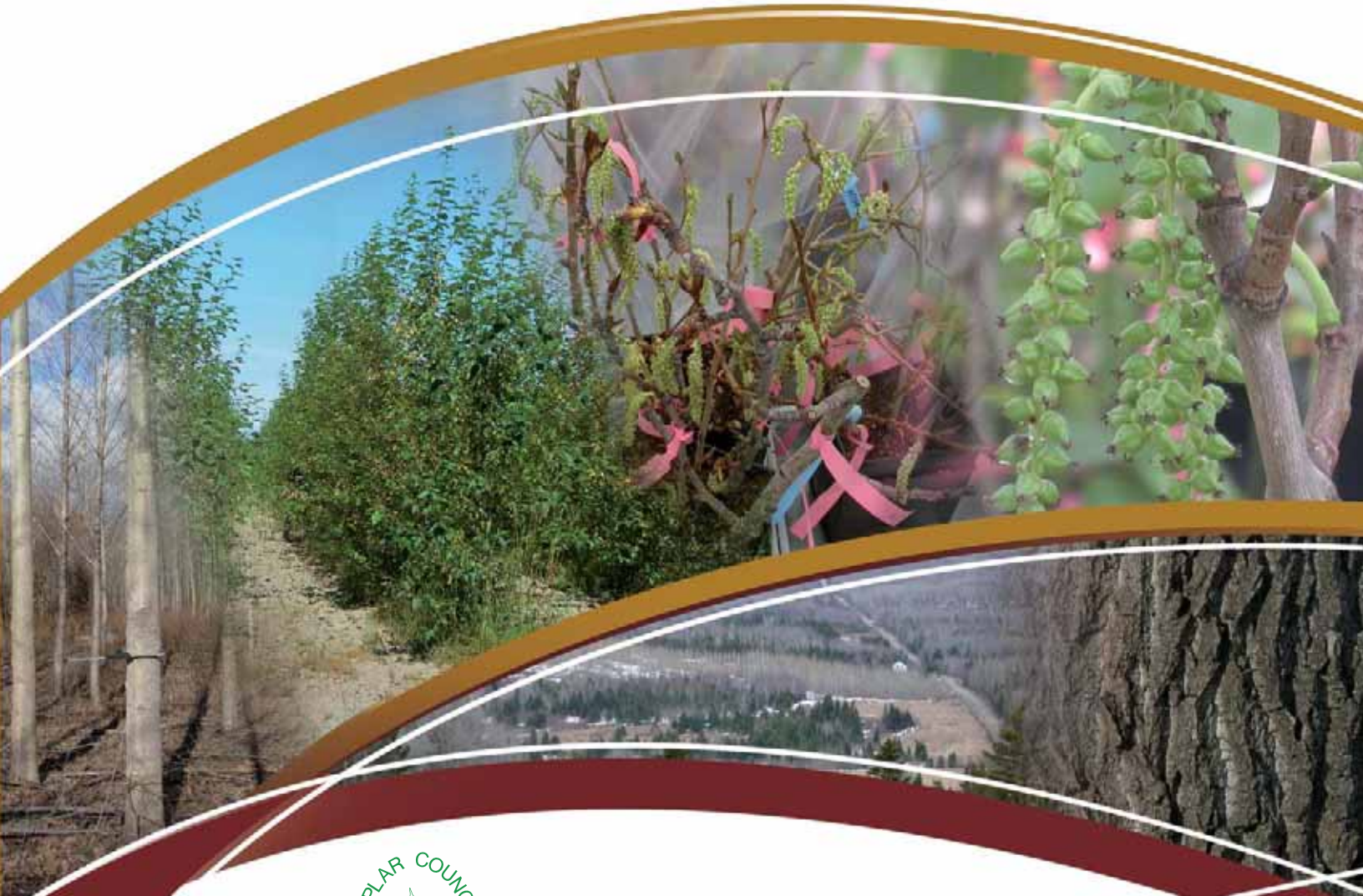
CPC/PCC
2007

Poplar culture: a collaborative effort from clone to mill

2007 Annual Meeting of the Poplar Council of Canada

Field Trip Guide

Rivière-du-Loup and Québec City, September 16-21, 2007



POPLAR COUNCIL CANADA CONSEIL DU PEUPLIER

Ressources naturelles et Faune
Québec

Conference program at a glance

2007 Annual Meeting of Poplar Council of Canada (PCC / CPC)

Poplar culture: a collaborative effort from clone to mill

Sunday Sept. 16	Monday Sept. 17	Tuesday Sept. 18	Wednesday Sept. 19	Thursday Sept. 20	Friday Sept. 21
AM	**Opening and general information:** Hôtel Lévesque, Rivière-du-Loup **Témiscouata Field Tour** **Stop #1:** Poplar farm Norampac Cabano	**Témiscouata Field Tour** **Stop #1:** Demo. poplar plantation PAC48103 / Packington – *Agence forêt privée* **Stop #2:** DRF poplar tests & collections / Packington	**PCC and IUFRO Larix$_{2007}$** Plenary session joint with Larix 2007: four invited speakers (Québec City Convention Centre)	**PCC** Conferences & posters (Québec City Convention Centre)	**IUFRO Larix$_{2007}$** Tree improvement programs at the DRF (Duchesnay)
Lunch (on your own)	Agora, Cabano	Saint-Marc-du-Lac-Long	(Provided at the Convention Centre)	(Provided at the Convention Centre)	(Provided at Duchesnay)
PM **15:00 –** Bus departure from Sainte-Foy (Université Laval) towards Rivière-du-Loup	**Témiscouata Field Tour** **Stop #2:** St-Modeste provincial nursery & propagation centre – MRNF **17:00** **Cocktail hour** offered by VALORITREMBLE Hôtel Lévesque	**Témiscouata Field Tour** **Stop #3:** Norampac plantations St-Eusèbe **Stop #4:** DRF clonal test CAB21196 / St-Eusèbe	**PCC** Conferences & posters (Québec City Convention Centre)	**PCC** Posters (Québec City Convention Centre) **Carrefour** **15 h – 17 h** **PCC / CPC** business meeting	Return to Québec City after lunch
(Supper on your own)	(Supper on your own)	(Provided on tour) Saint-Jean-Port-Joli	Banquet provided at the Québec City Convention Centre	(Supper on your own)	
Evening *Registration and Ice breaker (Hôtel Lévesque)*		Arrival in Québec City at 20:30	**PCC/CPC and IUFRO Larix$_{2007}$**		
(Hôtel Lévesque, Rivière-du-Loup)	(Hôtel Lévesque, Rivière-du-Loup)	(Lodging in Québec City)	(Lodging in Québec City)	(Lodging in Québec City)	

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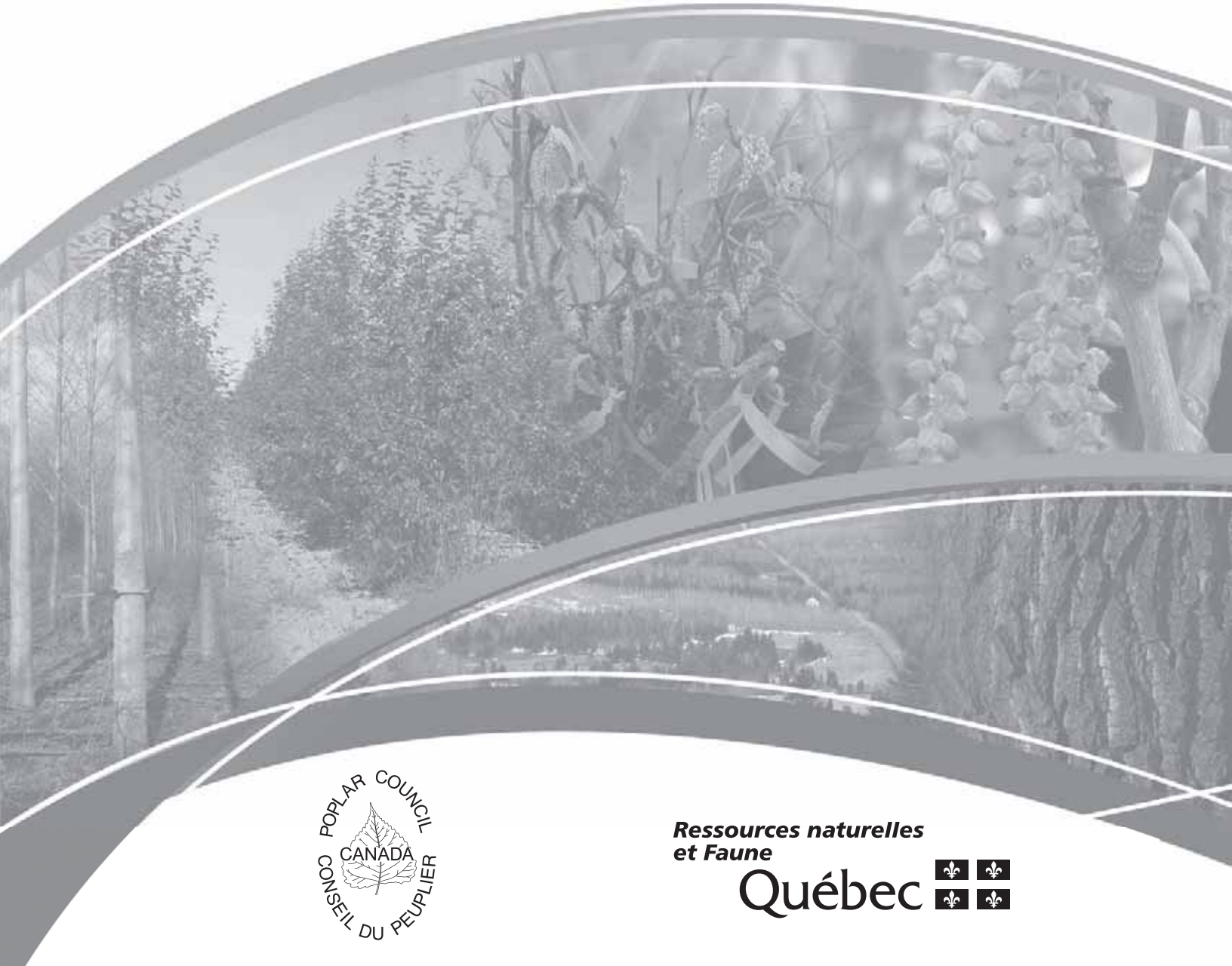

POPLAR COUNCIL CANADA CONSEIL DU PEUPLIER

Ressources naturelles et Faune
Québec

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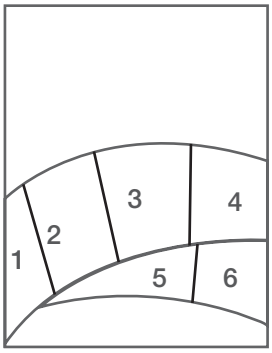

1-5. Alain Fauchon
6. Pierre Périnet
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Context

Forêt Québec, one of the sectors within the *ministère des Ressources naturelles et de la Faune du Québec*, has the mandate of administering the various facets of sustainably managing Québec's public forests, and of contributing to the development of the forest products industry and private woodlots. Within this broad framework, the mission of the *Direction de la recherche forestière* (DRF) is to participate in improving forest practices in Québec by undertaking research and development projects in diverse fields and by ensuring the transfer of know-how to practising foresters.

The Poplar Council of Canada (PCC) is a national non-profit organization committed to the wise use, conservation, and sustainable management of Canada's poplar resources. PCC, first established in 1977, has members from industry, wood lot owners, universities, research establishments, and provincial and federal governments. The principal objective of the CPC/PCC 2007 meeting is to share advances in poplar research in Canada and other countries, and to present various aspects of poplar culture with a number of cases from the Témiscouata area. This year's theme, "*Poplar Culture: a Collaborative Effort from Clone to Mill*", emphasizes the synergy achieved from cooperative efforts shared among poplar growers in the Bas-Saint-Laurent region.

In 1998, under the leadership of Hervé Gagnon (DRF) with the collaboration of the *Direction régionale des forêts du Bas-Saint-Laurent* and three organisms involved with poplar culture, a new research project was initiated to evaluate poplar varieties obtained from breeding for the region. Since the beginning, funding was provided through the *Programme de mise en valeur des ressources du milieu forestier (Volet 1)*. Ten years later, we have the opportunity to visit some plantations established in the Témiscouata area, where over 500 trees were selected in 2006 with in the hybrid progenies planted in Packington. The best ones will eventually replace the old clones planted in the area, and new parent trees will also be selected from the introduced species collections for future breeding.

A word from the organizers

The *Direction de la recherche forestière* (DRF) of *Forêt Québec*, in collaboration with the Poplar Council of Canada, the *Réseau Ligniculture Québec*, *Norampac – Division Cabano*, the *Direction régionale des forêts du Bas-Saint-Laurent*, the *Direction générale des pépinières et des stations piscicoles*, the *Agence de mise en valeur des forêts privées du Bas-Saint-Laurent*, the *Corporation Agro-forestière Transcontinental inc*. and the *Groupement forestier et agricole Taché*, welcomes participants to the 2007 Annual meeting of the Poplar Council of Canada to Québec. We hope that the CPC/PCC 2007 meeting will meet your expectations through the program activities we have organized, starting with two days of field visits.

Participants to the CPC/PCC 2007 will have the opportunity to discover the region of Bas-Saint-Laurent and to visit hybrid poplar plantations in the Témiscouata area. Cultural techniques for production of hybrid poplar and spruce and larch-improved stock will be presented at the Saint-Modeste nursery, where cutting propagation and somatic embryogenesis are integrated to standard nursery practice. Afterwards, participants will present the results of their research during poster and communication sessions, which will be held in Québec City as part of the *Carrefour de la recherche forestière*.

This year, the annual meeting of the Poplar Council of Canada is being held in conjunction with the Larix 2007 Symposium by holding the plenary session of invited speakers, a banquet at the Carrefour, as well as a visit to the *Centre d'expérimentation et de greffage de Duchesnay*, where the DRF's tree improvement programs will be presented. These two events are designed to emphasize two of our star species, poplar and larch, which have been the subject of the DRF's research programs since the early 1970^{s}. In passing, we mention that the DRF is celebrating its 40th anniversary this year. Hosting events like these can be traced back to the actions of visionary pioneers such as Messrs. Gilles Vallée and Jean Ménétrier, inititiators of the research projects in tree improvement and intensive silviculture.

Everywhere in the world we see a clear tendency of meeting the increasing demand for wood through the establishment of plantations. In Québec, the *ministère des Ressources naturelles et de la Faune* Act was modified in 2005 to include principles of forest ecosystem management associated with the functional zoning of the territory. Intensive silviculture therefore meets specific production issues on a reduced area, while reducing pressures on our natural forests. In addition, in the spring of 2006 the Québec government announced a silvicultural investment program funded with a $75 M budget over four years. These investments will allow us to carry out intensive silviculture on high-potential sites, especially the establishment of fast-growing species. Holding this CPC/PCC 2007 meeting integrates well with this thinking.

We wish you a pleasant stay in Québec, *la belle province*, and a successful and fruitful meeting!

The Organizing Committee

Acknowledgments

We extend our thanks to the *Carrefour de la recherche forestière* and the *Direction de la recherche forestière* (DRF) who host the 2007 Annual Meeting of the Poplar Council of Canada as part of the joint seminars of the Carrefour. Our financial partners played a key role by providing necessary material support for this regionally based multi-day event. Thanks for your support!

We acknowledge the contribution of all our collaborators in the Bas-Saint-Laurent region, specially for the Norampac – Cabano field visits. In addition to the organizing committee, several persons participated in organizing the meeting, in the regions as well as at the *Carrefour*, and we cordially thank them for their contributions: Stéphan Mercier, Maripierre Jalbert, Marie Dussault, Sabrina Morissette, Mireille Desponts, Daniel Robert and Jean Noël. Particular thanks to Jean Ménétrier and Jim Richardson for their help in developing the theme for the meeting.

We particularly thank Martin Perron, Clarence Dubé, Pierre Bélanger, Brigitte Bigué, Alain Fauchon, François Caron and Gaston Lapointe for their collaboration and constant support. Our thanks also are directed to DRF genetics and tree reproduction personnel, as well as to Nathalie Langlois, Jessica Groleau and Guillaume Plante for their help with publications. Also, our thanks go to the other persons who participated in organizing the meeting, particularly to the personnel of the Saint-Modeste nursery.

