss of food resources, loss of shade resulting in increased temperature and light and decreased moisture levels, and reduced habitat at a landscape level all result in biodiversity declines greater than that explained by loss of stand-level habitat alone.

Finally, biomass harvest can reduce the productivity of forest soils, depending on the intensity of harvest and the nutrient capacity of the forest soil.

7.1 Birds

A review of literature assessing the impact of forestry on bird communities in New Brunswick and Nova Scotia found forestry practices can have dramatic changes in the habitat available to birds. It recommends snags, cavity trees and coarse woody material be maintained during forest harvesting.[76] Other research has found that maintaining a canopy closure of 70 per cent and a density of 80 large trees per hectare is necessary to maintain a full complement of forest bird species; neither of these conditions are present in a clearcut biomass harvest.[77]

In a 2022 study, Betts et al. found that frequent clearcutting and landscape-level transformation due to intensified forestry practices (Figure 5) has caused declines in forest bird populations in the Maritime

[75] Atlantic Power Corporation. 2016. Technical Assessment: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-permitting-and-compliance/atlantic-power/technical_assessment_report-8808.pdf.
[76] B. Freedman & G. Johnson. 1999. Studies of forestry and avian communities in Nova Scotia and New Brunswick. In *Biology and Conservation of Forest Birds. Society of Canadian Ornithologists Special Publication* No. 1: 65-72.
[77] J.-S. Guénette & M.-A. Villard. 2005. Thresholds in forest bird response to habitat alteration as quantitative targets for conservation. *Conservation Biology* 19(4): 1168-1180.

provinces of Canada.[78] The study aimed to quantify the impact of the loss of biological complexity, disregarding loss of total forest cover, on bird populations. As such, the results of this study are important to consider in the context of increased harvesting intensity.

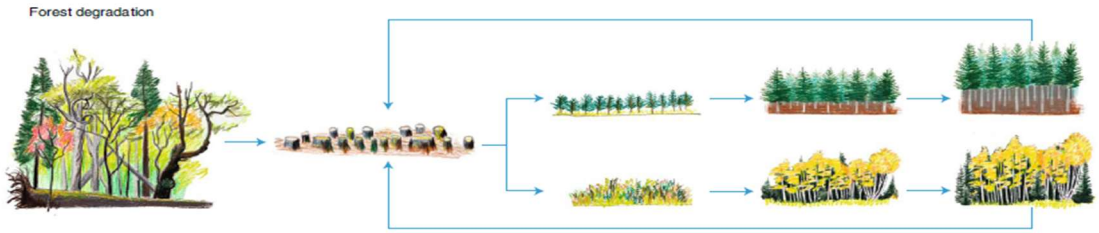

Figure 5: One-way conversion of biologically complex forest to simplified industrial forestry stands

The Betts et al. study notes that from 1985 to 2020, some three million hectares of forest was clearcut within the Acadian Forest region of eastern Canada. Most of these clearcuts were converted to plantations and/or thinned and are now dominated by monoculture or a mix of early-successional tree species (Figure 6).

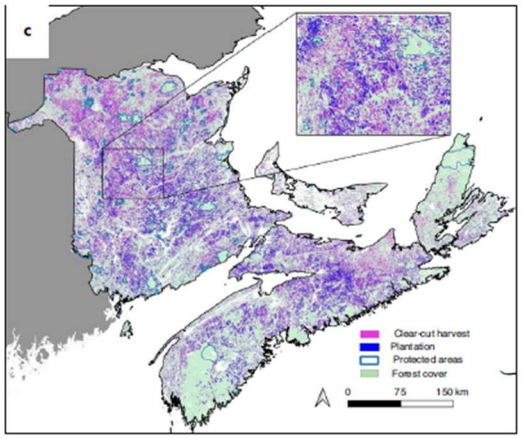

Figure 6: Cumulative clearcut disturbance and plantations, 1985 to 2020 (protected areas noted in green)

Old forest declined by 39 per cent during this 35-year period, while total forest cover increased by just 6.5 per cent (Figure 7). During this time period, more than 280,000 square kilometres of forest bird habitat were lost in this region, representing the habitat for an estimated 33 to 104 million birds. The study found that increasing clearcutting was strongly associated with habitat declines for all bird species associated with old forests.

