Analysis of a wood production strategy from expert perspectives

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ABSTRACT

In 2020, Quebec adopted a strategy to increase the quantity and quality of timber it produces. During a roundtable discussion held in the fall of 2021, experts in forestry and in related fields expressed their views on the new strategy and its implementation challenges. The main purpose of this article is to present the key observations from the roundtable. The observations addressed two themes: the general context in which the strategy was developed, and the context of its implementation on the ground. Although most of the panellists agreed on the relevance of such a strategy, particularly as regards to climate change mitigation and wealth creation, several questions remain. The challenge of harmonizing uses, regionalization, spatialization of management decisions, labour shortage, and uncertain ecosystem dynamics make it difficult to assess the strategy's potential impact on the ground and its ability to achieve its targets.

Keywords: forest management, intensive silviculture, timber production, decision-making process

RÉSUMÉ

En 2020, le Québec a adopté une stratégie nationale de production de bois (SNPB) afin d'augmenter la quantité et la qualité de la matière ligneuse produite. Au cours d'une table ronde tenue à l'automne 2021, des experts de la foresterie et de domaines connexes se sont prononcés sur cette nouvelle stratégie et sur les défis de mise en œuvre qu'elle pose. L'objectif principal de cet article est de présenter les principaux constats émis au cours de cette table. Les constats ont été divisés en deux thématiques, soit le contexte général d'élaboration de cette stratégie et le contexte de sa mise en œuvre en forêt. Bien que la plupart des panélistes s'entendent sur la pertinence de créer une telle stratégie, notamment en ce qui a trait à l'atténuation des changements climatiques et à la création de richesses, plusieurs interrogations persistent. Les défis d'harmonisation des usages, de régionalisation, de spatialisation des décisions d'aménagement, de manque de main-d'œuvre et de la dynamique incertaine des écosystèmes complexifient l'évaluation des retombées potentielles de la SNPB sur le terrain et sa capacité d'atteindre les cibles établies.

Mots-clés : aménagement forestier, sylviculture intensive, production de bois, processus décisionnel

Introduction

In many parts of the world, forest managers are encouraged to adopt practices that make the forest industry more competitive through development of the various forest resources. One way to improve competitiveness is to intensify silvicultural practices that can sustain timber production while supplying timber with the characteristics desired by the forest industry. These so-called "intensive" practices, generally confined to small areas, can ease the pressure on natural forest stands (Messier *et al.* 2003). Silviculture intensification is similar, in some respects, to agricultural practices, because of the recurrence of treatments, the interest in production at the scale of the individual tree, and the increase in human intervention (Bell *et al.* 2006; Gravel and Meunier 2013). Intensifying silvicultural practices is part of a portfolio of possible options (Royer-Tardif *et al.* 2021). In Western countries, especially Canada, more intensive practices are generally integrated into a forestry matrix subordinated to various management objectives, such as the conservation of protected areas and the multiple use of forests (Barrette *et al.* 2014).

In Quebec, in accordance with the *Sustainable Forest Development Act*, the forest regime adopted in 2013 is designed to manage forest resources by establishing measurable objectives and targets using an ecosystem-based management approach that narrows the gaps between natural landscapes and landscapes that are managed to maintain multiple ecosystem functions. To achieve this, the government developed a forest management policy and decision-making process based on three decision scales and the corresponding time scales: strategic (long-term), tactical (medium-term), and operational (short-term) (Fig. 1). Deci-