We recognize the invited speakers, authors, moderators and CPC/PCC 2007 participants for their contributions.

We acknowledge with gratitude the leadership of Hervé Gagnon, recently retired, with the special poplar tree improvement project in the Bas-Saint-Laurent region. We also thank Pierre Drolet and the *Direction régionale des forêts du Bas-Saint-Laurent* for providing the funding since 1998 through the "*PMVRMF – Volet 1*".

Lastly, we wish to underline the indispensable contribution of the organizing committee members and the major support given by *Forêt Québec* managers for this event.

Pierre Périnet,

Chair, Organizing Committee

Thanks to our sponsors!

The organisers of the 2007 Annual Meeting of the Poplar Council of Canada thank all the contributors for their valued collaboration and their support for funding.

Category Platinum

Ressources naturelles et Faune Québec

Norampac Division Cabano

Category Silver

RÉSEAU LIGNICULTURE QUÉBEC

VALORITREMBLE

Category Nickel

NBG

Les Industries ST-MICHEL 1995
USINE DE TOURNAGE DE BOIS
Spécialités:
Composantes de meubles et d'escaliers,
Reproduction de moulures, etc.

Québec – *Land of Forests*

Forests are an integral part of the heritage of Quebecers, who have a deep emotional link to them and to everything that affects this precious resource, whether they are lovers of nature, forest workers or Sunday visitors. In Québec, more than in other developed countries, forests are everywhere and fulfill many environmental, social and economic functions. Managing this invaluable resource falls to the Minister of the *ministère des Ressources naturelles et de la Faune*.

Québec has an area of 1.5 Mkm^2, equivalent to that of Germany, France and Spain combined. Its territory is scattered with thousands of lakes and rivers, which makes it the most abundant jurisdiction in fresh water in the world in per capita terms.

Three distinct vegetation zones are present in Québec. In the north, the **Arctic zone** is characterized by vegetation composed of shrubs and plants; in the centre, the **Boreal zone** is dominated by stands of conifers; and in the south, called the **Temperate northern zone**, by hardwood and mixedwood stands. Southern Québec in turn is divided into three sub-zones, with the continuous boreal forest covering 73% of the forested area. The other two more southerly situated sub-zones in the northern temperate zone, are the sub-zone of the mixed forest (covering 13% of the area), and the deciduous forest that covers 14%. Because most of Québec's population is concentrated in the St. Lawrence River valley, the forests in the latter sub-zone have largely been removed for agriculture and urbanization since colonization began.

Summary of the forestry portrait of Québec

The forested area of Québec covers 655,124 km^2, of which 89% (584,721 km^2) is in the public domain and 11% (70,403 km^2) is privately owned. Accessible forests on public lands cover an area of 451,966 km^2 and contain a merchantable volume of 3,755.0 Mm^3. Softwood cover (fir, spruce, jack pine and larch) is markedly dominant. The average volume, all species included, is 83 m^3/ha. Depending on the cover type, the area of productive and accessible forests is distributed as follows: hardwood – 10%, mixed – 17%, softwood – 63% and no cover – 10%. In terms of volume, the same categories break down as follows: hardwood – 15%, mixed – 22%, softwood – 63%. A proportion of the stands are in the mature age class, since 60% of this area contains stands that are less than 60 years old. The gross merchantable volume is composed of 73% softwoods and 27% hardwoods (20% hard hardwoods and 7% poplars). As a general rule, Québec's forests are relatively young in the south and older in the north. With the exception of some spruce stands on the North Shore, softwood stands have an even age structure and harvesting is done using the cutting-with-regeneration-and-soil-protection method. In deciduous stands, which are generally of uneven age, single-tree harvesting is most commonly used. When adequate cutting methods are employed, forests in Québec usually regenerate naturally.

In order to conserve as well as develop our natural resources on public lands over the entire area of the province, the MRNF minister, in concert with the ministers of the other concerned ministries, prepares a land use plan under the authority of the *Act Respecting the Lands in the Public Domain*. This plan is important, on one hand, to align the actions of the ministries and other governmental organisations with respect to the control and management of the territory and, on the other, to inform the public and other interested parties about government policies. The land use plan distinguishes three broad categories of public lands: those where production is prohibited, those where production is permitted, though subordinate to conservation of the environment, and those where harvesting and resource use is the priority, while respecting the other functions and uses of the forest. *The Regulations Respecting Standards of Forest Management for Forests in the Public Domain* elaborates on the conditions to be respected in each of these categories. This regulation targets three main objectives: protect all of the resources in the forest; guarantee the compatibility of forest management activities with the government's allocated use of the territory, and to ensure the continuation or restoration of the forest cover.

The minister of the MRNF allocates of wood volumes from forests in the public domain to supply conversion plants. *The Timber Supply and Forest Management Agreement* (CAAF) is the principal tool at the disposal of the minister to carry out this allocation. The holder of a harvesting permit for a conversion plant, who also has been granted a CAAF, is authorized to harvest each year on a defined territory, a volume of roundwood of one or several species in order to ensure the operation of the mill. The territory on which the CAAF is exercised is called a "management unit". This territory combines one or several "common areas", that is, areas where one or a certain number of forestry companies are authorized to harvest wood of distinct species, groups or quality. Each common area is subject to a general forest management plan and a specific allowable cut calculation.

The CAAF has 25-year duration and can be extended every five years for another five-year period if the beneficiary has respected his obligations and the provisions of the law and its regulations.

Information source:

Ministère des Ressources Naturelles, 2002. *Rapport sur l'état des forêts québécoises*, 1995-1999. 272 p.

Portrait of the Bas-Saint-Laurent Administrative Region

A look at its forested habitat

The forest vegetation of the Bas-Saint-Laurent Administrative Region is in the eastern part of the fir/yellow birch bioclimatic sub-domain. This sub-domain covers the largest area in the region. On the Gaspé Peninsula, it is confined to the coastline and valleys that open to the sea. At higher elevations it is replaced by the eastern sector of the fir/yellow birch sub-domain. Relief in the eastern part of the fir/yellow birch sub-domain is generally not difficult. It is formed of a succession of elevations and hills that correspond to folds in the bedrock running parallel to the St. Lawrence River, where the elevation ranges from 200 to 400 m. The bedrock consists mainly of calcium sedimentary rocks covered in great part by glacial deposits and alteration deposits. The eastern sector of the fir/yellow birch sub-domain is also characterized by a relatively mild climate, with a mean annual temperature of 1 to 3°C. Favoured by its proximity to the ocean, precipitation is higher than in the western sector of the fir/yellow birch sub-domain, which translates into a greater abundance of balsam fir (*Abies balsamea* (L.) Mill.).

Fir/yellow birch types, associated with mesic sites (mid-slopes), include several species. Besides balsam fir and yellow birch (*Betula alleghaniensis* Britt.), white spruce (*Picea glauca* (Moench) Voss), red spruce *(Picea rubens* Sarg.) and red maple (*Acer rubrum* L.) are common. Previous to the industrial era, fir/yellow birch types formed irregularly structured stands in which the dynamics was regulated by windfall and spruce budworm epidemics. Harvesting since the start of the 19th Century, and colonists' fires have favoured shade-intolerant species such as white birch (*Betula paperyfera* Marsh.) and trembling aspen (*Populus tremuloides* Michx.), hardwoods that now are an important component of our landscapes. During the last spruce budworm (*Choristoneura fumiferana* Clem.) epidemic (1975-!985), vast areas of conifer stands with yellow birch were clear cut, followed by the planting of black spruce (*Picea mariana* (Mill.) B.S.P.), white spruce and Norway spruce (*Picea abies* (L.) Karst).

Several other forest stands, in which the composition varies depending on topography, soils, and drainage conditions, are well represented in the territory. On relatively flat and rocky sites with slower drainage, conifer stands dominated by fir and red spruce are established. This type of stand also colonizes the very thin soils of escarpments and the summits of some hills. In similar conditions, but on calcium substrates, eastern white cedar (*Thuja occidentalis* L.) becomes the sub-dominant species (fir/cedar). The lower depressions of the Appalachian folds, fed by mineral-rich water, generally are occupied by cedar stands, the oldest often having individuals of impressive size, sometimes over 300 years old. Closed depressions tend to favour the development of ombrotrophic, shrub or wooded bogs. Finally, maple stands are sometimes present on southerly exposed slopes and on summits less than 500 m in elevation, particularly in the area of Lac Témiscouata.

Information source:

Petitclerc P., N. Dignard, L. Couillard, G. Lavoie et J. Labrecque, 2007. *Guide de reconnaissance des habitats forestiers des plantes menacées ou vulnérables.* Bas-Saint-Laurent et Gaspésie. Ministère des Ressources naturelles et de la Faune, Direction de l'environnement forestier. 113 p.

http://www.mrnf.gouv.qc.ca/publications/forets/connaissances/guide-especes-menacees.pdf

The Lac Témiscouata Regional Landscape Unit

The Lac Témiscouata regional landscape unit (RLU) is located on the international border with Maine and that of New Brunswick, 50 km southeast of Rivière-du-Loup. Topography is rather broken and formed of medium sloped hills (mean slope: 9%). The mean elevation is 305 m. Summits rarely surpass 500 m. This RLU is especially distinguished by the importance of its thin till. Deep till is rare and limited to depressions and principal valleys. The rather well-developed river system is part of the Atlantic watershed. Several large, elongated water bodies dominate the landscape, the main ones being Témiscouata, Jerry, Long and Grand Las Squatec lakes. The Madawaska River is the outflow from *Lac Témiscouata* and flows east to the St. John River.

The unit is part of a southerly sub-region of the fir/yellow birch bioclimatic domain. The climate is of sub polar, sub humid type, continental (mean annual temperature: 2.5°C, growing degree-days from 1 222 to 1 333°C. It is characterized by a growing season of medium length (160 to 170 days). The aridity index is 125. Annual mean precipitation is from 900 to 1 000 mm, of which 30 to 35% falls as snow.

Sugar maple/yellow birch and fir/yellow birch, the potential vegetation in this domain, are present in abundance on mesic sites. Fir/yellow birch types also occupy lower slopes on less well-drained tills. Hydric sites are colonized by fir/cedar and ash, whereas swamp cedar is found on organic soils.

Soils are mainly adapted for forest uses. Agriculture is practised on a little more than 10% of the area, but abandoned lands are numerous.

Information source:

Robitaille, A. et J.P. Saucier, 1998. *Paysages régionaux du Québec méridional*. Les Publications du Québec. Sainte-Foy (Québec). 215 p.

[1] The regional landscape unit (RLU) is a part of southern Québec characterized by a recurring organization of the principal permanent ecological vegetation elements. Geology, surface deposits, relief, elevation, hydrology and the bioclimate constitute the permanent factors for demarcating and structuring it, whereas those for potential vegetation and the distribution of some tree species serve as indicator species for the climate.

Notes

The Poplar breeding program in Québec

By Pierre Périnet

Direction de la recherche forestière, MRNF

In Québec, the *ministère des Ressources naturelles et de la Faune* (MRNF) has been conducting a poplar tree improvement program at the *Direction de la recherche forestière* (DRF) since 1969, directed by Mr. Gilles Vallée (Riemenschneider *et al.*, 2001). The program is mainly oriented towards the production of superior varieties of hybrid poplar adapted to Québec bioclimatic conditions for commercial planting on both public and private land.

Five poplar species are mainly crossed for hybrid production: *Populus deltoides* (D), *P. balsamifera* (B), *P. maximowiczii* (M), *P. trichocarpa* (T), and *P. nigra* (N). Other hybrids were also obtained from the *Populus* section *(Leuce*) producing vigorous clones of *P. alba* × *P. grandidentata* and *P. tremula* × *P. tremuloides*. More than 5 000 clones have been or are still under evaluation since the beginning of the program. For now, more than 40 clones of *Aigeiros-Tacamahaca* hybrids are produced in provincial nurseries for commercial planting representing annually an average of 1 500 ha of poplar plantations in Québec.

Major selection traits are growth, cold hardiness, tree form (straightness, branchiness), disease and insect resistance, site adaptability and wood quality. *P. maximowiczii* hybrids are particularly well adapted to forest sites (with acidic and less fertile soils) and colder areas in northern Québec (Balsam Fir – Yellow Birch and Balsam Fir – Paper Birch bioclimatic domains 4 & 5). In southern Québec, prevalence of *Septoria musiva* canker forces us to select for resistance; eighteen Septoria resistant clones (representing DN, TD, DN×M, NM, and BM hybrids) are now planted in the St.Lawrence Valley region (Sugar Maple – domains 1, 2, & 3).

Progenies are first screen in nursery or progeny tests, and then superior clones go through multi-stage testing in several locations. Once selected for commercial deployment, cultivars are released through provincial nurseries for 1-0 steckling production and deployment. The ministry is responsible for cultivar selection, steckling production and deployment for both public and private land. With more than 40 clones, genetic diversity is maintained using different hybrids, families and clones for each ecological region. In general, approximately up to 6-19 clones could be used for planting per region.

In southern Québec, clones of DN, TD, and DN×M hybrids are used on the best sites. On less fertile sites, NM and BM hybrids thrive better on forest soils and at higher elevations. For now, the DM hybrids although very performing are too susceptible to canker, and often, not hardy enough for northern locations.

Promising clones of NM and DM will soon be released for planting in domains 3 and 4.

In northern Québec, *P. maximowiczii* hybrids with *P. balsamifera* and *P. trichocarpa* (MB, MT) are cold-hardy and show the best growth and adaptability to forest soils. Multiple-species hybrids with *P. maximowiczii* (M×DT, M×DB, and (DN×B)×M) demonstrate a very good growth potential for those regions which are free of canker.

The provincial list of selected clones for planting is revised regularly based on the results from the clonal tests in different regions. Several projects are going on within the network *Réseau Ligniculture Québec* in collaboration with scientists, forest industry partners, and provincial nurseries. The poplar research team contributes to different projects on Septoria canker, wood quality and molecular genetics studies conducted by scientists from Université Laval, Concordia University, University of Alberta, Forintek and the Canadian Forest Service.

Climate change and an eventual spread of Septoria canker may have a major influence on the poplar tree improvement program. Trees may benefit from climate warning but extreme climatic events might also jeopardize our selection efforts.

[2] Riemenschneider, D.E., Stanton, B.J., Vallée, G., and Périnet, P. 2001. *Poplar breeding strategies.* Part A, Chapter 2. In Poplar Culture in North America. Edited by D.I. Dickmann, J.G. Isebrands, J.E. Eckenwalder, and J. Richardson. NRC Research Press, National Research Council of Canada, Ottawa, ON K1A 0R6, Canada. pp. 43-76.

Photo 1. Hybrid poplar clonal test at Saint-Eusèbe, 12 years. (Photo Alain Fauchon).

Photo 2. Clonal collections at Packington, 9 years. (Photo Alain Fauchon).

Seed and Forest Plant Production in Québec

By Alain Bonneau

Pépinière de Saint-Modeste, Direction générale des pépinières et des stations piscicoles, ministère des Ressources naturelles et de la Faune, Québec, Canada

In Québec, the production of seeds and forest plants is coordinated by the *Direction générale des pépinières et des stations piscicoles*, whose mandate is: **"To contribute increasing the productivity of Québec's forests by ensuring the production of improved seeds and plants according to the needs of clients and at the lowest possible cost."**

Reforestation in Québec is in the order of 150 million plants annually, allocated as follows:

- 122 M on public forests;
- 28 M on private forests.

These plants are produced by 23 nurseries (Fig. 1), with the following proportions:

- 45 M by the six MRNF nurseries (Berthier, Grandes-Piles, Normandin, Saint-Modeste, Sainte-Luce, and Trécesson);
- 105 M by 17 private nurseries, via contracts negotiated with the *Office des producteurs de plants forestiers du Québec*.

To produce these plants, 450 M seeds are required each year, of which 80% are from improved sources, coming mainly from the 1127 hectares of provincial seed orchards. In addition, the best identified individuals in tree improvement programs are being used to carry out controlled crosses in order to produce elite seeds for use in the production of cuttings. The same crosses are also being used to produce plants by somatic embryogenesis.