[78] M.G. Betts et al. 2022. Forest degradation drives widespread avian habitat and population declines. *Nature Ecology & Evolution*. 6: 709-719.

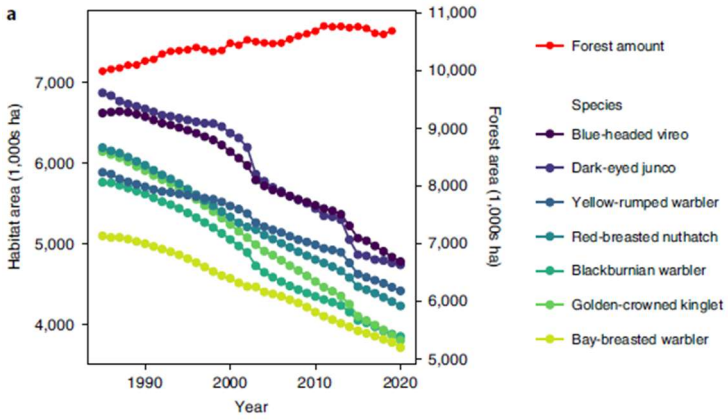

Figure 7: Increase in total forest area in Maritime Provinces while habitat for forest birds declined

The researchers also found that almost all forest-bird populations investigated were positively impacted by increasing amounts of habitat. The researchers found that despite slight increases in total forest area, forest bird species have declined markedly and that this decline is driven by forest degradation rather than forest reduction. Four species that are associated with old forest habitat have declined by more than 30 per cent between 2010 and 2020. This rate of decline is consistent with the "threatened" category according to COSEWIC.[79] Figure 8 below, for example, shows the habitat loss (and gain) for golden-crowned kinglets from 1985 to 2020.

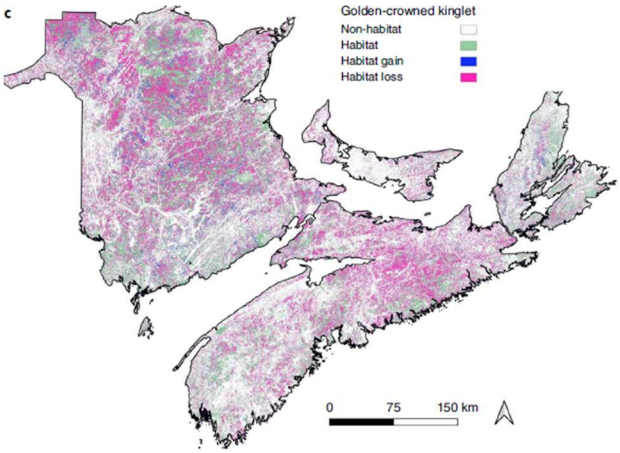

Figure 8: Habitat loss and gain for golden-crowned kinglet, 1985 - 2020

The study also notes that the decline of some forest-bird species outpaces habitat loss. Blackburnian warbler populations, for example, declined by about 70 per cent between 1985 and 2020, but lost only 33 per cent of their habitat. The authors offer that these species may be experiencing habitat thresholds, whereby declines in habitat below a certain threshold results in exponential population decline, or they are experiencing other threats (wintering ground habitat loss, climate change, contaminants and/or mortality on migration). Figure 9 shows forest habitat, clearcuts and young forest

[79] Committee on the Status of Endangered Wildlife in Canada: https://www.cosewic.ca/index.php/en/assessment-process/cosewic-assessment-process-categories-and-guidelines/status-categories.html

regeneration in and around Fundy National Park in southern New Brunswick while Figure 10 shows the lack of blackburnian warbler habitat due to land use in this same area.