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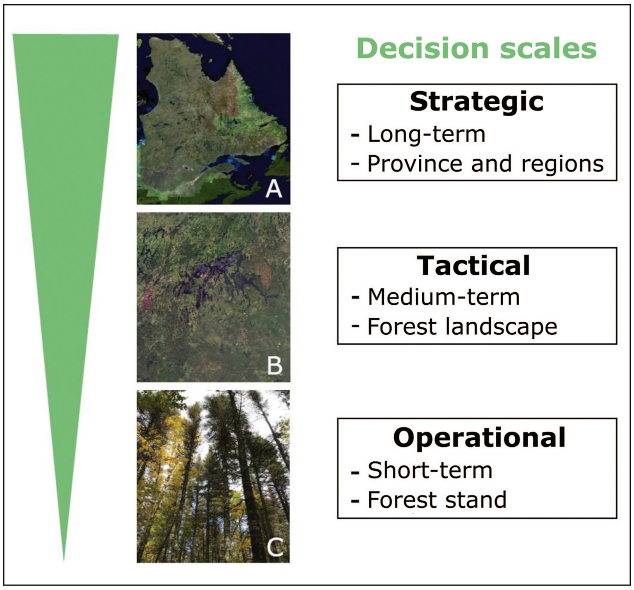

Fig. 1 Decision scales used in forest management in Quebec and examples of their corresponding spatial and temporal scales. Images
A and **B** show the provincial/regional scale and the forest landscape scale, respectively. Image **C** shows the forest stand scale. Images **A** and **B** were produced in ArcMap 10.8 using February 2022 images from the Service d'imagerie du gouvernement du Québec (WMTS), while image **C** was taken in the Gaspé region of Quebec by C.-M. Canuel in 2019.

sions at the strategic or long-term scale define the general vision and set targets that will guide the forest management process for a given area over several rotations.[1] Tactical decisions are concerned with the medium-term perspectives of managing forest landscapes in different regions with regard for their specific issues. Decisions at the operational scale concern the management and spatialization of silvicultural interventions in forest stands considered in the short term (Desrosiers *et al.* 2010). These three decision scales, which are reflected in the planning process, are also consistent with the Sustainable Forest Management Strategy (MFFP 2015).

Québec Timber Production Strategy (QTPS)

In connection with silviculture intensification, in 2020, the province adopted the Québec Timber Production Strategy (QTPS), which sets out the government's timber production policies. The QTPS presents a plan for managing Quebec's forests responsibly to increase the forest products industry's contribution to the province's economy and its regional economies while addressing the needs and values of society. It also outlines the major role that forests will play, now and in the future, in achieving the province's climate change mitigation objectives (MFFP 2020). It is part of the Sustainable Forest Management Strategy (MFFP 2015), a global strategy adopted by the Quebec government when it updated its forest regime in 2013. The QTPS aims to address the challenges posed by the imperative to create diversified wealth, in view of the government's policies regarding ecosystem protection and conservation and social acceptability. Although the QTPS is not a statutory document, it establishes guidelines and targets for timber production with a view to sustainable management of Quebec's forest resources. It is composed of five axes with a total of 11 objectives (Table 1).

By virtue of its foundations and objectives, the QTPS is an important tool for the government in guiding decisions on managing Quebec's timber resources and forests. However, its implementation on the ground is a matter of great concern. In particular, the QTPS contains quantitative targets for increasing timber production for the province. Those targets include annual allowable cut increases[2], annual allowable cut harvest rates, and average yield from managed areas[3]. Implementation of the QTPS will affect many sustainable forest management decisions at all three scales (strategic, tactical, and operational). For these reasons, the QTPS is drawing praise, concern, and criticism from different forest stakeholders.

In this paper, we present the main points discussed by a panel of experts during a roundtable at Colloque Biodiversité 2021, a symposium organized by the Quebec Network for Reforestation and Intensive Silviculture and Réseau Environnement (Textbox 1). To structure the discussion on the QTPS and ensure consistency between sections, we present two thematic contexts, subdivided into three or four sub contexts depending on the topic. In the first section, we discuss the general context in which the QTPS applies. In the second section, we discuss the implementation of the QTPS. In the third section, we present a conclusion containing a synthesis of key ideas that will provide a clearer understanding of the issues with the QTPS in the environmental, social, and economic contexts.