The main species being produced are black spruce, jack pine, white spruce and Norway spruce. Along with conifer production are 1.5 M hard hardwoods and 1.5 M hybrid poplars.

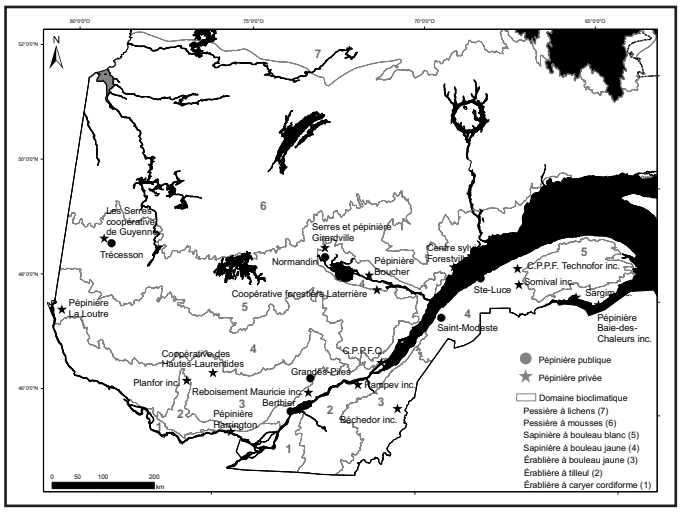


Figure 1. Location of the 23 government and private nurseries in Québec. (Map modified from Lamhamedi *et al.* 2005).

To be among the leaders in reforestation, Québec's objective is to produce the highest quality plants. They represent the leverage required to increase the productivity and yield of our forests. To ensure good survival after planting, and in order to attain the anticipated productivity, rigorous quality control is exercised for each lot shipped. Desirable qualities are mainly for:

- a well-developed root system;
- robustness of plants (H:D ratio);
- plant dimensions (H and D);
- absence of disease and insects;
- nitrogen reserve;
- well-formed plant (stem and roots).

Reference:

Lamhamedi, M.S., R. Mario, L. Veilleux. 2005. *Élaboration des seuils de tolérance au gel des plants d'épinette blanche 1+0 en pépinière forestière selon les régions écologiques du Québec.* Ministère des ressources naturelles et de la Faune, Direction de la recherche forestière. Mémoire de recherche 147, 52 p.

Notes

Portrait des plantations de la région Bas-Saint-Laurent

By Carl Gagnon, ing.f., M.Sc.

Direction régionale du Bas-Saint-Laurent (MRNF)

Depuis trois décennies, les efforts et investissements en aménagement forestier ont été considérables au Bas-Saint-Laurent, dans les forêts de toutes tenures. Rappelons qu'au début des années 1970, les programmes d'aménagement forestier de la forêt privée ont débuté dans la région (Fonds de recherche de l'Université Laval, Programme québécois de mise en valeur des forêts privées et le Programme fédéral de développement forestier de l'est du Québec).

Le reboisement a joué un rôle de premier plan comme intervention sylvicole. Les aménagistes ont priorisé le reboisement des terres agricoles abandonnées (friches) et des terrains forestiers mal régénérés. De plus, l'épidémie de tordeuse des bourgeons de l'épinette a eu un impact majeur qui a mené à la récupération de massifs importants de sapinières surannés. Le reboisement a permis de minimiser les impacts futurs de ce désastre, tout en améliorant le rendement de la forêt. Nous constatons aujourd'hui le fruit des efforts consentis au reboisement. Selon les données de la Direction de la production des semences et des plants (DPSP), entre 1964 et 2003, près de 450 millions de plants ont été mis en terre dans la région.

La présentation d'aujourd'hui a pour objet de brosser un portrait des plantations faites dans la région, tant en forêt privée que publique. Nous constaterons que les informations relatives aux plantations sont parfois incomplètes, principalement en forêt privée. Je vous présenterai la méthodologie utilisée afin de construire une base de données géomatiques des plantations de la région Bas-Saint-Laurent en date de l'année 2003. Par la suite, je vous présenterai les résultats de nos observations.

Objectif général

L'élaboration d'une base de données géomatiques des plantations de la région a été initié pour…

- fournir un intrant supplémentaire à la Direction des inventaires forestiers (DIF) du MRNF dans le but de bonifi er les résultats qui seront disponibles suite au 4e inventaire décennal;
- améliorer la connaissance afin d'effectuer les suivis et interventions sylvicoles nécessaires.

Annuellement, les cartes écoforestières du MRNF sont mises à jour par la DIF suite à la réception des rapports d'interventions forestières pratiquées en forêt publique. Par contre, il n'existe présentement pas de mécanismes de mise à jour annuelle pour les propriétés privées. Les informations sont mises à jour suite aux inventaires décennaux. Plus spécifiquement, cet exercice de recherche des plantations a été initié afin de fournir des pistes à la DIF afi n qu'ils bonifient l'information non visualisable par le photointerprète (année de reboisement, secteurs reboisés, espèces reboisées) sur les propriétés privées pour le 4e inventaire décennal. L'objectif est d'assembler les différentes sources d'information relatives aux plantations de la région, afin de préciser les données incomplètes.

Méthodologie

Trois sources d'information ont été utilisées afin de bâtir cette base de données géomatiques :

- Les données écoforestières du 3e inventaire décennal ont servi de référence et de base à la couche assemblée. Rappelons que ces données sont mises à jour annuellement pour la tenure publique. Par contre, pour la forêt privée, les informations ne sont pas disponibles ou sont incomplètes après 1991. De plus, les données connues le sont uniquement selon les critères des superficies minimales des normes d'inventaires du 3e inventaire décennal. Selon le 3e inventaire décennal, la forêt privée détient environ 68 000 ha de plantation (incluant la grande forêt privée).
- Numérisation de plusieurs cartes papiers des plantations réalisées entre 1953 et 1995, élaborées en collaboration avec les conseillers forestiers de la forêt privée. Aucune superficie minimale n'a été rejetée. Dans le cadre de cet exercice, plus de 60 000 ha ont été numérisés par le MRNF-BR01.
- Numérisation des prescriptions de reboisement réalisées en forêt privée entre 1990 et 2003 (réalisée par l'Agence régionale de mise en valeur des forêts privées du Bas-Saint-Laurent et la Forêt modèle du Bas-Saint-Laurent). Aucune superficie minimale n'a été rejetée. Dans le cadre de cet exercice, plus de 25 000 ha ont été numérisés.

L'intégration des trois sources de données a permis de bâtir une base de données plus complète jusqu'en 2003. Aucune superficie minimale n'a été rejetée. Le chevauchement des données a permis de recenser de nouvelles superficies et préciser plusieurs informations incomplètes, telles l'espèce reboisée ou l'année du reboisement.

Résultats

Données des livraisons de plants

Avant de présenter les résultats de la base de données géomatiques, voyons quelques statistiques relatives aux livraisons de plants et à leur mise en terre. Ces informations devraient nous permettre de faire le parallèle avec nos compilations.

La figure 1 présente l'évolution du reboisement en forêts privée et publique pendant 4 décennies, au Bas-Saint-Laurent. Nous constatons que le nombre de plants mis en terre annuellement était de moins de

Tableau 1. Sources des données forestières des plantations, région Bas-Saint-Laurent

Provenance des données	Informations relatives aux données		
	Années concernées	**Superficie avant intégration (ha)**	**Superficie après intégration (ha)**
Inventaire du 3e décennal*			
Avec données incomplètes sur l'année	1951 à 2003	25 068	**17 549**
Avec données incomplètes sur l'essence	1952 à 2003	29 206	**19 819**
Avec données complètes	1952 à 2003	172 287	**181 674**
Sous-total		**201 493**	**201 493**
Autres sources de données			
Numérisation des cartes papiers (MRNF - BR01)	1952 à 1995	60 965	**21 986**
Agence des forêts privées Bas-Saint-Laurent	1990 à 2003	24 239	**21 135**
Forêt modèle du Bas-Saint-Laurent	1995 à 2003	1 093	**1 093**
Total :			**245 707**

* Version mise à jour jusqu'en 2003 en forêt publique

10 millions jusqu'en 1983. Par la suite, ce niveau s'est élevé subitement à plus de 23 millions en 1986, puis à 31,5 millions en 1987. Entre 1986 et 1995, soit pendant une période de 10 années, près de 265 millions de plants ont été mis en terre dans la région (59 % des plantations actuelles). Par la suite, ce niveau a fléchi considérablement. Entre 1996 et 2005, 112 millions de plants ont été reboisés. Bien que le niveau de reboisement était peu élevé avant 1985, nous constatons que le nombre de plants reboisés depuis plus de 20 ans s'élève à 90 millions (20 % des plantations).

La figure 2 illustre la proportion des espèces reboisées entre 1964 et 2003, toujours dans la région. Nous voyons que jusqu'en 1980, l'épinette blanche était l'espèce la plus reboisée (35 %) suivi de l'épinette de Norvège (23 %). Aussi, nous remarquons que la catégorie « autres résineux » (regroupant les pins, les mélèzes, le sapin et le thuya) était reboisée en forte proportion (36 %). Notons que l'épinette noire était reboisée en faible quantité. Après 1980, l'épinette blanche et l'épinette noire sont les espèces vedettes (respectivement 33 % et 40 % des espèces reboisées).

Informations sur les plantations

Superficie en plantation

Tel que présenté dans la méthodologie, trois sources d'information ont été utilisées. Le tableau 1 présente la superficie totale pour chaque provenance de données, avant intégration. Il présente également le résultat de l'intégration. Nous constatons que l'exercice de numérisation des plantations a permis de répertorier 44 000 ha de nouvelles plantations, en plus de préciser l'espèce pour 9 387 ha et l'année de la plantation sur une superficie de 7 519 ha. Malgré ces efforts, nous n'avons pu préciser l'année du reboisement pour plus de 17 500 ha de plantation du 3e inventaire. Selon cette synthèse, une superfi cie de 245 707 ha est en plantation au Bas-Saint-Laurent, dont 105 211 ha en petite forêt privée. Les plantations représentent 12,7 % de la superficie forestière de la région. Aussi, il faut noter que ces surfaces tiennent compte des regarnis de la régénération naturelle qui sont de l'ordre de 7 400 ha. Rappelons que ces informations et périmètres seront revus par le photointerprète lors du 4e inventaire décennal, ce qui permettra de préciser la superficie en plantation au Bas-Saint-Laurent. Le photointerprète constatera que certaines plantations

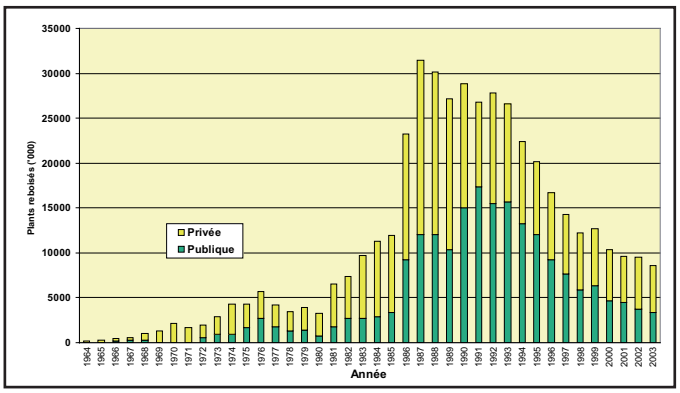


Figure 1. Évolution du reboisement en forêts privée & publique entre 1964 et 2003, région Bas-Saint-Laurent.

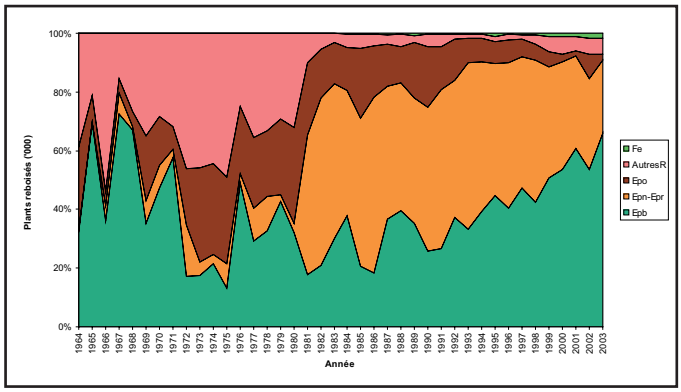


Figure 2. Espèces reboisées en forêts privée & publique entre 1964 et 2003, région Bas-Saint-Laurent.

Tableau 2. Superficies en plantation en 2003 selon les tenures, région Bas-Saint-Laurent

Tenures	Superf. (ha)
Forêt publique :	
Territoires publics et CAAF	121 958
Territoires publics intramunicipaux	12 033
Forêts d'expérimentation ou d'enseignement et de recherche	1 025
Forêt privée :	
Petites propriétés privées	105 211
Gandes propriétés privées	5 481
Total :	**245 707**

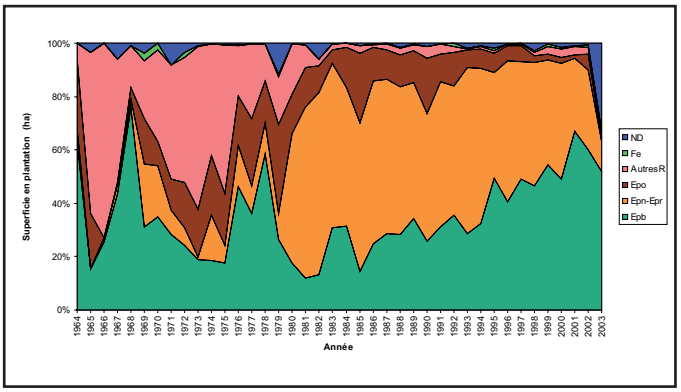


Figure 3. Espèces reboisées en for. priv. & publique entre 1964 et 2003 suite à l'assemblage des données géomatisées (incluant le regarni de régénération naturelle), région Bas-Saint-Laurent.

n'ont pas obtenu le succès escompté : certaines n'ont pas survécu à la mise en terre, alors que d'autres ont été envahies par des espèces commerciales feuillues ou des espèces ligneuses non commerciales.

Le tableau 2 présente la répartition des plantations selon les tenures. Nous constatons que 55 % des plantations sont en forêt publique et que la balance est en petite et grande forêts privées (respectivement 43 % et 2 %).

Espèces reboisées

La figure 3 illustre la proportion des espèces reboisées suite à l'assemblage des données géomatiques, pour les années dont on détient les informations sur les espèces reboisées (livraisons de plants présentés à la figure 2). Si l'on compare les 2 figures, nous pouvons affirmer que les données sur les livraisons de plants et celles sur les plantations (informations cumulées et DIF) sont relativement comparables. La perte de précision quant à l'espèce est souvent issue des reboisements de plusieurs espèces plantées mixtes ou en monoculture par micro-secteurs, ce qui complexifie le travail de cartographie et oblige à effectuer des regroupements et se limiter aux principales espèces reboisées. Dans le cadre de cet exercice de comparaison, mentionnons que seule l'espèce dominante a été retenue pour les plantations mixtes.

Le tableau 3 présente les espèces reboisées selon l'âge de la plantation. Plus de 75 000 ha sont des plantations d'épinette blanche, environ 112 000 sont des plantations d'épinette noire, un peu plus de 26 000 ha sont en épinette de Norvège, 11 000 ha sont en pins, mélèzes et cèdre et enfin 820 ha sont des plantations de feuillus. Mentionnons que nous ne connaissons pas l'espèce pour environ 19 800 ha de plantations.

Âge des plantations

Le tableau 3 nous montre que 8 642 ha de plantations ont plus de 31 ans et 42 713 ha ont entre 21 et 30 ans. Il semble que les superficies sans année de plantations (17 549 ha) ne sont pas nécessairement dans la cohorte des plantations les plus vieilles. Enfin, plus de 175 000 ha de plantations (72 %) ont 20 ans et moins.