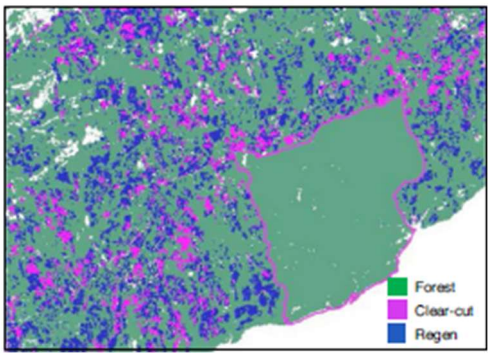

Figure 9: Clearcuts, post clearcut regeneration, and forest in vicinity of Fundy National Park, NB (1985 – 2020)

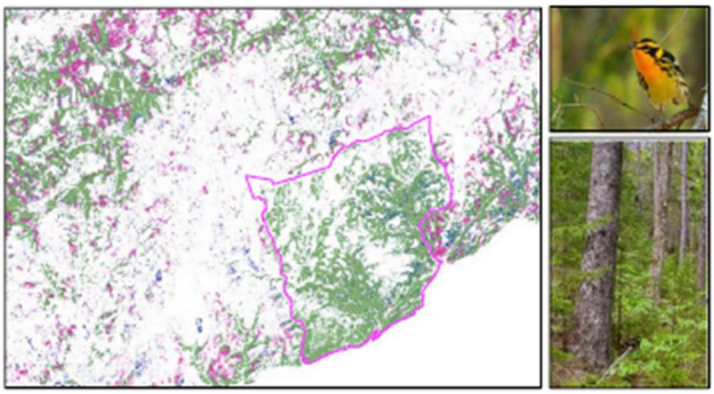

Figure 10: Same region as Figure 9, showing Blackburnian warbler habitat (old coniferous and mixed forest) 1985 - 2020: green = current; pink = loss; blue = gain; white = non-suitable habitat as of 1985; pink outline is Fundy National Park

7.2 Amphibians

In a review of studies across North America, researchers found that the negative impacts of clearcutting on amphibians can be long lasting, due to the loss of coarse woody debris, the drier and warmer microclimate conditions, and reduced leaf litter and food resources.[80] The researchers emphasize that amphibians need to move overland and have access to suitable aquatic environments. The drier environment of clearcuts, especially in biomass harvests, may be the most important driving factor in

[80] P.G. deMaynadier and M.L. Hunter Jr., 1995. The Relationship between forest management and amphibian ecology: a review of the North American literature. *Environ. Rev*. 3(3-4): 230-261. Additional studies include: D.A. Patrick et al. 2006. Effects of experimental forestry treatments on a Maine amphibian community. *Forest Ecology and Management*. 234(1-3): 323-332; R.C. Waldick, B. Freedman, & R.J. Wassersug. 1999. The consequences for amphibians of the conversion of natural, mixed-species forests to conifer plantations in southern New Brunswick. *Canadian Field-Naturalist* 113(3): 408-418; A.E. Morneault et al. 2004. The effect of shelterwood harvesting and site preparation on eastern red-backed salamanders in white pine stands. *Forest Ecology and Manag*. 199(1):1-10; P.G. deMaynadier & M.L Hunter Jr. 1998. Effects of silviculture edges on the distribution and abundance of amphibians in Maine. *Conservation Biology* 12(2): 340-352; R.D. Semlitsch, et al. 2009. Effects of Timber Harvest on Amphibian Populations: Understanding Mechanisms from Forest Experiments. *BioScience* 59(10):853-862.

the decline of amphibian populations in these locations. The researchers noted similar trends across North America's forest regions.