General context

Wealth creation: A sure value

Wealth creation and the value generated by Quebec's forests are mentioned at various points in the QTPS. On a theoretical level, value is not taken as a single thing but rather as an umbrella concept (Holland 2011). For forestry, two types of values characterize the total economic value of forest ecosystems: use values and non-use values. These values, which vary in tangibility, are broken down according to the many goods and services provided by ecosystems (MEA 2005). For example, timber, non-timber forest products, and recreation are more tangible values than cultural, spiritual, or human well-being services. However, the primary value addressed in the QTPS is that of direct use—in other words, the supply of timber. The QTPS does not discuss the other types of values associated with the forest. Hence, if we focus on this one value, how is it possible to increase the wealth generated by the forest? To answer this question, we must consider four possibilities: (1) increase the quality of forest products, (2) increase

[1]The scale used may vary. In some cases, it may be the entirety of Quebec's productive forest land; in others, it may be a type of forest such as spruce or maple.

[2]Annual allowable cut on the public land is determined by the Office of the Chief Forester, an independent body within the Ministère des Forêts, de la Faune et des Parcs. Annual allowable cut is the maximum volume that can be harvested annually from a forest management unit.

[3]Average forest yield refers to the average annual increase per unit area (m^3/ha*yr).

the quantity of products and co-products, (3) increase the productive area, or (4) increase the quantity of timber produced per unit area.

First, increasing value through better fibre quality requires the adoption of silvicultural strategies that include close monitoring of field work to ensure that it is having a positive impact on forest productivity. At the provincial level, the concept of quality may refer to the production of a similar volume of timber, but with a higher unit value ($/m^3). For example, for a given area of forest, it would be necessary to focus on the production of trees with a higher market value depending on the species or phenotype characteristics. In this context, value can be increased by producing the same quantity of timber but focusing on species or genotypes that have a higher unit value.

Second, to increase value, it would be necessary to improve fibre processing capability. To achieve this, two options are available. The first is to produce more with the quantity and quality of timber currently being harvested. This means reducing losses by improving processing techniques, which will increase the value generated per stem. This option, based on optimizing stem processing, among others by modernizing equipment, has been employed in recent years.The second option would be to generate more valuable co-products (e.g., biofuels or other bioproducts derived from wood debris). While it is always sensible to engage in research and development to find new uses for wood fibre, it is probably not a good idea in the short term to rely solely on this approach to increase the value of wood products. Increasing the use of the volume of wood already available by also encouraging the use of wood that would otherwise be left standing or as woody debris on the ground in cutblocks (which currently cannot be processed) is part of the solution to increasing value.

Table 1. Axes and objectives of the Québec Timber Production Strategy (MFFP 2020)

Axis	Objectives
Production of economically desirable timber characteristics	Increase production of timber with the desired
	Make profitable investments in the forest
	Increase the robustness of management strategies so that they are able to withstand risk and uncertainty in the context of climate change
	Provide the necessary care to forests in which silvicultural investments have been made in order to achieve the desired results
Harvest of available timber	Increase the harvest of available timber
	Make better use of the timber available in the short and medium term
Private forest's contribution to collective wealth forests	Increase the harvest of available timber in private
	Increase timber production in private forests
Forest sector's contribution to climate change mitigation goals	Help to increase carbon sequestration in the forest and in forest products
Innovation and knowledge	Support innovation, research, and development
	Incorporate leading-edge knowledge into forestry practices

Third, value can be increased by expanding the productive forest area. This option may be complex to implement because forest area growth is limited by several factors, including physical factors (the northern limit), ecological factors (protected areas), anthropogenic factors (increasing urban development) and political factors. Yet it is an attractive option in the context of afforestation of marginal or abandoned lands (e.g., mine sites or uncultivated farmland); reforested lands can contribute to increased CO_2 sequestration and storage and to timber supply (Forster *et al.* 2021; Ménard *et al.* 2022). In the context of value creation, however, it is a solution with negligible benefits, except as part of a forest carbon credit scheme. Currently, there is an accumulation of uses and rights on productive forest area, which greatly constrains the potential for expansion. On the other hand, the timber supply could be increased by making more use of timber on private lands. By creating greater synergy between public and private holdings, a larger volume of fibre could be brought into play, and the flow of timber to the major users could be stabilized.