Tableau 3. Évolution des superficies reboisées en forêts privée & publique selon l'assemblage des données géomatisées (ha), région Bas-Saint-Laurent

Âge de la plantation*	Espèce dominante de la plantation						Total
	Epb	Epn-Epr	Epo	AutresR	Fe	Non déterminée	
10 ans et moins	20 008	16 148	1 371	677	195	1 649	40 048
11 à 20 ans	42 087	73 703	16 438	3 089	481	957	136 754
21 à 30 ans	10 363	21 472	7 097	2 947	56	778	42 713
31 ans et plus	2 550	801	1 306	3 759	67	159	8 642
Non déterminé	285	296	138	533	22	16 276	17 549
Total	75 293	112 420	26 350	11 005	820	19 819	245 707

* Période de temps suite à la mise en terre. L'âge du plant (1 à 4 ans) n'est pas pris en considération.

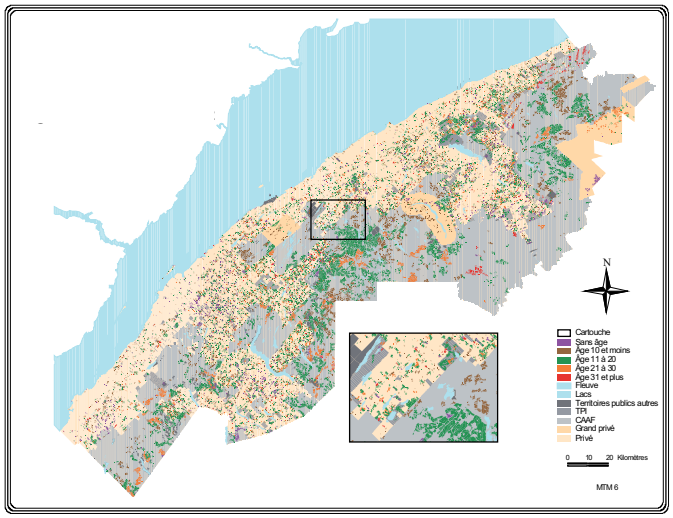


Figure 4. Plantation de la région du Bas-Saint-Laurent.

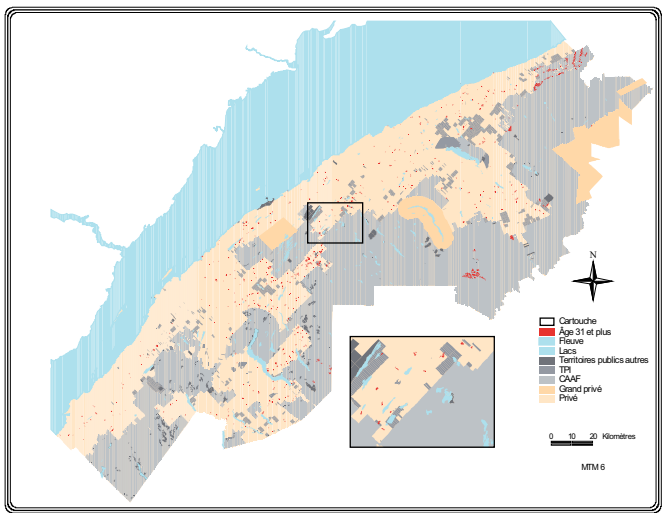


Figure 5. Plantation 31 ans et plus, région Bas-Saint-Laurent.

Localisation des plantations

Suite à l'exercice d'intégration, voici deux exemples illustrant la localisation des plantations et la capacité de la géomatique. La figure 4 présente la localisation de l'ensemble des plantations répertoriées de la région (245 707 ha) alors que la figure 5 illustre uniquement les plantations de 31 ans et plus (8 642 ha).

À l'aide de ces connaissances, la DIF pourra mettre à jour les superficies et données sur les plantations suite à l'analyse du photointerprète. Le présent portrait est optimiste et inclus l'ensemble des plantations réalisées, sans tenir compte de l'état actuel de la plantation. Il semble que plusieurs vieilles plantations ont disparu. La mise à jour de ces cartes jumelée à des visites terrain permettraient d'obtenir un meilleur portrait de la situation.

Conclusion

Dans un contexte d'aménagement intensif des plantations, nous avons constaté que la géomatique est un outil incontournable pour localiser les plantations et en effectuer le suivi dans le temps. Afin d'améliorer nos connaissances, les aménagistes doivent concilier certaines informations afin de mettre à jour les données sur les plantations. Aussi, nous avons fait la démonstration que la base de données géomatiques de la DIF est essentielle afin de présenter un portrait décennal des plantations.

Pour terminer, mentionnons que les aménagistes doivent aller plus loin et noter des informations plus fines sur les suivis et soins apportés ou à apporter aux plantations. Cette approche permettra d'optimiser les interventions nécessaires à leur entretien (porter les bons diagnostics au bon moment), d'augmenter les rendements forestiers et d'améliorer la qualité des bois.

Remerciements

Je remercie sincèrement les personnes et les organismes qui ont contribué à la confection de ce portrait :

- L'Agence régionale de mise en valeur des forêts privées du Bas-Saint-Laurent
- Les conseillers forestiers de la région
- La Forêt modèle du Bas-Saint-Laurent
- Le personnel des UG 11 et UG 12
- Le personnel du BR01 et plus particulièrement : René Plante, Normand Proulx et Gino St-Pierre

Note : Ce texte a déjà été publié dans le Compte-rendu du Colloque sur les éclaircies commerciales dans les plantations, tenu le 7 et 8 juin 2006 à Hôtel Lévesque, Rivière-du-Loup, pp. 5-10.

Day 1 – September 17

Stop 1, Cabano
Bas-Saint-Laurent Administrative Region (page 8)

'Cabano' comes from the Montagnais 'Cacano', signifying 'we disembark', which was where the First Nations that arrived from New Brunswick came to do their great portage. Indeed, the town of Cabano was founded in 1898 on the old trail of the Témiscouata. portage, the celebrated land and river route that linked Acadia and Québec during the French regime.

Cabano is a town (number 1 on map) in the regional county municipality of Témiscouata, Québec, within the Bas-Saint-Laurent Administrative Region (AR). It has an area of 122 km^2, with 3,212 residents. Located about half way between Rivière-du-Loup and Edmundston, New Brunswick on Highway 185 (trans-Canada) and at the junction of Route 232, axial highway that leads east to Rimouski and west towards Pohénégamook, Cabano is an industrial, commercial and tourism crossroads in Témiscouata.

The Bas-Saint-Laurent Administrative Region, in which the Regional County Municipality of Témiscouata and Cabano are located, has a total area of 22,637 km^2. Forested land covers 19,320 km^2, of which 70% is public and 30% private property. Accessible, productive forests on public land totals 10,833 km^2, and have a gross merchantable volume of 100 Mm^3. Water and non-forested land make up 2% and 13% of the area, respectively. The area of protected areas, parks and ecological reserves totals 160 km^2.

Public forests in the Bas-Saint-Laurent AR contain 61% of the gross merchantable volume in the region. Softwood and mixedwood cover types are predominant. The average volume, all species included, is 92 m^3/ha. According to cover type, the area of accessible and productive forest is distributed as follows: hardwood 16%, mixedwood 31%, softwood 45% and no cover 8%. In terms of volume by cover type the breakdown is as follows: hardwoods 19%, mixedwoods 33% and softwoods 31%. Stands belonging to age class 60 cover 62% of the area. Gross merchantable volume is composed of 65% softwoods and 35% hardwoods. Softwoods are principally in the fir/spruce/jack pine/larch group. Fir is the predominant species, with hard hardwoods representing 26% and poplars 9% of the hardwood type

Bas-Saint-Laurent Administrative Region.
Day 1 and 2 – September, 17-18.
Cabano (N° 1 on the map), Saint-Modeste (N° 2), Packington (N° 3), Saint-Eusèbe (N° 4), and Rivière-du-Loup (N° 5)

Information sources:

http://www.mrctemiscouata.qc.ca/Cabano.html

Ministère des Ressources Naturelles, 2002. *Rapport sur l'état des forêts québécoises*, 1995-1999. 272 p.

Notes

Day 1 – September 17

Stop 1, Cabano
Culture of Hybrid Poplar at Norampac – Cabano

By Clarence Dubé

Norampac – Cabano, Québec, Canada

Norampac – Cabano, a division of Cascades Canada Inc., is a pulp and paper manufacturer making corrugated paper.

Norampac – Cabano began its own adventure with growing poplar in 1996.

To date, we have developed some 600 ha of plantations, 300 of which are on agricultural land and 300 on forest sites.

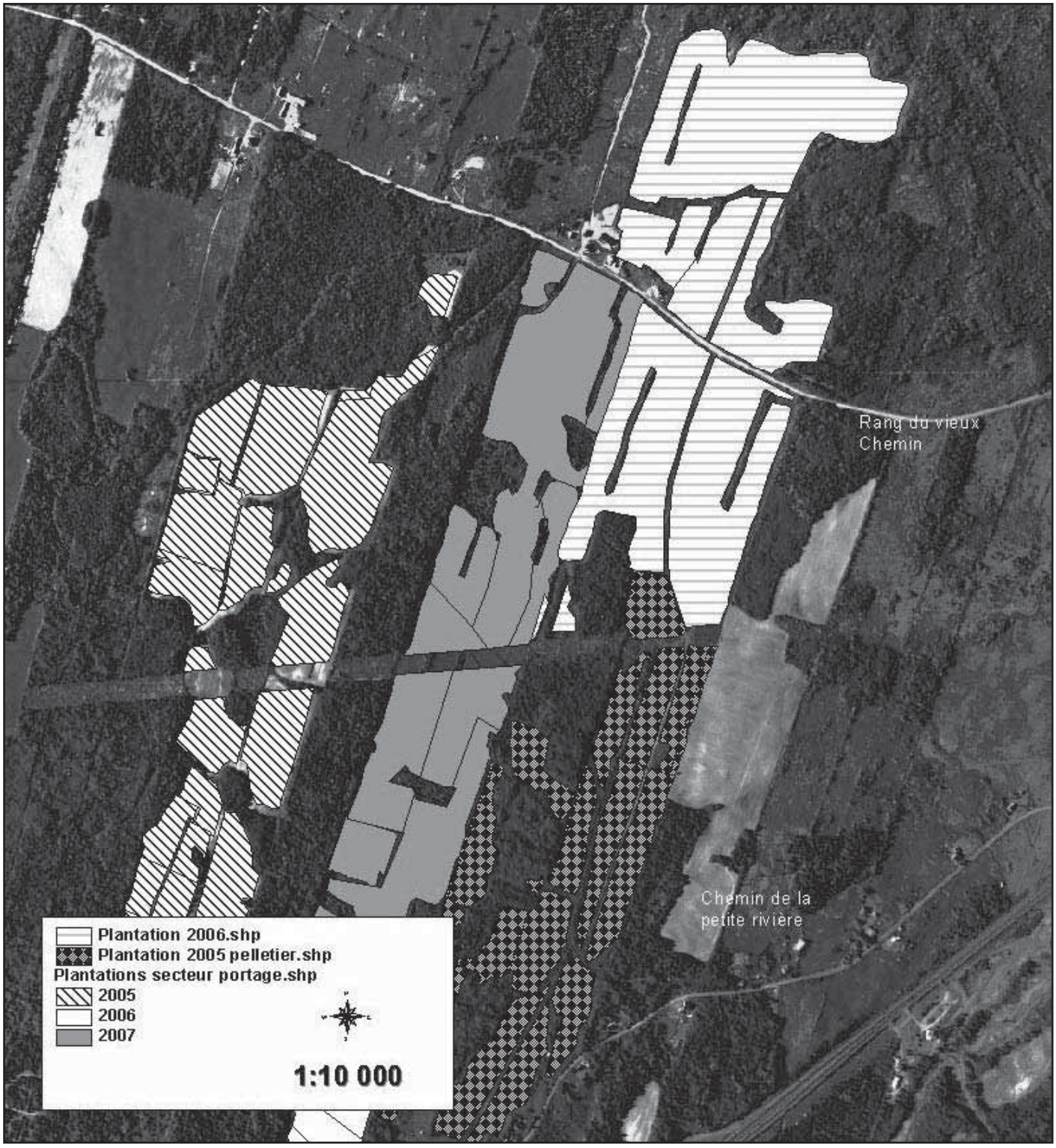
We own and operate a nursery, producing 80,000 1-m-tall poplar whips (sets) per year for reforestation and afforestation purposes.

The company's goal is to reforest 100 ha per year, and to be able to carry out harvesting on a rotation of 15 to 20 years, with a yield of 200 m^3 or more per hectare.

Photo 1. Hybrid poplar plantations at Saint-Eusèbe, sector E. Dubé. (Photo Alain Fauchon).

Notes

Day 1 – September 17
Stop 1A



Norampac hybrid poplar plantations – Pelletier-Portage Sector.

Stop 1A, Norampac – Cabano, Pelletier Area – Plot 2

Plot 2 of the Pelletier Area represents a recent operational hybrid poplar plantation established mechanically during spring 2006.

Table 1. Site

	Pelletier Area	Plot 2
Location	Saint-Louis-du-Ha! Ha!	
Area (ha)	95.7	33.1
Plantation (ha)	53.4	
Farmland (ha)	53.4	33.1
Forestland (ha)	-	-
Number of trees	34 747	21 880

Table 2. Plantation data

Site preparation	2005
Mechanical planting	2006
Spacing	3.5 m x 4 m
Clones (table 4)	4
Number of plants	**21 880**
Bare-root	21 730
Sets	150

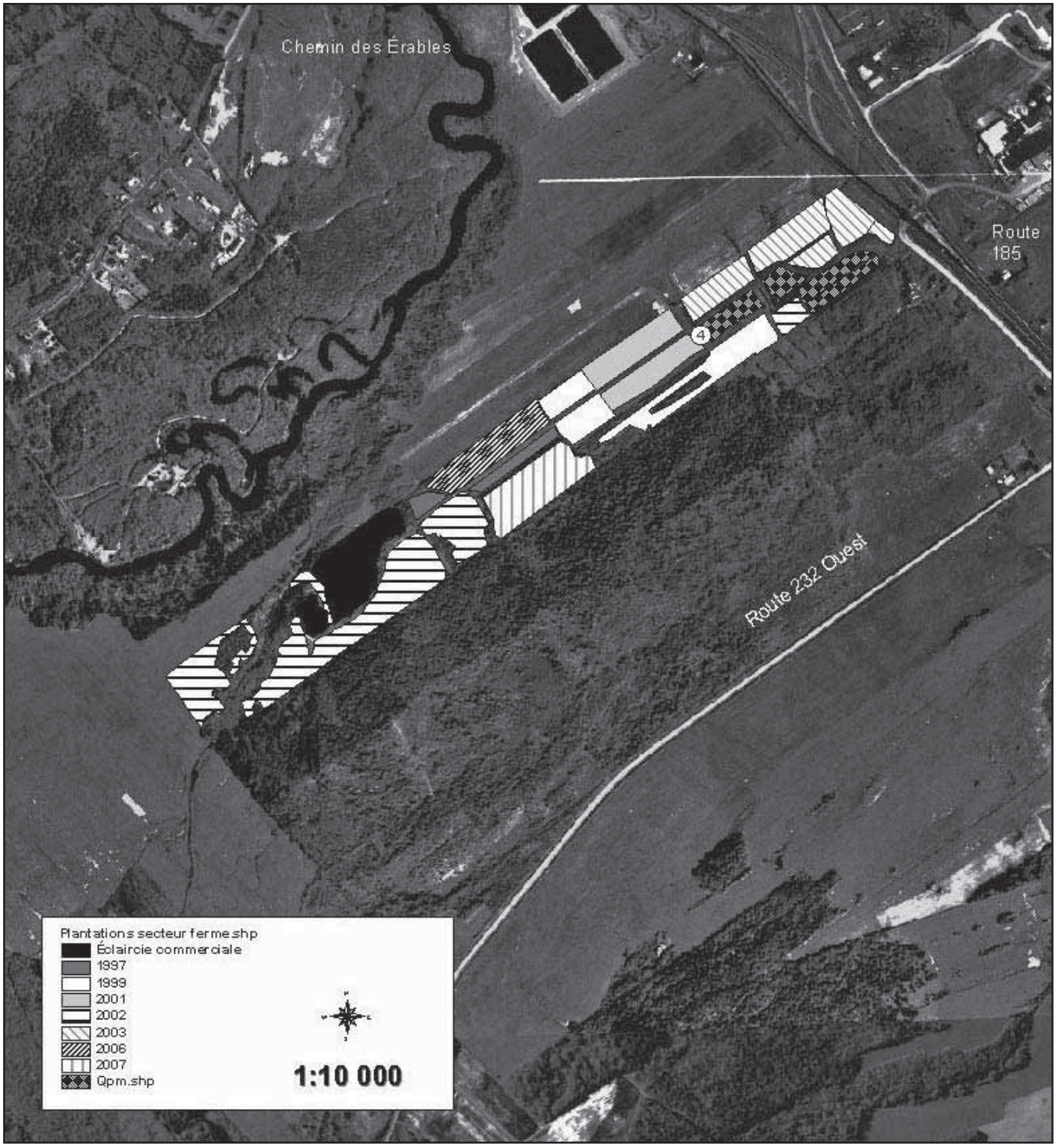
Table 3. Site preparation and tending schedule

Year	2005			2006			2007		
Season	S	Su	F	S	Su	F	S	Su	F
Site preparation									
Sludge application (140 mton/ha) + ash near the power line		X							
Ploughing			X						
Installation of a culvert			X						
Harrowing with a disc harrow				X					
Tending									
3 mechanical weedings with toothed harrow (*déchaumeuse*)					X			X	

Table 4. Clones

Clones	Hybrid	Bare-root	Sets
915311	M × B	4 147	0
915318	M × B	7 753	150
750301	M × T	3 500	0
750316	M × T	6 330	0

Day 1 – September 17
Stop 1B



Norampac Hybrid Poplar Plantations – Poplar Farm Sector.