Studies of partial harvests have not found negative impacts of harvesting on amphibians.[81]

7.3 Soil Organisms and Above-ground Insects

In a mixed-forest study in Quebec, researchers found that the abundance of soil microarthropods (type of soil insects) decreased by 68 per cent following whole-tree harvesting, compared to a 56 per cent reduction following conventional clearcutting.[82] Similarly, researchers in Quebec's Boreal Forest have found that clearcutting and removal of deadwood reduces the abundances of forest beetles and soil microarthropods, concluding that conventional clearcutting does not leave enough coarse woody material to sustain arthropod communities.[83]

Partial cutting in a northern hardwood forest in Quebec, however, has been found to have no adverse effect on soil fauna.[84] Similarly, a study in Maine found that partial cutting had no impact on mountain click beetles.[85]

In a review of the available literature, Spence et al noted that clearcutting and intensive forestry management results in local losses of species.[86]

7.4 Ground Plants, Bryophytes and Lichens

Researchers in New Brunswick have found clearcutting reduces the abundance and diversity of ground vegetation, especially bryophytes, and recommend minimizing forest floor disturbance, maintaining shade cover and leaving uncut strips or patches.[87] Other researchers in New Brunswick forests have found similar results.[88]

7.5 Deadwood Habitat

---

[81] H.C. McKenny, W.S. Keeton & T.M. Donovan. 2006. Effects of structural complexity enhancement on eastern red-backed salamander (*Plethodon cinereus*) populations in northern hardwood forests. *Forest Ecology and Management* 230186-196.

[82] B.A. Bird and L. Chatarpaul. 1986. Effect of whole-tree and conventional forest harvest on soil microarthropods. *Canadian J of Zoology* 64: 1986-1993.

[83] T.T. Work et al. 2008. Evaluation of carabid beetles as indicators of forest change in Canada. *The Canadian Entomologist* 140: 393-414.

[84] J.-D. Moore, et al. 2002. Effects of two silvicultural practices on soil fauna abundance in a northern hardwood forest, Quebec, Canada. Canadian J of Soil Science. 82: 105-113.

[85] S.L. Thomas, R.G. Wagner & W.A. Halteman. 2008. Influence of harvest gaps and coarse woody material on click beetles (Coleoptera: Elateridae) in Maine's Acadian Forest. *Biodiversity and Conservation* 18(9): 2405-2419.

[86] J.R. Spence et al. 2008. Conservation of forest-dwelling arthropod species: simultaneous management of many small and heterogeneous risks. *Can. Entomologist* 140(4): 510-525.

[87] M.R. Roberts & L. Zhu. 2002. Early response of the herbaceous layer to harvesting in a mixed coniferous-deciduous forest in New Brunswick, Canada. *Forest Ecology and Management* 155(1-3): 17-31.

[88] N.J. Fenton, K.A. Frego & M.R. Sims. 2003. Changes in forest floor bryophyte (moss and liverwort) communities four years after forest harvest. *Canadian J of Botany* 81: 714-731; AND A.L. Ross-Davis & K.A. Frego. 2002. Comparison of plantations and naturally regenerated clearcuts in the Acadian Forest: Forest floor bryophyte community and habitat features. *Canadian J of Botany* 80: 21-33.

Researchers have documented reduced amounts of standing dead trees and coarse woody material in managed versus unmanaged forests. A study in the Great Lakes states found that coarse woody material in red pine forests was 90 per cent less immediately after clearcutting and 35 per cent less after 90 years of regrowth. Standing dead trees were 99 per cent fewer immediately after clearcutting and 75 per cent fewer 90 years after clearcutting.[89] Whole-tree harvesting resulted in 44 to 55 per cent less forest floor organic matter in a Quebec study,[90] and a significant decrease in forest floor organic matter for 64 years following harvest in northern hardwood forest.[91]

7.6 Fish and Other Aquatic Species

Forests maintain healthy aquatic ecosystems and provide ecosystem services such as clean drinking water, flood and drought protection as well as habitat for many species. Simply put, healthy watercourses depend on healthy forests.