Fourth, value can be increased by augmenting the volume of timber produced per unit area. This solution requires the adoption of intensive silvicultural practices whose aim is not to increase timber quality and unit value, but to produce a larger volume of timber by focusing on characteristics that ensure operational efficiency with less regard for quality. This approach has been adopted by several countries, including New Zealand (Yao *et al.* 2017) and Nordic countries (Lindahl *et al.* 2017). However, these countries are employing monoculture models, whereas Canada is taking the opposite approach by focusing on extensive management based on sustainable management principles associated with natural disturbances[4]. Increased harvest volume could also mean more tree harvesting in an extensive management context.

[4]The Canadian Council of Forest Ministers has developed a framework that includes a set of criteria and indicators. More specifically, the framework has six sustainable forest management criteria: (1) biological diversity, (2) ecosystem condition and productivity, (3) soil and water, (4) role in global ecological cycles, (5) economic and social benefits, and (6) society's responsibility (CCFM 2005).

Textbox 1. Roundtable at Colloque Biodiversité 2021

The main issues associated with the implementation of the Québec Timber Production Strategy, a new strategy to increase timber production, were explored in an expert roundtable held on October 4, 2021 as part of Colloque Biodiversité 2021, a symposium jointly organized by Quebec Network for Reforestation and Intensive Silviculture and Réseau Environnement in conjunction with the Natural Sciences and Engineering Research Council of Canada and the Ordre des ingénieurs forestiers du Québec. For the occasion, a variety of panellists from academia, government and industry were invited to comment on this new roadmap and on the challenges of its implementation in the short, medium and long term. The panellists who took part in the roundtable discussion, moderated by Nancy Gélinas, Dean of the Faculty of Forestry, Geography and Geomatics at Université Laval, shared their thoughts on the Québec Timber Production Strategy. The panel was composed of the two lead authors of this article, Anne Bernard, forest engineer and postdoctoral fellow in the Silva21 project at Université Laval, and Claudie-Maude Canuel, forest engineer and doctoral candidate in Forestry Sciences at Université Laval; Thomas Moore, forest engineer and project manager in the Ministère des Forêts, de la Faune et des Parcs; Pierre Drapeau, director of the Centre for Forest Research and full professor in the Department of Biological Sciences at the Université du Québec à Montréal; Éric Lapointe, forest engineer and superintendent of private lands and forest operations for Domtar; Evelyne Thiffault, forest engineer and professor in the Wood and Forest Science Department at Université Laval; and Mathieu Bouchard, forest engineer and professor in the Wood and Forest Science Department. Nicolas Bélanger and Nelson Thiffault, co-directors of the Quebec Network for Reforestation and Intensive Silviculture, proposed and organized the event and participated with the authors. Nicolas Bélanger is a full professor in the Science and Technology Department at Université TÉLUQ, and Nelson Thiffault is a researcher with the Canadian Wood Fibre Centre (Natural Resources Canada). The content of this article is an interpretation of the remarks and ideas presented during the roundtable; it is the sole responsibility of the authors. The panel discussion can be viewed at the following address:

https://youtu.be/bypoHs5jv-M?list=PLugocxT5-EWMVqh4RJ_hrO5fkeUCI3ziS

Currently, only certain stems or parts of stems are harvested depending on species, size, or fibre quality.

Increasing value based on quality and based on quantity are not mutually exclusive. It is perfectly feasible to employ intensive practices to increase timber volume while focusing on species or phenotype characteristics that generate greater value. However, how that value will be created needs to be better defined in the QTPS. There are many land-related and social issues involved. Hence, the option chosen must also be based on these factors, which are likely to influence how stakeholders coexist on the land. Lastly, where sustainable development is concerned, the renewable nature of wood and its derivatives gives it an advantage over other primary resources.