Stop 1B, Norampac – Cabano, Poplar Farm – Plot 4

Plot 4 within the Poplar Farm represents a hybrid poplar demonstration plantation which contains 24 rows of about 70 seedlings each.

Table 1. Site

	Poplar farm area	Plot 4
Location	Cabano	
Area (ha)	30.4	2.1
Plantation (ha)	17.8	
Farmland (ha)	8.8	2.1
Forestland (ha)	9.0	-
Number of trees	14 264	1 685

Table 2. Plantation data

Site preparation -Ploughing and harrowing	2000
Mechanical planting	2001
Fill planting	2003
Spacing	3 m x 4 m
Clones (table 4)	24
Number of plants Bare-root 0-1 Sets	**1 685** 1 545 140

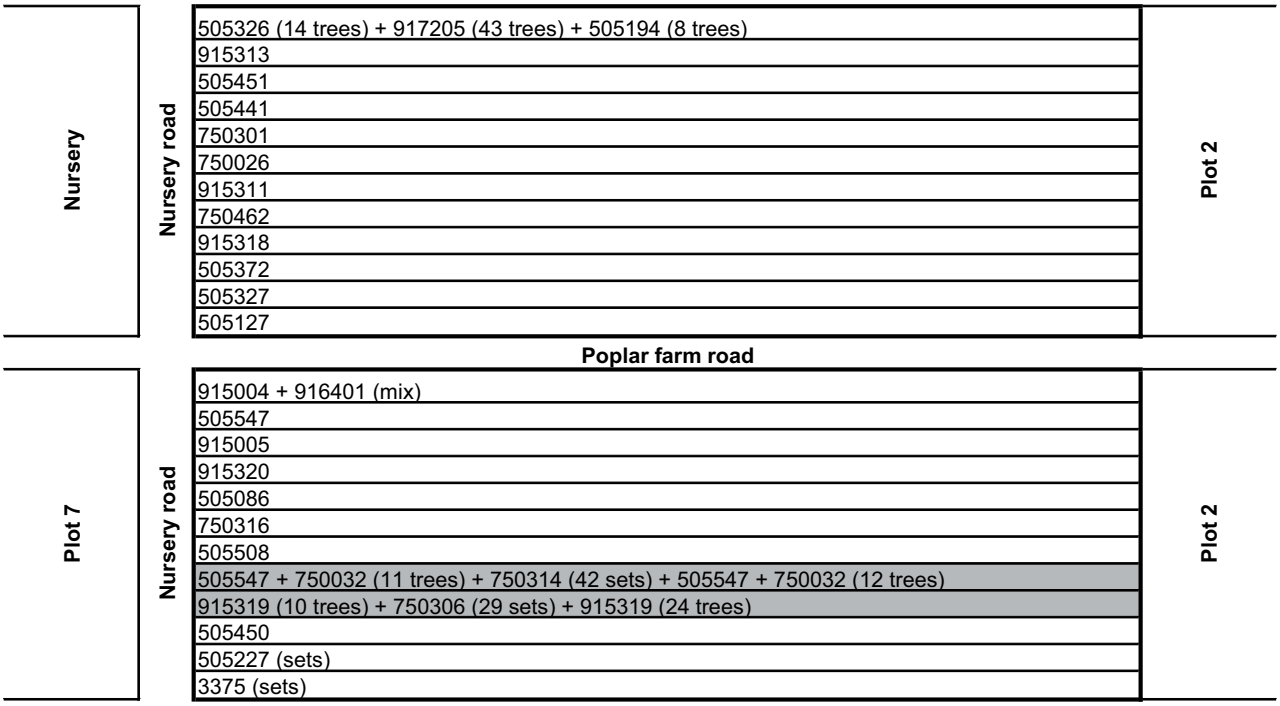
Table 3. Tending schedule

Year	2001			2002			2003			2004			2005			2006		
Season	S	Su	F	S	Su	F	S	Su	F	S	Su	F	S	Su	F	S	Su	F
2 or 3 mechanical weedings (*déchaumeuse*)		X			X			X										
3 mechanical weedings within the sludge application zone (*déchaumeuse*)											X			X				
Crown pruning				X									X					
Pruning													X					
Pruning of epicormic branches																X		
Growth measurements (25/clone)																		X

Table 4. Clones

Hybrid	Hybrid parental species	Clones
B × M	*Populus balsamifera* × *P. maximowiczii*	3375, 915004, 915005
DN × M	(*P. deltoides* × *P. nigra*) × *P. maximowiczii*	916401
DT × M	(*P. deltoides* × *P. trichocarpa*) × *P. maximowiczii*	917205
M × B	*P. maximowiczii* × *P. balsamifera*	915311, 915313, 915318, 915319, 915320
M × DT	*P. maximowiczii* × (*P. deltoides* × *P. trichocarpa*)	505086, 505127, 505194, 505227, 505326, 505327, 505372, 505441, 505450, 505451, 505508, 505547, 750026, 750032, 750462
M × T	*P. maximowiczii* × *P. trichocarpa*	750301, 750306, 750314, 750316

Norampac



N.B.: Clones 750314 and 750306 were established as sets in 2003 in order to replace some dead bare-root plants. Mortality is due to the sewage sludge application that was meant to act as mulch.

Fill planting 2003

Figure 1. Poplar farm - plot 4 layout

Table 5. Measurements after 6 years of growth[1]

Clone	Diameter (cm)	Height (m)
917205	7.1	9.0
915313	6.0	7.1
505451	6.8	7.7
505441	8.0	7.9
750301	9.3	9.9
750026	10.2	10.1
915311	11.8	10.1
750462	10.6	10.7
915318	11.7	10.2
505372	10.7	9.4
505327	11.0	9.4
505127	7.6	7.4

[1] Mean of 25 trees measured per clone

Notes

Day 1 – September 17
Stop 2, Saint-Modeste

The Saint Modeste nursery is located in the municipality of Saint Modeste (N° 2 on map), about 20 kilometers southeast of Rivière du Loup (N° 5 on map). The municipality is also part of the Municipal Regional County of Rivière du Loup and the Bas-Saint-Laurent Administrative Region (AR).

Notes

Saint-Modeste Nursery

By Claude Bérubé, Alain Bonneau, Jean-Yves Guay, Corine Rioux, Michel Rioux, Roger Touchette, Denise Tousignant et Laurence Tremblay

General Overview

Confident of its mission and proud of its staff, the Saint-Modeste Nursery (Photos 1-2) is happy to welcome you. This enterprise is an important asset in the regional economy of the Bas-St-Laurent (Lower St. Lawrence). The 400-odd employees (7 permanent, 125 seasonal and about 270 casuals in rush periods) share a payroll of almost $3.7 M per year, which is in addition to expenditures on goods and services in the order of $1.5 M, of which half is paid to companies in the region.

Our Mission

To meet the needs of our clients:

- Supply at competitive prices, trees that meet the highest quality standards;
- Actively contribute to genetic improvement programs for seeds and plants;
- Develop and employ leading-edge production techniques.

Our Values

To accomplish our mission, we promote the involvement of all personnel by maintaining a work environment where sharing, mutual assistance, confidence and respect prevail

Since its establishment in 1961, the production level of the Saint-Modeste Nursery has adjusted to meet the reforestation needs of Québec (Table 1). From 1985 to 1992, the considerable increase in demand for trees, combined with the start of containerized seedling production, triggered an expansion of the production area from 50 to 90 hectares. Production reached a peak in 1987, with 32 M plants produced. Since 1993, annual production has stabilized at about 10 M deliverable pants, in order to adjust to two major changes in Québec's reforestation strategy: the increasing interest in natural regeneration and the advent of large-dimension plants (LDP). Also, it was during this period that the first cutting-propagated plants were produced, as a result of several years of selection and improvement efforts by the Ministry. The Bouturathèque system (1989) and the double-walled exterior enclosure (1998), both designed by the MRNF, offer two unique and complementary approaches to cutting propagation of black spruce (*Picea mariana*), white spruce (*P. glauca*), Norway spruce (*P. abies*), and hybrid larch (*Larix* x *marschlinsii*). In 2001, a production facility for somatic embryogenesis was established. This technique will allow us to multiply top-performing clones at a large scale and to accelerate their use.

Photos 1-2. Aerial views of the Saint-Modeste Nursery (Photos: Jocelyn Landry).

Table 1. Evolution of production objectives and products at the Saint-Modeste Nursery.

Period	Average annual production (shippable plants)
1961 – 1984 6	M bareroot plants
1985 – 1992	12 M bareroot plants and 13 M containerized plants
1993 – 2007	Approximately 10 M plants. In 2007: 3.5 M bareroot plants (of which 2.0 M were propagated by cuttings); 4.5 M containerized LDP, of which 2.0 M were produced by cuttings); 2.1 M plants of smaller dimension.

Figure 1. Final steps in plant production: pruning poplar roots; wrapping bareroot spruce; containerized seedlings ready for shipping (Photos: MRNF).

The role of the Saint-Modeste Nursery in the production of hybrid poplar (HP) dates back to the 1970^{s}. During this period, 30-cm cuttings, and sets of about 1.5-m were sent directly for reforestation. Insufficient site preparation before planting and a lack of plantation maintenance resulted in the failure of this approach. HP production was almost completely interrupted for about ten years.

At the end of the 1980^{s}, demand for hybrid poplar increased. Following the results of work carried out by the Direction de la recherche forestière, production methods were modified: hybrid poplar was produced as 1.5-m tall bareroot stock, and as 1-m tall container stock in 750 to 1000 cm^{3} cavities. Today the technique used is strictly by bareroot production.

Over about the last ten years, the HP production level at Saint-Modeste has varied from 50 K to 100 K bareroot plants annually. The total now being produced by Québec's six government-owned nurseries is 1.3 million plants in 2007, and was 1.5 million during the previous three years.

Figure 1 illustrates the different steps involved in growing hybrid poplar and spruce (bareroot plants) and a crop of container-grown conifers.

Stop 1: Hybrid poplar production

Nursery production of hybrid poplar makes use of a vegetative reproduction method. The recommended improved clones are established in stoolbed areas for the production of cuttings. Cuttings are transplanted in the spring to produce rooted plants in a single growing season, ready for reforestation projects the following year.

Stoolbed areas

The stools are the main source of supply for cuttings. At the Saint-Modeste Nursery, the stoolbed area is located where no larch species are located nearby, because they are the alternate host of rust diseases found on poplars.

After having amended the soil with peat moss and compost, the formed beds are covered with plastic mulch. Every four beds a lane is left for the passage of tractors to do maintenance and seasonal fertilizations. Liquid fertilizer applications are always followed by rinsing the foliage for 15 minutes.

Herbicide treatments to remove weeds are applied immediately after the cuttings are planted, before budbreak. A mixture of Lorox 3 kg/ha (linuron) and Dual II Magnum 2 L/ha (metolachlor) gives very good results. Towards the end of June, when stems are between 50- and 75-cm tall, an application of Gallery at 1.5 kg/ha (isoxaben) on damp soil takes care of weed control for the remainder of the season. A single insecticide treatment is done for aphids: Pirimor 50DF at 0.5 kg/ha (pirimicarb) sprayed at high pressure is effective. If needed, a second application is done. Monitoring is carried out for the numerous other insects that attack poplars.

In the second growing season, stools produce an average of 35 cuttings each, up to a maximum of 50 cuttings for some clones. In early September, 5% of the stools are evaluated to ascertain the potential number of 15-cm cuttings that will be available for transplanting the following spring.

Coppicing the stools is done after leaf fall, towards the end of October. The bundles are placed in a cold room at -2°C. All the harvested stems are placed in bags, with sorting done when they are trimmed in the shop.

When coppicing is completed, leaves are removed from the soil using a vacuum like the type used to harvest peat, to limit the dissemination of rust spores and other fungal diseases.

Trimming is done using a band saw. Cuttings are bundled in packages of 50 using elastics, and are 14 to 15 cm long. They are put in plastic bags on a layer of slightly damp peat and covered with a cloth. A thin layer of peat covers the cloth. The tub is slid into a plastic bag and stored frozen at -2°C over the winter (Photo 3).

Production of rooted cuttings

The nursery beds to be used for transplanting cuttings are first prepared by establishing a green manure crop the year before. Green manures are part of our integrated pest control program to reduce pests, and especially, the need for manual weeding.

Cuttings are transplanted in six rows per bed, with a 1.3-m wide spacing to facilitate vertical root pruning when lifting plants. Root pruning shortens the roots into the desired length between rows, leaving to do only pruning of roots that grew between plants within the rows during sorting and classifying the plants.

Planting depth is very important; only the topmost bud is left exposed above the soil. Vertical planting, not at an angle, will make future planting easier.

As soon as transplanting is done, irrigation closes the furrows made by the transplanting unit. Next day, a pre-emergent herbicide is applied: a reservoir mixture of 3 kg/ha Lorox and 2 L/ha Dual II Magnum is the most effective treatment.

After one month of growth, double stems emerging from the second buds are removed. At the same time, we remove the few weeds present. The following day, Gallery is applied at 1.5 kg/ha.

When fertilizing, we apply up to 50 kg/ha nitrogen per season. Towards the beginning of August, crops are no longer irrigated in order to prevent slowing down the hardening off process.

The cuttings classification inventory is carried out in early September. These inventories will be used to determine the height classes and stem defects. At the same time, a phytosanitary inspection is done by specialists.

Plant lifting is done when leaves have fallen, in late October (Photo 4). Plants are classified and some eliminated using the following criteria: broken stem, curved stem, root weakness and breakage. Roots are pruned in a radius of 10 cm around the stem.

Plants are bagged 50 per bundle with a little peat to cover the bottom of the bag and the root system. The bag is closed and four elastics hold the plants to prevent breakage during handling in the cold room and transport to the planting site. Bags are stored on palettes at -2°C until spring.

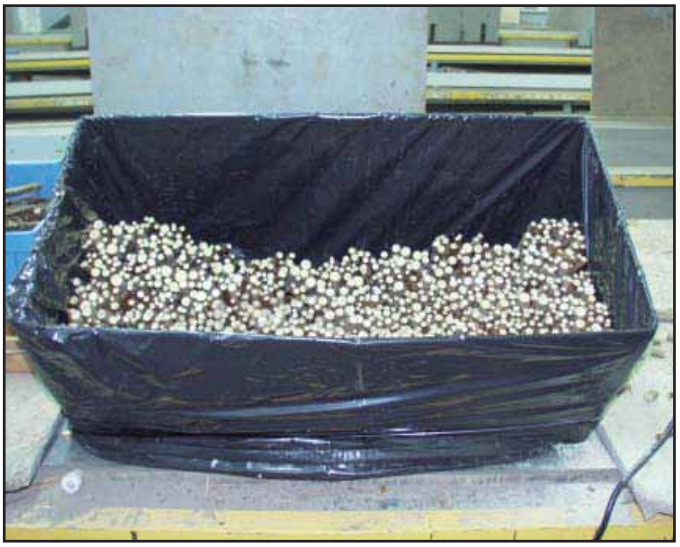


Photo 3. Cuttings prepared for storage at -2°C.