Forest harvesting, generally, can impact aquatic environments by potentially increasing sedimentation, nutrient concentrations, and stream temperature, and by changing the rate at which water moves from the forest and into watercourses. All of these can reduce the health of aquatic ecosystems, and these impacts are likely increased with increasing residue removal through biomass harvesting.[92]

Woody material left on site after conventional clearcutting can help to slow snow melt in the spring and slows the movement of water through the forest and into watercourses spring to fall. This has the beneficial impact of moderating water input into watercourses and of reducing soil erosion (and thus sediment input) in sloped areas. Woody material left on site also provides shade that helps to moderate water temperature entering aquatic environments.[93]

A review of studies in New Brunswick of the impacts of conventional forest harvesting on aquatic ecosystems found that sedimentation of watercourses due to forestry activities increased with increasing intensity of harvesting. However, the review noted that detrimental impacts on watercourses were most closely associated with increases in building of forest roads, rather than with forest harvesting itself.[94]

---

[89] M.D. Duvall & D.F. Grigal, 1999. Effects of timber harvesting on coarse woody debris in red pine forests across the Great Lakes states, USA. *Can J of Forest Research*, 29(12): 1926-1934.

[90] S. Brais, et al. 1995. Changes in nutrient availability and forest floor characteristics in relation to stand age and forest composition in the southern part of the boreal forest of northwestern Quebec. *Forest Ecology and Management* 76: 181-189.

[91] W.W. Covington. 1981. Changes in forest floor organic matter and nutrient content following clearcutting in northern hardwoods. *Ecology* 62: 41-48.

[92] Nadeem W. Shah, et al. 2022. The effects of forest management on water quality. Forest Ecology and Management. 522 (October 15)

[93] Evelyn Thiffault. 2015. Forest Biomass Harvesting: Best Practices and Ecological Issues in the Canadian Boreal Forest. Natural Resources Canada, Canadian Forest Service.

[94] Maitane Erdozain, et al. 2022. Understanding the effects of forest management on streams and rivers: A synthesis of research conducted in New Brunswick (Canada) 2014 – 2018. The Forestry Chronicle. November 23.

Notably, aquatic ecosystems in eastern Canada are negatively impacted by acid precipitation changing the aquatic environment's acidity, and climate change causing warmer water temperatures.[95] Additional pressure caused by increasing forest harvesting intensity and extent can compound the stresses on aquatic environments.

7.7 Forest Soil Productivity

Biomass harvesting, as envisioned in New Brunswick under the now-defunct Biomass Policy, removes otherwise non-merchantable woody material from the forest, including tree branches and tops, woody shrubs, and dead trees. All of these play an important role in nutrient cycling in the forest (their importance to biodiversity is discussed further in this report), given that the bulk of nutrients in a tree are located in its bark, small branches and leaves or needles. A study in Maine showed that whole-tree cutting removes 90 per cent of the above-ground biomass of a harvested stand, and 91 per cent of the nitrogen, phosphorus, potassium and calcium nutrients contained above ground (excluding stumps). This removal rate is two-to-four times the nutrient loss caused by stem-only clearcut harvesting, while only increasing biomass removal by 40 per cent.[96] Studies on eastern forests have also found that carbon pools in forest soils decrease significantly following clearcutting.[97]

Forest harvesting and soil acidification stress (caused by acid precipitation and/or conversion of hardwood or mixedwood sites to softwood), can lead to nutrient deficiencies, causing declines in forest health and productivity. Even stem-only harvesting can lead to nutrient deficiencies when short-rotation cutting is employed, or on sites that are nutrient poor.[98]

New Brunswick's Biomass Policy warned against biomass harvesting that depletes forest productivity, but it applied only to Crown lands (approximately half of the province's forests) and there is no publicly-available evidence it has ever been applied and adhered to on Crown lands.