Harmonization of uses in the context of intensive forestry

The main objective of the QTPS is to increase wood production. However, other forest users must not be left out when the QTPS is implemented. There are a multitude of land claims that predate the QTPS, including First Nations' claims to ancestral lands. The implementation of a strategy focused on timber production could lead to more claims and more dissatisfaction in certain sectors. How can multiple uses be reconciled while ensuring that forest production satisfies value creation needs? Some stakeholders are concerned that they will not have access to the forest lands defined in the QTPS and that multi-use value will be reduced. The issues surrounding the harmonization of forestry operations today are legion and resolving them can be a complex task. In addition, with growing public interest in forest land for recreational purposes, harmonization issues will multiply.

In Canada, there are a variety of public participation tools through which the different users can play a role in forest management. In the Quebec context, Local Integrated Land and Resource Management Panels (LILRMPs) are the main vehicle for stakeholders to learn about the many forest issues and participate in the decision-making process. There are LILRMPs for all public forests, bringing together stakeholders at the regional level. LILRMP membership nevertheless varies from one region to another and from one stakeholder group to another (Bernard 2021). Stakeholder disengagement may be due to historical and cultural circumstances that have worked against the balance of power, sidelining the interests of less influential players (Miller and Nadeau 2017). Through participation mechanisms such as LILRMPs and other types of consultation groups, stakeholders are asked to take position on various issues, including those related to intensive silviculture. While stakeholders share their interests, needs and expectations, the resulting decisions favour the concerns of governments and industries over those of other stakeholders (Miller and Nadeau 2017; Bernard 2021).

When forest management decisions are relatively centralized, it is common for stakeholders to demand greater transparency from government. Hence, the introduction of a timber production strategy does not necessary reflect what society wants in forest management. For many, it is a roundabout way of ignoring society's forest management interests. It is therefore important for managers of public land to develop clear and transparent timber production strategies. The issue of timber production is closely tied to conservation issues. With intensive silviculture in small, targeted areas, mills could, in the longer term, be assured a constant supply of timber, and the pressure on natural forests could be eased (Messier *et al.* 2009; Drapeau *et al.* 2022; Himes *et al.* 2022). Over time, this type of management approach would help meet conservation goals by facilitating the establishment of more protected areas.

Timber production's role in climate change mitigation

The QTPS talks about the forestry sector's potential to mitigate climate change and its impacts. In this regard, forest management is recognized as a means to fight climate change (Nabuurs *et al.* 2007). The use of wood products (lumber, panels, pulp and paper, bioenergy) may play a key role in forest management's ability to mitigate climate change (Eriksson *et al.* 2007; Paradis *et al.* 2019). For one thing, long-life products keep carbon (captured through photosynthesis as trees grow) out of the atmosphere for long periods of time, thereby delaying its emission in the form of greenhouse gases. For another, wood products, including new products from emerging industries such as forest bioenergy and bioproducts, which have less stringent fibre quality requirements than conventional wood products, have the potential to replace non-renewable materials and fossil-based energy sources. Wood products, which have a low carbon footprint, can thus reduce greenhouse gas emissions by replacing other products with a higher carbon footprint, such as concrete and steel in the construction sector, or fossil fuels in the energy sector (Gustavsson and Sathre 2006; Zhang *et al.* 2010). However, how much wood products can contribute to climate change targets depends on several complex ecological and socio-economic factors and remains a source of uncertainty (Giuntoli *et al.* 2020; Brunet-Navarro *et al.* 2021). In Quebec's current forest industry system, only a portion of the harvested wood is used to make solid wood products that store carbon over long periods of time. For example, in the case of the boreal fir forest in Montmorency Forest, an estimated 42% of the harvested softwood is turned into sawmill products on average, and about 45% into pulp and paper products (Paradis *et al.* 2019); the half-life of sawmill products is estimated to be 35 years, compared with only two years for pulp and paper products (IPCC 2014). According to a recent Quebec-wide study, the use of wood in the non-residential construction sector could contribute 3.5% of the greenhouse gas reduction targets by 2050 (Cordier *et al.* 2021).