Photo 4. Lifting rooted hybrid poplar plants. (Photos MRNF)

Before spring delivery, another phytosanitary inspection is done to ensure plant quality. It is advised to plant hybrid poplars early in the season; planting depth is paramount for survival. They are planted to a depth of 30 cm, with the first bud placed 15 cm underground.

Stop 2: Plant production by somatic embryogenesis

The MRNF is implementing an operational somatic embryogenesis (SE) technique used since 2001 at Saint-Modeste. White spruce is the first species being used for the initial phase of the project, with hybrid larch next. Compared to traditional methods, through somatic embryogenesis it will be possible to multiply in large numbers and to accelerate the use of improved or selected individuals, complementary to the rooted cuttings program. The principal advantage of this technique is that it allows for the conservation in liquid nitrogen (cryoconservation) of material (embryogenic tissue) being evaluated in plantations. Plants produced by somatic SE are evaluated in the nursery and in clonal tests where the best individuals are selected according to predetermined criteria. The selected clones will be multiplied to produce plants for reforestation. They could also be integrated into tree improvement programs and in breeding plans for the selection of the next generation of improvement (Figure 2).

SE opens the way to an unlimited number of somatic embryos using a single seed (= clone). These somatic embryos will become plants, for the genotype will be identical to the original seed. An example of the production steps for white spruce plants using somatic embryogenesis is presented in Table 2 and in Figure 2. Figures 3 and 4 illustrate the integration of SE in the MRNF's plant production program.

The production of plants from somatic embryogenesis will lead to the establishment of clonal tests, the production of stock plants for rooted cuttings and the study of clonal variability. Up to now, the somatic embryogenesis laboratory at Saint-Modeste has produced 13,000 plants

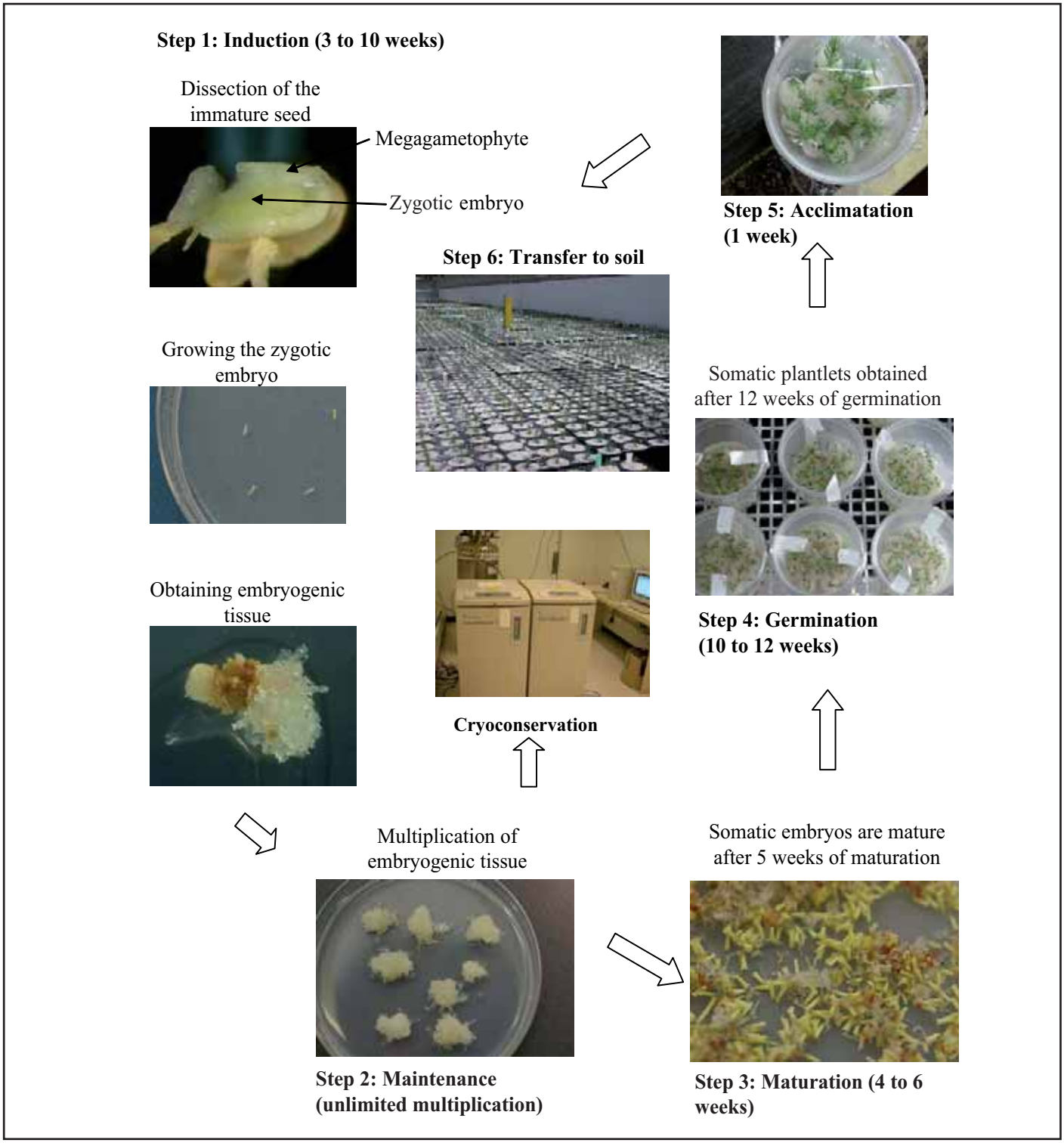


Figure 2. Example of steps to produce white spruce plants by somatic embryogenesis (Photos: Laurence Tremblay).

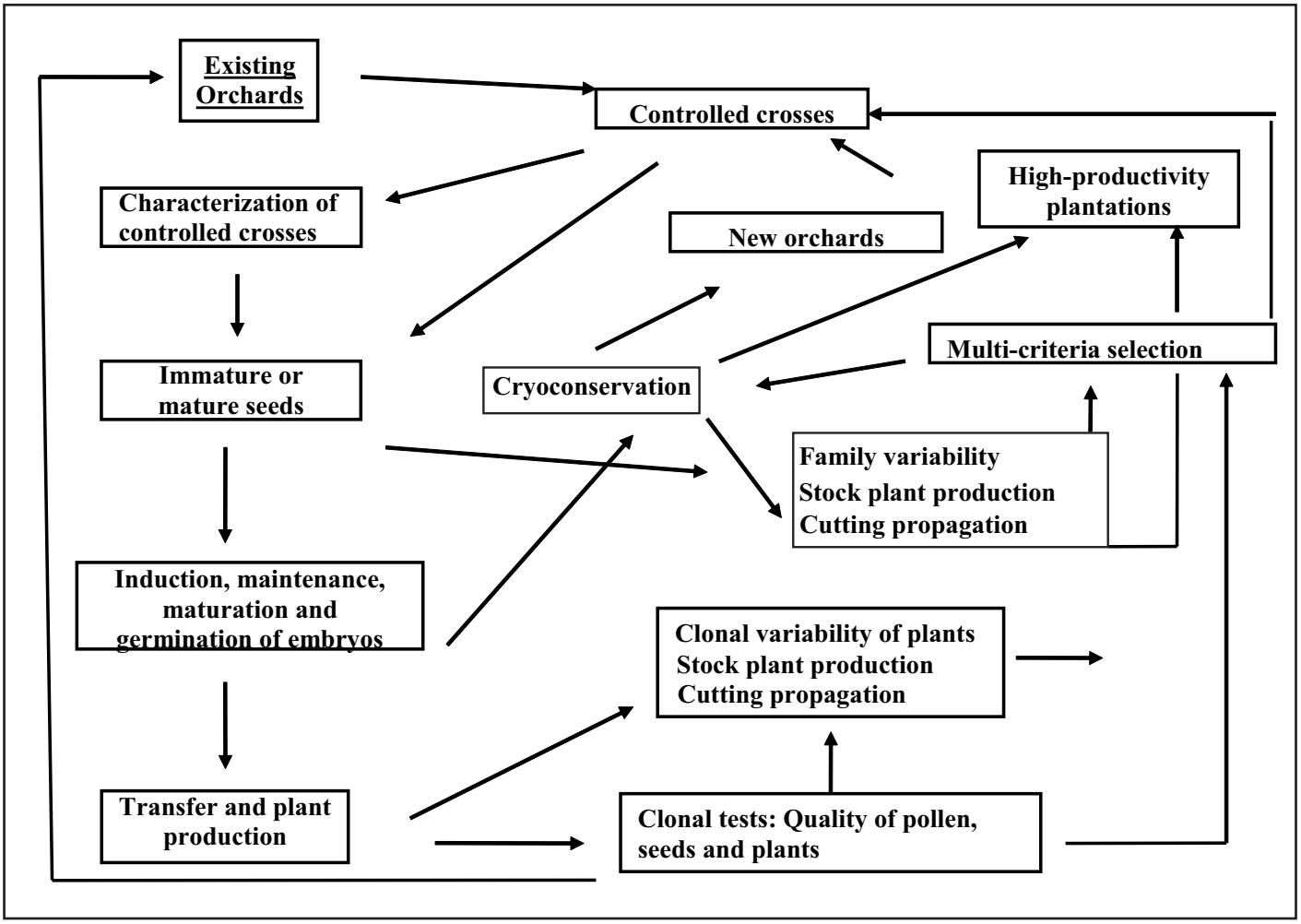


Figure 3. Integration of somatic embryogenesis in the MRNF's plant production program (Lamhamedi *et al*. 2006, 4e Atelier technique sur la production de plants forestiers au Québec, Québec, Canada).

Figure 4. Example of plants from SE showing clonal variability. The characterization of morpho-physiologic variables and aptitude for propagation by cuttings will be undertaken (Photos: Mohammed S. Lamhamedi).

Table 2. Description of the principal steps in obtaining plants by SE.

Steps	Description
Induction	Production of embryogenic tissue using a zygotic embryo extracted from a seed
Maintenance	Multiplication of embryogenic tissue that will remain at very slightly differentiated phase. This tissue is placed in cryoconservation (conservation in liquid nitrogen).
Maturation D	evelopment of somatic embryos at the cotyledon stage.
Germination	Development of somatic embryos into plantlets. This is comparable to the germination of the seed (growth of root system and functional cauline).
Acclimatation	Step indispensable for the survival and growth of plantlets
Transfer to soil	Transfer of acclimated plantlets into soil for growing in a greenhouse

from a clone prior to 2004 and 3,860 plants from 80 clones in 2004. Among these clones, 52 will be planted on reforestation sites in 2007 to establish the first clonal test. More than 9,000 plants produced from 163 new clones in 2005 are being grown to establish a second clonal test. In 2006, 300 new clones were selected for the establishment of a third clonal test. In addition, all the clones produced were cryopreserved at -196°C.

Stop 3: Softwood propagation by cuttings

Since 1989, the cutting propagation program at Saint-Modeste has made it possible for us to multiply genetically improved seeds. The annual production goal is for 2,230,000 white spruce, 1,220,000 black spruce, 500,000 hybrid larch and 50,000 Norway spruce, for a total of 4,000,000 deliverable plants. This requires growing about 8,000,000 cuttings.

Depending on the species, different production scenarios are used. Common to all species, cuttings are collected at the semi-lignified stage.

For black spruce, stock plants are grown in the greenhouse, so cuttings can be collected year round. Cuttings are rooted in mini-greenhouses of what we call the bouturathèque. We can remove 11 cuttings per stock plant, up to five times per year (every 10 weeks). Currently, we are doing three harvests per year to meet production objectives. Stock plants are used for two entire years.

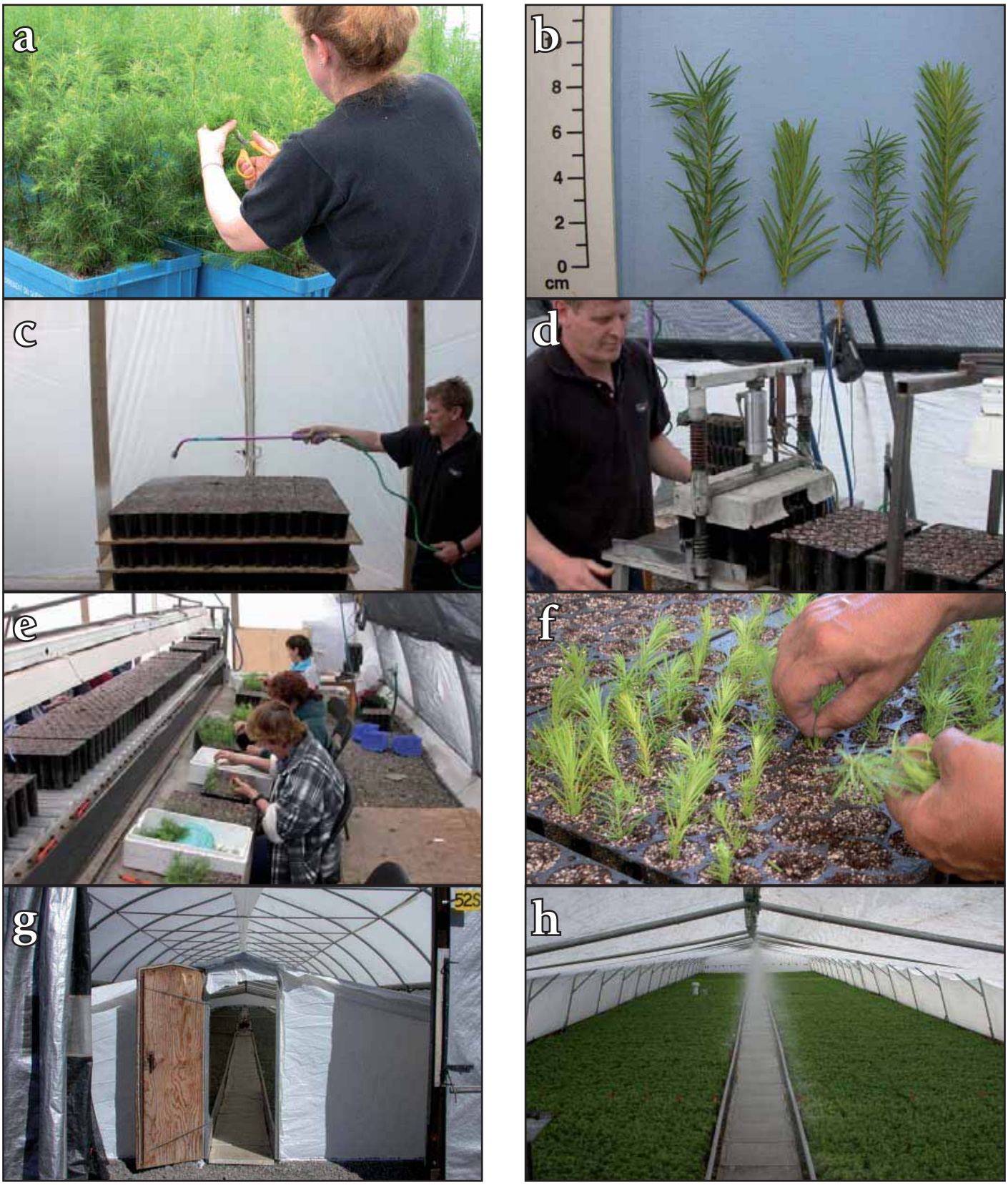
Hybrid larch (HL) production is based on forcing the stock plants in the greenhouse starting at the end of February for harvesting cuttings in May, June and, if necessary, July (Table 3). The multiplication factor is in the order of 60 deliverable plants per stock plant. Cuttings are then placed in chambers within tunnels

For white spruce and Norway spruce, the harvesting of cuttings is done in July. Stock plants are 2-0 plants grown on the production schedule of large-dimension plants in containers. The yield in cuttings from these is on average 13 cuttings each. Plants having served as stock plants are delivered for reforestation the next spring. Cuttings are placed in chambers inside tunnels in the same way as for hybrid larch.