In 2016, Keys at al. published a study of the potential impact of forest harvesting on the productivity of Nova Scotia's forest soils.[99] The authors developed a model to assess forest soils for depletions of nutrients due to various intensities of harvesting and stresses of soil acidification. The authors also compared soil survey data with actual soil sampling data at 25 spruce plantations. The authors found that calcium and nitrogen are the main growth-limiting nutrients across Nova Scotia, that current soil cation (positively charged ions essential for plant growth) contents are generally lower than what is reported in historic reports and that currently projected plantation yields are generally not sustainable on sites with weathering soils.

---

[95] For example, Natural Resources Canada. Threats to Forest Water Resources. https://natural-resources.canada.ca/our-natural-resources/forests/sustainable-forest-management/conservation-and-protection-canadas-forests/threats-forest-water-resources/15082

[96] Smith et al. 1986. Nutrient and biomass removals from a red spruce – balsam fir whole-tree harvest. *Canadian J of Forest Research*, 16(2), 381-388.

[97] J.B. Richardson, C.L. Petrenko, & A.J. Friedland. 2017. Base cations and micronutrients in forest soils along three clear-cut chronosequences in the northeastern United States. *Nutrient Cycling in Agroecosystems*. 109(2): 161-179.

[98] Kevin Keys et al. 2016. A Simple Geospatial Nutrient Budget Model for Assessing Forest Harvest Sustainability across Nova Scotia, Canada. *Open Journal of Forestry*. 6: 420-444.

[99] *Ibid*.

Keys et al. noted that nutrient deficiencies are possible even with conventional stem-only harvesting when cutting demands are high or when harvests occur on nutrient-poor sites. They found that conventional stem-only harvesting is not sustainable for 25 to 50 per cent of the assessed plantations. Plantations with non-sustainable harvesting rates were mainly associated with low-weathering soils and/or tree species with high nutrient demands. Keys et al. caution that predicted increases in yields through intensive forest management (planting, thinning, etc.) are not sustainable on all sites. Keys et al. recommend nutrient budget assessments be used in all forest management planning, especially in the context of biomass harvesting.

One of the authors of the Keys et al. study published a master's thesis on the same subject, although the geographic scope was limited to the landmass of Kejimkujik National Park in south-west Nova Scotia.[100] Figure 4, below, models the impact of differing intensities of harvesting on soil productivity within the study area. Green represents soils that can withstand harvesting without loss of forest productivity while red represents soils that cannot. White areas are water or wetlands. The harvesting intensities are stem only (i.e., conventional clearcutting), whole-tree cutting in the winter (no leaves on hardwood trees), and whole-tree cutting in the summer (leaves on). The left column shows the impact on productivity from harvesting alone, and the right column shows the impact of harvesting in conjunction with acid precipitation.

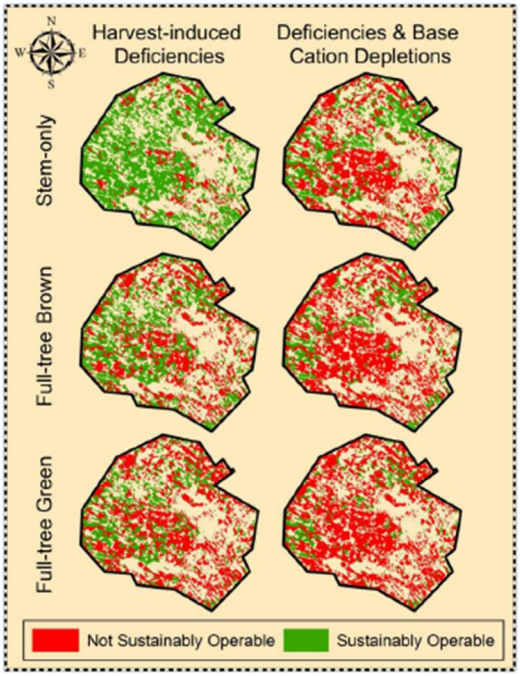

Figure 4: Impact of harvest types and timing on soil productivity

The study area is in a part of the province impacted by acid precipitation from the north-east United States, and generally has low-weathering soils. As such the soils in this region are particularly sensitive

[100] Josh Noseworth, *A mass balance, biogeochemical framework for assessing forest biomass harvest sustainability*. Masters of Science in Forestry Thesis, University of New Brunswick, 2011.

to impacts on soil productivity. The fact that even stem-only harvesting is unsustainable on the majority of soils in this area is striking, as well as the impact of cutting in winter versus summer.