Forest management also has the potential to enhance the forest's ability to sequester and store carbon, which would otherwise be present in the atmosphere as CO_2 (thus contributing to global warming) (Ruddell *et al.* 2007). However, forest management scenarios can have varying effects on emissions and sequestration of carbon and other gases (including methane [CH_4], a greenhouse gas 25 to 30 times more potent than CO_2) depending on forest type, intervention intensity and recurrence, and timber use (Paradis *et al.* 2019; Röder *et al.* 2019).

In some cases, more intensive wood harvesting may be compatible with management scenarios that promote carbon sequestration and storage. For example, a recommended way of increasing ecosystem carbon sequestration and storage is to use silvicultural treatments that limit soil disturbance and retain some canopy cover or promote rapid site recovery after harvesting. Stand tending practices that increase stem size and quality can also promote production of sustainable wood products capable of storing carbon for decades. Forest management's contribution to climate change mitigation cannot be generalized; it depends on the products generated by industrial forest harvesting, the condition of residual forest sites, and the supply and processing efficiency of industries that use the timber (Moreau *et al.* 2022). The effect of climate change itself on the composition and productivity of forest ecosystems may also limit the forestry sector's future ability to contribute to carbon sequestration and storage (Valade *et al.* 2017; Landry *et al.* 2021).

Timber production first and foremost serves the needs of societies here and elsewhere. From the global perspective of climate change mitigation, combined with our dependence on high-carbon products and energy sources such as fossil fuels, it makes sense for a province with an important forest sector to produce renewable materials and energy sources, provided that it adopts appropriate silvicultural practices. That said, can a strategy such as the QTPS justify increased forest harvesting? If so, under what conditions? In other words, does the implementation of such a strategy constitute a socially acceptable use trade-off? While the QTPS is part of the solution to climate change, it is only one of many.

Implementation of the QTPS

Regionalization of the implementation

The diversity of regional concerns justifies efforts to decentralize decision-making, including regarding the QTPS's implementation, which will require the development of regional strategies, i.e., strategies based on each region's social, economic, and ecological characteristics. While the QTPS outlines broad policy directions, regional strategies describe ways of increasing timber production at the local level.

Decentralization of forest land management decisions and professional autonomy are two demands that forest stakeholders have made regularly in recent decades (Colfer and Capistrano 2005). However, how quantitative targets and objectives were determined before the development and application of regional strategies raises questions. For example, do forest managers, forest workers and other specialists involved have the necessary tools to do so? Are the tools available the right ones? Are the targets and objectives developed in a strategy such as the QTPS realistic? Managers of public forests will have to come up with answers to all these questions over the next few years, answers that will serve to document the successful implementation of such a strategy.

Labour: Availability and responsibility issues

Like other industries, the forestry sector has a labour shortage. Questions are being asked about the applicability of the QTPS, which talks about expanding forestry interventions at a time when silvicultural companies are struggling to recruit workers. Achieving the QTPS's targets for increased yield and harvest rates will require the use of new technologies and innovations in practices. However, the question remains: who will be able to do this work when there are growing labour shortages? The introduction of new practices and technologies at the operational level will challenge companies to recruit sufficient numbers of skilled, high-performing employees. Moreover, the incomes of many stakeholders in the forest industry, such as silvicultural workers, operators, and entrepreneurs, generally depend on their performance. Those incomes could shrink as the stakeholders will need time to assimilate new technologies and work techniques. Hence, there is a new challenge: ensure the financial stability of workers while securing timber supplies for mills.