For all species, stock plants are held for a maximum of two years. Cuttings from one-year-old stock plants have a mean rooting success of 85 to 90%.

Table 3. Example of seasonal crop production schedule of stock plants for HL at the Saint-Modeste Nursery.

Year	Month	Production stage
1	End April	Seeding in containers of type 15-700 (15 cavities of 700 cm^3)
	May – October	Crop in tunnel, ends with a hardening-off period in greenhouse
	November	Storage in cold room at -4˚C
2	End February – May	Transfer to greenhouse. Transplant in 4 L pots. Forced growth in greenhouse
	Early May	1st crop
	Mid-June	2nd crop
	Mid-July	3rd crop



Photos 5a-h. Steps in the production of hybrid larch cuttings in dual chambers at the Saint-Modeste Nursery: a) First harvest of cuttings from forced stock plants in greenhouse in May; b) harvesting of growing cuttings, at a length of about 7 cm; c) misting water to normalize water content in rooting containers; d) perforation of rooting substrate and installation of containers on a conveyor; e) operation of inserting cuttings; f) detailed view of insertion of cuttings; g) exterior view of a dual rooting chamber; h) interior view of a dual rooting chamber (Photos: Patrick Lemay, Nicole Robert and Denise Tousignant.

Table 4. Dendrometric criteria and target for nitrogen level at delivery time for container-produced plant categories (quality A1).

Plants	Crop density (plants / m^2)	Cavitv volume (cm^3)	Individual mean height (cm)	Height/Diameter ratio (cm/mm)	Minimum N concentration in tissues (%)
Large dimension	200	310	≥ 35	≤ 6.5	1.7
Medium dimension	300	200	≥ 27	≤ 6.5	1.7
Small dimension	570	110	≥ 18	≤ 6.5	1.7

Steps involved in propagation by cuttings

- Cuttings with an optimal length of 7 to 10 cm are manually removed using scissors (Photos 5 a-b). Shoots that are too short are left on the plants to continue growing.
- Cuttings are placed in containers of type 45-110 (45 cavities of 110 cm^3) containing a peat and perlite growing medium (40% : 60% v : v). (Photos 5 e-f). Beforehand, each container is dampened (Photo 5c) and holes are preformed in the cavities (Photo 5d). At the time of the cutting operation, productivity is about 3,300 cuttings per person per day (cpd) for hybrid larch (harvesting, cutting procedure and handling). In comparison, production is ± 4,300 cpd for black spruce (BS) and up to 6,000 cpd for white spruce (WS).
- Cuttings are then placed in dual chambers (in a tunnel), and hermetically closed (Photos 5 g-h). Water is supplied by a robotic spray unit and a fogging boom, controlled by the temperature and relative humidity registered in each chamber, so as to simultaneously maintain the foliage moist and the water vapour pressure within 1.0 to 1.5 kPa.
- After 12 weeks, 85% of the cuttings are rooting. After a period of acclimation, the rooted cuttings are stored in the soil and spend the winter outdoors. Transplanting as bareroot stock or in large-dimension containers takes place the following spring. Cuttings are delivered for planting two years later, as large-dimension plants.
- Trials using cuttings from low-volume containers (Jiffy® 18 mm), harvested while dormant, are underway. They could lead to modifications in current methods, especially opening the way to mechanized transplanting and harvesting dormant cuttings.

Stop 4: Container production of conifer plants from seeds

The usable production area is 26,000 m^2 of tunnel greenhouses, or the equivalent of 4.5 M large-dimension plants (LDP) (Table 4). The different species produced, in order of importance, are: white spruce, black spruce, larches, balsam fir, Norway spruce, red spruce and red pine. The great majority of the plants is produced as LDP. White spruce is one of the most difficult species for LDP production because it requires a finely adjusted production regime (Table 5).

The crop production schedule includes the following activities, throughout the two years of production:

- **Regular crop inspection** (presence of pathogens, insects and weeds);
- **Periodic monitoring of growth medium water content**: Overabundant or too-little irrigation hinders the normal development of the root system and, as a consequence, plant growth. We wish to maintain a water content of 25% (v : v);
- **Establishment of crop standards** for each species and plant type. We use growth development curves, according to the time in the season, for height, diameter, biomass, and concentration of minerals in the growth substrate and tissues. These standards serve as the basis for the fertilization schedule;
- **Monitor crops every two weeks** (mineral content of growing medium and tissues, biomass of stems and roots, height and diameter), needed to periodically revise the fertilization schedule;
- The year of spring delivery, all plants undergo quality control before leaving the nursery, according to set criteria for morphology, and dendrometric and qualitative benchmarks. Usually plant classification is done before delivery because a minimum of 85% of the delivered plants must meet the standards. From a quality standpoint, there are 20 possible rejection criteria, of which one is called « Root deficiency » (for the plant to be accepted, the rooting substrate must be whole and capable of accepting normal handling);
- The growing season extends from the end of April to the end of October. We accumulate between 2,200 and 2,500 degree-days of growth, on a 1°C basis. The first year, plants are grown in unheated tunnel greenhouses (Photo 6), whereas the second year, they are grown in exterior production areas.

Table 5. Schedule of the main production techniques for large-dimension white spruce grown in containers.

Month	First year (1+0)	Second year (2+0)
End of winter	• Stratification of seeds. • Use of seeds of calibre 1–2–3 (excluding small seeds, calibre 4).	• Removal of winter covers immediately after snow melts. • Moving containers to outdoor production areas.
April	• Seeding very early in season (end April) (2.5 viable seeds / cavity) • Growth medium composed of 80% fibrous peat and 20% vermiculite (v : v). Volumetric density of medium: 0.10 g / cm^3.	• Placing on supports raised at least 10 cm from soil to allow aeration and cavity drainage. Thus, the root system only develops within the cavity and growing conditions are optimized. • Fertilization starts as soon as the growth medium is thawed.
May	• Placing in tunnel greenhouses (covered with semi-transparent polyethylene) on raised supports 10 cm from the soil. • Daily surface irrigation during the germination phase.	• During the entire active growth period, fertilizer inputs are divided (2 applications per week) in order to reduce the risk of leaching of minerals. • The fertilization schedule takes into account contract requirements for minimal nitrogen concentrations of plants at the time of delivery.
June	• Manual thinning to one plant per cavity (the most vigorous and most centred). (Photo 6) • Managing the temperature in sheltered areas (opening side panels as soon as the temperature is above 30 °C).	
July	• Low-intensity lighting immediately to stimulate elongation of the stem (18-h photoperiod).	
August	• Stopping lighting to give the signal for hardening off.	
Sept.	• Closure of aeration panels in greenhouse tunnels to maintain a high temperature and to stimulate root development and hardening of the plant.	
October	• Removal of the polyethylene from greenhouse tunnels	• Placing containers on the ground.
Nov.	• Installation of a winter cover to minimize risk of roots freezing (If plants have a height of 10 cm or more, risk of stem breakage is high). • 1+0 target: biomass 1,200 mg, height 9 cm, Crown/Root ratio 3.0 and concentration of tissue N close to 3%.	• Installation of snow fences to provide winter protection for both the crowns and root systems.

Photo 6. Thinning plants in a tunnel.

Stop 5: Bareroot production of conifer plants produced from seeds

The usable nursery production area is 60 hectares. We can produce up to 4.0 M large-dimension plants (Table 6). The different species produced are, in order of importance: white spruce (WS), black spruce (BS), larches, balsam fir, Norway spruce, red spruce, red pine and white pine. The great majority of the plants is produced as LDP. The production schedule is over a period of four years, two years as seedlings followed by transplanting and another two years of growth (Table 7).

The production schedule includes the following activities, throughout the four years of production:

- **Regular crop inspection** (presence of pathogens, insects and weeds);
- **Soil management:** Good management of soils is fundamental to ensure success: green manure, and the periodic addition of compost and peat to maintain a minimum of 8% organic matter. Before entering into production, the soil undergoes a year of green manure production;
- **Establishment of crop standards** for each species and plant type. We use growth development curves, according to the time in the season, for height, diameter, biomass, and concentration of minerals in the soil and tissues. These standards serve as the basis for the fertilization schedulesuivi régulier de culture (teneur en éléments minéraux du sol et des tissus, biomasse des tiges et des racines, hauteur);
- The year of spring delivery, all plants undergo quality control during lifting and sorting. The principal criteria are morphology and dendrometric and qualitative benchmarks (Figure 5). A target of 85% of the delivered plants must meet the standards, but often this surpasses 90%;
- **Regular monitoring of crops** (mineral content of soil and tissues, biomass of stems and roots, height);
- The year of spring delivery, all plants undergo quality control during lifting and sorting. The principal criteria are morphology and dendrometric and qualitative benchmarks (Figure 5). A target of 85% of the delivered plants must meet the standards, but often this surpasses 90%;
- The growing season extends from the end of April to the end of October. We accumulate between 2,200 and 2,500 degree-days of growth, on a 1 °C basis. The first two years, plants are grown at a high density (Photo 7) to obtain a balanced plant with a dense root system (Photo 8).

In the spring of the 5th year, as soon as the soil thaws, we lift, sort, wrap and store the plants in a cold room at 2.5°C until delivery. It is essential that the plants be lifted while still dormant. All of these operations related to the plants are of extreme importance, or their survival could be threatened. The plants are wrapped in bundles of about 80 each while taking care to coat the roots with damp peat moss.

Table 6. Morphological criteria and target for nitrogen level at delivery time for two categories of bareroot spruce plants.

Plants	Seedlings Crop density (plants / m^2)	Transplants Crop density (plants / m^2)	Minimum height (cm) for delivery	Root density target (Ref.: Figure 5)	Minimum N concentration in tissues (%)
Large dimension	600	50	≥ 35 WS ≥ 40 BS	A and B	1.7%
Medium dimension	600	65	≥ 20 WS ≥ 25 NS	A and B	1.7%

Table 7. Schedule of the main production techniques for large-dimension white spruce grown as bareroot stock.

Month	First year (1+0)	Second year (2+0)
End of winter	• Stratification of seeds. • Use of seeds of calibre 1–2–3 (excluding small seeds, calibre 4).	
May ↓ October	• Seeding very early in season (early May) (3.5 viable seeds / deliverable plant). • Germination on a molded bed with 2 cm of peat on surface (hardly mixed with the soil). • Covering seeds with a layer of calcite 5 mm deep. • Daily surface irrigation during the germination phase. • Shading throughout entire season that cuts 50% of solar radiation (Photo 7). • During the entire active growth period, nitrogen fertilizations are divided (1 application every 10 days) to reduce the risk of leaching. • Root wrenching soil at 10 cm and vertical root pruning at the end of August to improve root density. (Photo 8) • A tissue concentration target of 2.5% nitrogen in the fall.	• Fertilization starts as soon as the soil is thawed. • During the entire active growth period, nitrogen fertilizations are divided (1 application every 10 days) in order to reduce the risk of leaching. • Root wrenching soil at 15 cm and vertical root pruning at the end of August to improve root density (Photo 8). • A tissue concentration target of 2.5% nitrogen in the fall.
Month	**Third year (2+1)**	**Forth year (2+2)**
End April	• As soon as soil thaws, seedling lifting and root pruning (10 cm). • Storage in bags in refrigerated cold room at 2.5 °C.	
May ↓ October	• Mid-May, selection and transplanting of seedlings. For example, we reject plants < 12 cm in height having a poorly developed root system. • We first of all ensure that the soil is sufficiently dampened so it can be well packed to encourage plant growth. • During the entire active growing period, nitrogen fertilizations are divided (1 application every 10 days) to reduce the risk of leaching. • Root wrenching soil at 18 cm and vertical root pruning to improve root density (Photo 8). • Autumn nitrogen tissue concentration target of 2.2%.	• Fertilization starts as soon as soil thaws. • During the entire active growth period, nitrogen fertilizations are divided (1 application every 10 days) to reduce the risk of leaching. • Root wrenching soil at 20 cm and vertical root pruning in August to improve root density (Photo 8). • Autumn nitrogen tissue concentration target of 2.2%.

Photo 7. Bareroot: seeding covered with shade structure.

Photo 8. Vertical pruning of plant roots. (Photos MRNF)

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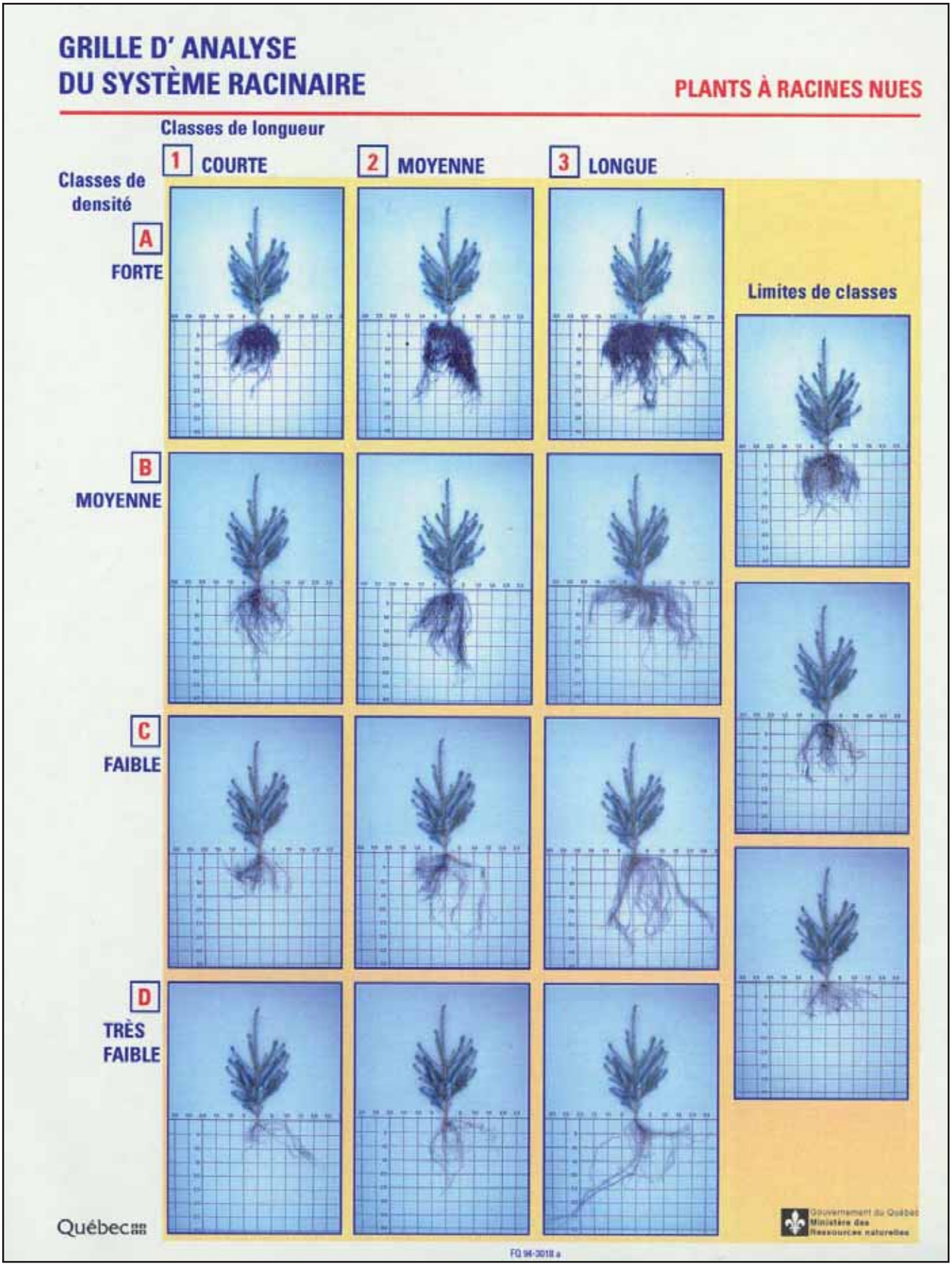

Figure 5. Classification grid for the root system of bareroot plants.