In New Brunswick, the Department of Natural Resources, in conjunction with Dr. Paul Arp (University of New Brunswick), developed a nutrient budget model for Crown lands in 2008. The model has not been revisited since 2012, when its use was abandoned. The department reports that the model indicated biomass could be harvested once from the majority of forest sites in New Brunswick without significant impacts to soil nutrients. The department also noted that the impact of acid rain on forest soils is of more concern than a one-time biomass harvest.[101]

In summary, whole-tree harvesting (and conventional clearcutting) presents risks to long-term forest productivity on certain soils, especially marginal soils, slow-weathering soils, and those impacted by acid precipitation.[102]

8. Conclusion

NB Power's proposal to convert its Belledune coal-fired electricity generating station to burn biomass (torrefied or black pellets) would result in the largest biomass electricity facility in Canada. There are no suppliers of torrefied pellets in New Brunswick, so this report considers the impact of the proposal under two scenarios: Either a supply of torrefied pellets is established in New Brunswick, or raw biomass is exported to manufacturers of torrefied pellets outside of the province.

Industrial harvesting of biomass is harmful to forest biodiversity. Biomass removed for energy consists of logging residues including tops and branches of trees, dead trees and trees otherwise unmerchantable because of their size, species or quality. All of this woody material plays an important role in the forest ecosystem. It provides essential habitat for much of a forest's wildlife, it returns nutrients and organic matter to the soil thereby protecting soil productivity and it helps protect water quality and aquatic habitats.

NB Power's proposed 375-megawatt biomass energy facility is estimated to require the equivalent of 920,000 to 2,392,000 tonnes of green biomass per year. There is not enough biomass within a reasonable trucking distance (150 kilometres) of the Belledune site to supply this amount, even if NB Power were somehow able to acquire the entire annual production of biomass on both Crown and private land. The bottom line is that were the Belledune biomass project to proceed, it would create a massive new demand for biomass, far outpacing what the province can provide.

In addition to the severe negative impacts of biomass harvesting on forest biodiversity, potential reductions in greenhouse gas emissions are dubious, at least for the next decades. Due to the

[101] Comm. from Shawn Morehouse, Department of Natural Resources and Energy Development, June 7, 2024

[102] For example: M.K. Mahendrappa et al. 2006. Environmental Impacts of Harvesting White Spruce on Prince Edward Island. *Biomass and Bioenergy*, 30: 363; D.A. Scott et al. 2004. Forest soil productivity on the southern long-term soil productivity sites at age 5, in Kristina F. Connor, ed. 2004. *Proceedings of the 12th biennial southern silvicultural research conference*. Gen Tech Rep SRS-71. Asheville, NC: US Department of Agriculture, Forest Service, Southern Research Station; E. Thiffault, et al. 2011. Effects of forest biomass harvesting on soil productivity in boreal and temperate forests – A review. *Environ Rev* 19(278). Counter findings: R.F. Powers, et al. 2005. North American long-term soil productivity experiment. *Forest Ecology and Management* 220(31).

inefficiency in converting biomass energy to electricity, the additional reduction in forest carbon stores as well as the potential decline in forest productivity, it is very likely that the proposed Belledune biomass facility would increase GHG emissions relative to the current coal-fired facility for at least several decades.

Fortunately, there are alternatives. Greenhouse gas emissions can be reduced by replacing oil-fired heating systems with biomass fuel, provided that the biomass is harvested using low-impact forestry methods that retain a significant portion (between 30 and 70 per cent) of the forest post-harvest.