Forest resource management is socially, economically, and environmentally complex. Consequently, it should not be conceived as a standardized, normative system, as it often lies at the intersection of different spheres that involve both science and ethics. In view of the need for early action to ensure successful implementation of the QTPS, professionals in the field will play a key role. Their skills, knowledge and judgement must be leveraged. One concern is the expanding role of mathematical tools in forest management decision-making. For example, modelling, a tool that is often employed in a deterministic approach rather than a stochastic one, is used to achieve the QTPS's targets. However, those targets must be achieved with due regard for the principles of sustainable forest management. The dynamic and interactive relationship between resources and society would benefit more from the use of stochastic processes rather than deterministic ones. Yet successful implementation of the QTPS probably depends on the input of professionals in the field aided by the most advanced mathematical tools. The adoption of such an approach would provide the flexibility needed to deal with the complexity of forest resource management.

Spatialization of intensive practices (zoning or allocation)

Since the QTPS applies to the entire forested part of Quebec, spatialization will play a major role in its implementation. Implementing the QTPS requires significant investments to increase the production of economically valuable timber. Moreover, because not all the various forest ecosystems have the same vulnerability to disturbances, application of the QTPS will necessarily vary with local circumstances. One of the characteristics of Quebec's forest is that it is submitted to natural disturbances that are often unpredictable and vary in frequency, severity, and extent. Moreover, the forest management that is done obeys the principles of ecosystem management, which require that efforts be made to narrow the gaps between the natural forest and the managed forest. However, the cumulative effects of forest management and natural disturbances create even more uncertainty about the evolution of forest stands as regards climate change and timber supply (Boulanger *et al.* 2019). Under these conditions, it is important to judiciously select areas where silvicultural investments are appropriate and to adequately protect them from natural disturbances.

To increase timber production, there is a need for a clear and consistent vision of forest harvesting objectives on managed sites. This will optimize the return on investment, particularly for intensively managed sites. One way of meeting this need is to adopt a functional land-use zoning approach such as the TRIAD, which could facilitate the concurrent achievement of various objectives for the forests (Himes *et al.* 2022). Although this approach is not new (Bowes and Krutilla 1985; Swallow and Wear 1993; Vincent and Binkley 1993) and has proven itself in several contexts, including Quebec (Messier *et al.* 2009), only protected areas and timber production intensification areas have a different allocation status today. While the QTPS does not set a target for the establishment of areas of increased timber production (AITPs), it raises an issue concerning the need to use this tool to achieve targets for increasing timber production. Introducing AITPs without first determining a more explicit frame of reference for all of Quebec's forests exacerbates the concerns that some forest users already have. Those concerns are especially acute since the implementation of AITPs remains incomplete in various regions of Quebec for environmental and socio-economic reasons. Despite strict zoning approaches, there are other approaches that could be explored, including spatial prioritization of issues and management objectives.

To rethink the distribution of uses in relation to utilization issues at the scale of the forest, it has been proposed that communications between forest users be improved so that they can participate early in the decision-making process. This proposal will promote the application of the sustainable forest management principles put forward in Quebec's Sustainable Forest Management Strategy (MFFP 2015).

Considering risk in a dynamic ecosystem

The forestry sector is facing many challenges, and there will be more in the coming years. First, climate change has its own share of uncertainties. Temperate and boreal forest ecosystems are expected to undergo significant changes in the coming decades due to prolonged periods of drought, changes in precipitation patterns, soil acidification, changes in seasonality and species phenology, and so on (e.g., D'Orangeville *et al.* 2018; Boulanger *et al.* 2022). It is difficult to predict how forest ecosystems will change in response to these new climatic conditions. In addition, market diversification has been a major issue for Quebec since the decline of the pulp and paper industry (Bogdanski 2014). It is hard to predict what fluctuations will occur in the wood products market and to suggest silvicultural scenarios to meet demand, which remains full of uncertainties. For example, the paperboard industry has seen a rapid increase in product demand due to the growth of online shopping. The same is true for emerging industries such as lignocellulose and forest bioenergy, whose success will not be truly measurable until they are tested. Aside from timber production, the forest is also affected by various pressures, including those related to land use and forest resources as a whole. For example, the demand for other services such as maintaining biodiversity, access to wildlife, vacationing, and the maintenance of spiritual values and Indigenous uses could increase or even surpass the demand for wood products.

It is important to incorporate and consider all the uncertainties associated with the implementation of a strategy such as the QTPS to ensure that the targets and objectives remain realistic. Does the QTPS in its current form sufficiently reflect the various risks inherent in forest land management? A number of risks were considered during its development. The following risk categories were considered and assessed:

1. Vulnerability to climate change
2. Natural disturbances (disease and insects)
3. Marketability of products
4. Change in land use
5. Capacity to carry out all the work in the silvicultural scenarios

However, little information is provided as to how these risk categories were considered, including the risk tolerance dimension. The tolerance was considered acceptable in the QTPS's choices. Similarly, there is little information that can be used to trace how the targets were set. It is difficult to assess how realistic the proposed quantitative targets are. Better communication by decision-makers would make it easier to gauge the credibility of the QTPS and its targets, and it would inspire greater confidence in the choices. At this point, only the implementation of the QTPS will show how effectively the risks have been weighed.

On another note, it seems essential to have the capability to revise such a strategy periodically to reflect changes in knowledge and the forest situation. Under Quebec's current forest regime and considering past events, forest management decisions are often reviewed on a five-year cycle (e.g., calculation of annual allowable cut). Historically, monitoring of the effects of forestry interventions on forest ecosystems has been considered deficient in Quebec (Office of the Chief Forester 2015; Auditor General of Quebec 2017), a weakness that may have constrained the province's ability to make sufficiently accurate and reliable projections. This lack of monitoring and reliable data is not only a matter of great concern but also an important issue, in view of the extent and heterogeneity of natural forests like those in Quebec. In the implementation of a strategy such as the QTPS, monitoring data is needed so that periodic review can be carried out. A data collection and monitoring system must therefore be put in place.

Conclusion

A strategy to increase timber production will serve to guide forest management decisions and thereby improve forest resource management. Such a strategy must be implemented with a view to creating value in timber quantity and quality. However, the benefits of increasing the value drawn from forests depend largely on its implementation. The on-the-ground implementation of a strategy like the QTPS and its potential impact on the various stakeholders who use the forest land are a source of concern. As pointed out by Drapeau *et al.* (2022), the application of intensive silviculture (plantation timber) near timber processing and use hubs (mills and urban centres) would strengthen our capacity to deal with climate uncertainties, including our ability to rapidly detect and control forest fires, which are likely to become more frequent because of climate change. In the medium and longer term, mills could begin transitioning their source of timber supply from natural forests to plantations. That transition would both decrease harvesting pressure on natural forests and promote greater consideration of harmonization issues associated with the multiple uses and values of the forest.

Implementing a strategy like the QTPS requires a wide variety of tools and expertise. It must encourage the use of holistic approaches that require the collaboration of all the players along the value chain. Consequently, without competent and properly trained forest workers to carry out intensive management, it is difficult to ensure the strategy's success. It is also important for all forestry professionals to work together to increase the strategy's chances of success.

A strategy of this sort must be implemented in a global context, where sustainable forest management principles take precedence over improvements in economic and financial benefits. Stakeholders who use the forest land and stakeholders who are responsible for forest management need to establish a constructive dialogue. If timber production leaves no room for other uses of the forest, investments made in the short and medium term will result in losses in the longer term. The work of multidisciplinary teams appears to be paramount in the development of a strategy like the QTPS and a prerequisite for its successful implementation.

A strategy such as the QTPS must be aligned with the Sustainable Forest Management Strategy, whose concept of ecosystem-based management has been central to Quebec's forest regime for the past decade. It must also be flexible and dynamic so that it can evolve in response to social demands and changing economic and environmental needs. Because of climate change, the past is no longer as strong a predictor of the future, and forest management paradigms are necessarily evolving toward so-called adaptive management (Achim *et al.* 2022). The strategy must be flexible enough to allow for adaptation and evolution of silvicultural practices needed to manage change. The use of iterative processes that encourage feedback could provide that kind of flexibility and support continuous improvement.

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