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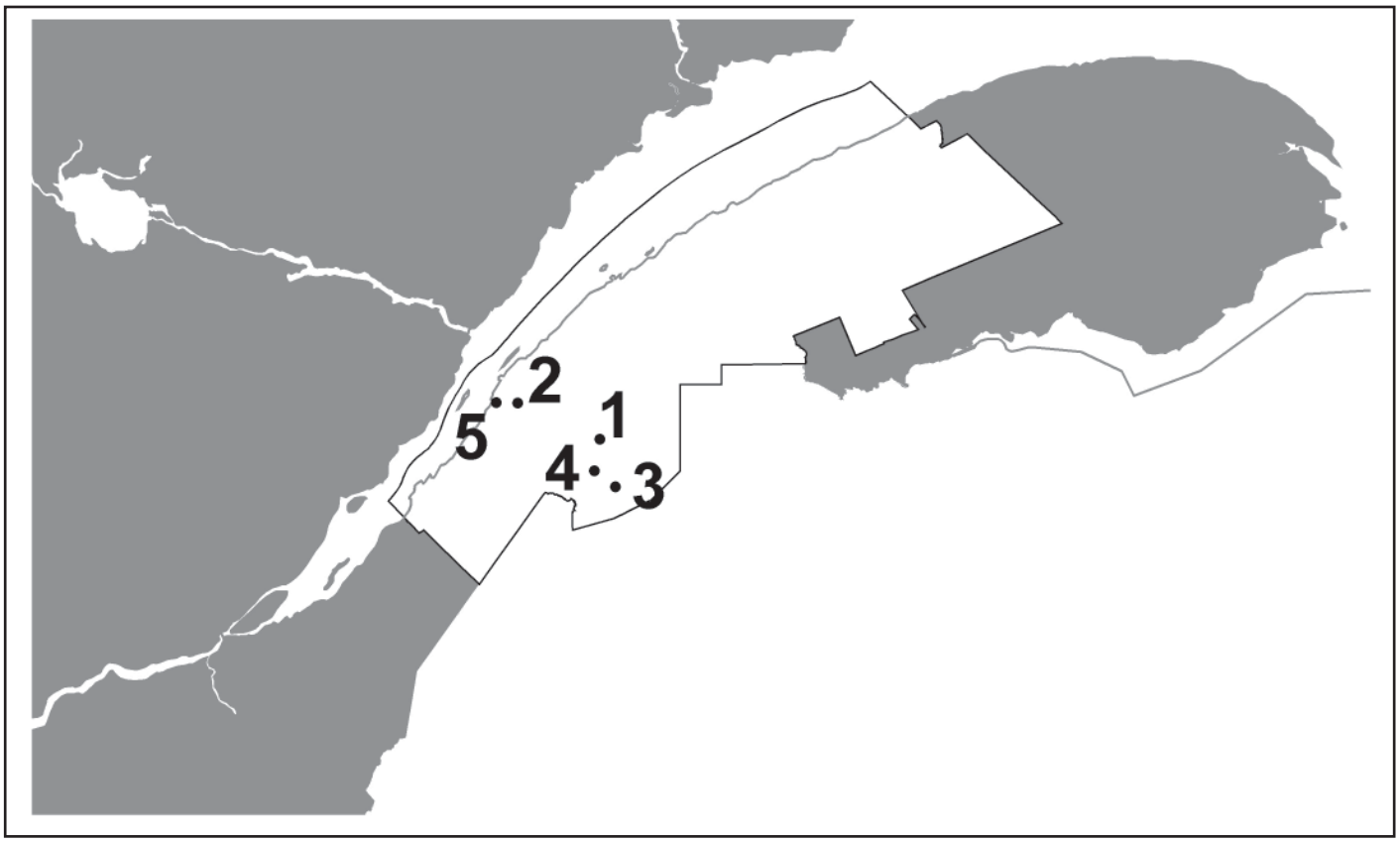
Day 2 – September 18

Stops 1 and 2, Packington
Portrait of the Bas-Saint-Laurent Administrative Region (page 8)

Packington (number 3 on map) is a municipality in the Témiscouata regional county municipality, Québec, located in the Bas-Saint-Laurent Administrative Region (*see the forest characteristics of this administrative region: Day 1, Stop 1)*

Packington also lies in the township by the same name. This township, established in 1869, was named in honour of Sir John Packington, Colonial Secretary in 1852 and the main promoter of the construction of the Intercolonial Railway. The main road is bordered with trees, and lets us catch a glimpse of the peaceful-looking houses. Warmth and hospitality are the outstanding welcoming characteristics in Packington. This is why visitors feel so good and return year after year. Packington also boasts an important system of watercourses: several fish-laden lakes, rivers and streams offer fishermen excellent opportunities to practise their sport.



Bas-Saint-Laurent Administrative Region.
Day 1 and 2 – September, 17-18.
Cabano (N° 1 on the map), Saint-Modeste (N° 2), Packington (N° 3), Saint-Eusèbe (N° 4), and Rivière-du-Loup (N° 5)

Information sources:

http://www.mrctemiscouata.qc.ca/Benoit.html

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Notes

Day 2 – September 18

Stop 1, Packington
Production of hybrid poplar on private woodlots in the Bas-Saint-Laurent

By Marc-André Lechasseur, ing.f.

Agence régionale de mise en valeur des forêts privées du Bas-Saint-Laurent, Rimouski, Québec

When the *Agence régionale de mise en valeur des forêts privées du Bas-Saint-Laurent* was established, the cultivation of hybrid poplar on private woodlots was in its early stages. The Bas-Saint-Laurent has benefited from several clonal tests that contributed to the selection of better adapted clones for different areas in the region. Hybrid poplar therefore sparked curiosity and, at the same time, misgivings about what the true productive capacity of these trees that came from human intervention.

On the other hand, with the presence of operational expertise and financial support often lacking, the first plantations of hybrid poplar led to mixed results, and in some cases were unconvincing.

In 2002, the *Direction de la recherche forestière* proposed to the Agency and three forestry advisers in the region, a partnership to establish various hybrid poplar demonstration plantations with a sufficient financing package to carry out site preparation, planting and maintenance. The main objective was to promote poplar growing while establishing plantations in visible places on the private woodlots of landowners. Thus, three areas of uncultivated land located in Témiscouata, the Matapédia valley and Matane were planted with clones recommended by the *ministère des Ressources naturelles et de la Faune* (MRNF) for each region. The *Direction de la recherche forestière* ensures monitoring and measurements of the plantations, in collaboration with three joint management groups with the *Direction régionale des forêts du Bas-Saint-Laurent* (MRNF).

In 2004, the Agency began to analyse the issues of private woodlots, starting with available knowledge, and in 2005 adopted a series of principles and priorities to guide the development of the silvicultural strategy when the time comes to modify its plan for forest protection and development (PPMV).

Among the principles chosen is the development of intensive silviculture, mainly hybrid poplar, as an opportunity to meet the required conjunctural volume of poplar within 25 years. Developing intensive silviculture is therefore a priority for the Agency, which will dedicate resources in order to promote the emergence of operational expertise. The objective is to make it an effective regional management tool, and avoid the shortfall in poplar fibre supplies to mills that is forecasted for 2030, by harvesting the available cyclical volumes.

Parallel to these activities, the woodlot producers of the *Bas-Saint-Laurent* and the *Fédération des organismes de gestion en commun du Bas-Saint-Laurent*, in partnership with the Agency, developed a sustainable development plan for the private woodlands of the Bas-Saint-Laurent, which contains 23 projects. The Agency is the promoter of eight projects, of which one is for the cultivation of fast-growing species.

The project's aim is to establish plantations of fast-growing species at a steady rate, from 50 to 300 hectares per year for hybrid poplar and from 50 to 100 hectares per year for hybrid larch over the 2005 to 2009 period. The sites identified are unused agricultural lands and forest sites. The project was conditional on obtaining funds dedicated to implementing the Kyoto Protocol, the remainder being taken on by industry and the Agency. The project should require investments in the order of $2 M. It will contribute to the resurgence of the regional economy by developing operational expertise and by the activity generated over the short term in nurseries to establish the plantations. In addition, the project will favourably position the Bas-Saint-Laurent region to assist Canada in attaining the Kyoto Protocol objectives, particularly for Québec.

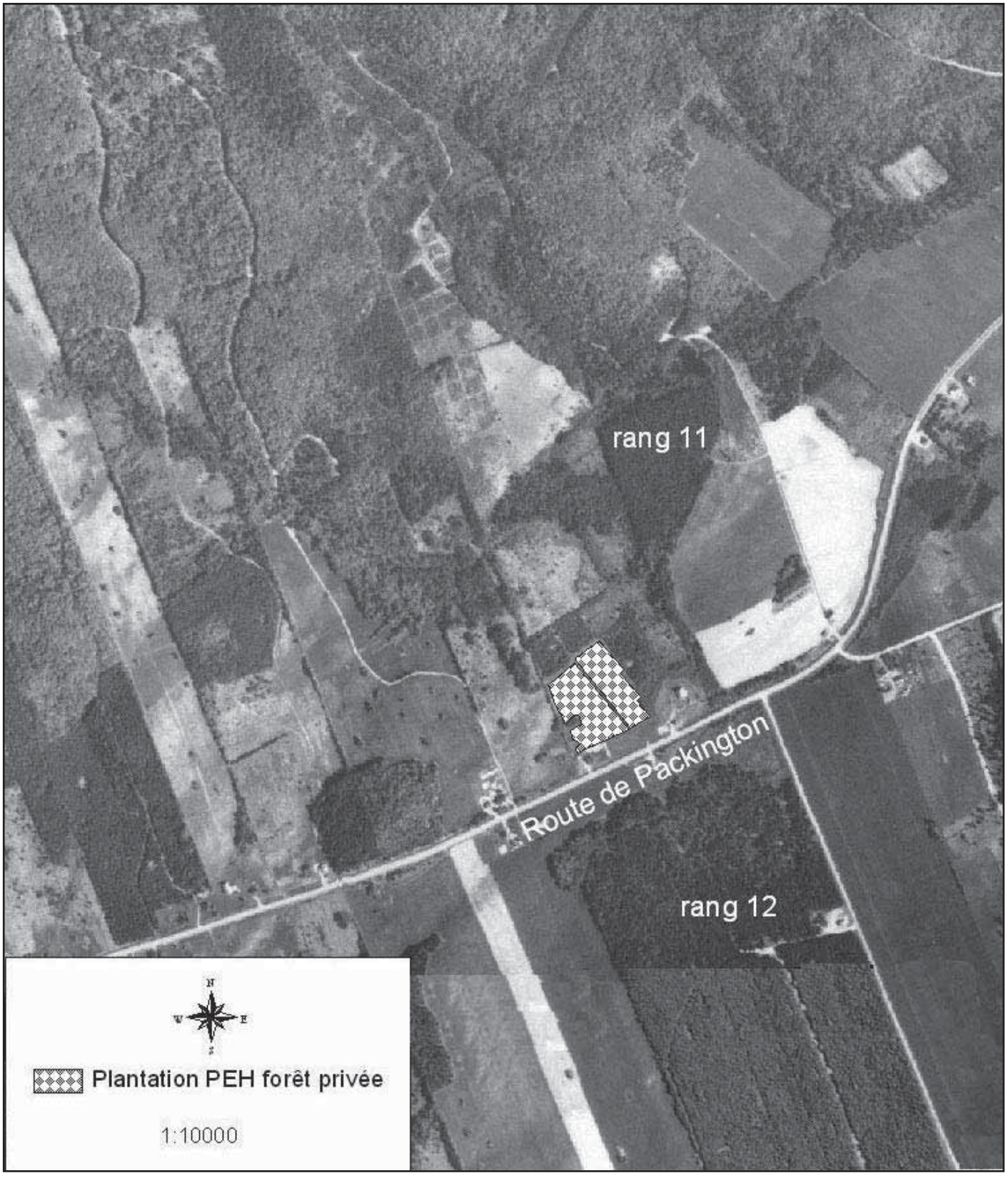
In spite of limited financial resources, the Agency decided in 2006 to establish a special budget for poplar growing, covering all the cultural activities required for site preparation, planting, plantation maintenance, pruning for shaping, and thinnings. For the years 2006, 2007 and 2008, the Agency will financially support activities on 150 hectares, representing investments in the order of $600,000. This undertaking marks the beginning of the implementation of its project to grow fast-growing species and for setting up conditions conducive to developing operational expertise, and for obtaining our desired objectives for these plantations.

To date, many efforts have been undertaken to inform the forestry advisers and landowners about poplar growing. Among the many management options offered to landowners, growing hybrid poplar is a way to make selected plots of land very productive, helping them to diversify their revenues over a relatively short horizon.At first glance, this should fan the interest of landowners, but two obstacles impede the development of a poplar growing program. Though fibre production is well-known as an agricultural product, there are always usage conflicts between the two productions, leaving few sites available for reforestation. The second obstacle is of a financial nature. Intensive production requires important investments. Let us hope that setting up of a carbon credit in Canada will bring about the injection of new funds to support the development of hybrid poplar production.

[3] Conjunctural volume is one that is harvested, for a given period, to supplement the annual allowable cut within the framework of a sustained and increasing yield, without reducing it.

Notes

Stop 1, Packington (cont.)



Hybrid poplar plantations on private woodlots.

Demonstration Plantation at Packington (5 years) – Technical Sheet

Demonstration test planted in 2003 on a private land with 12 selected clones used for planting in the region.

Test	**PAC48103**
Ecological region	4fM
Regional landscape unit (RLU)	63, *Lac Témiscouata*
Coordinates	Latitude: 47° 30' 23'' N Longitude: 68° 45' 19'' W
Altitude	320 m
Tenure	Private land owned by Mr. *Denis Painchaud*, *route de Packington*
Former state of site	Grassland
Soil	Silty to sandy loam (wet at some places)
Site preparation	Ploughing / harrowing in August 2002
Plant material	Bare-rooted plants
Year of establishment	Mai 20, 2003
Number of clones	12
Spacing	3 m × 3 m
Number of blocks or repetitions	3 (+ 4th repetition for 9 clones)
Number of trees per plot	49 (7 plants × 7 plants)
Number of trees - test	2,205
Number of trees – left-over	408
Total area	2.35 ha
Tending	2003, 2004, 2005: 3 cultivations per year with a toothed harrow + fieldmouse traps 2006, 2007: cultivator (2 times)
Measurements	2003 (1 year), 2007 (5 years)

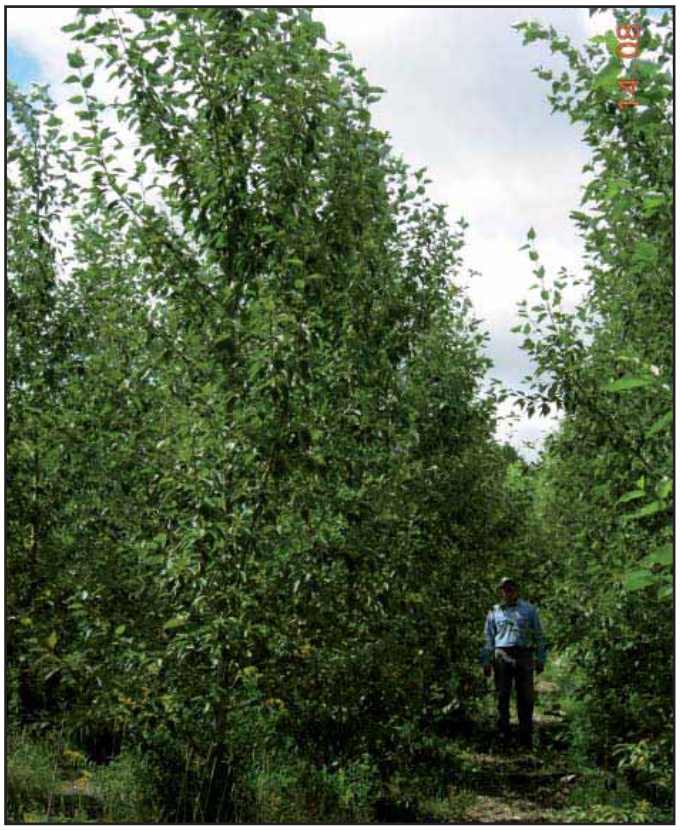
Growth Data – Height and Diameter (August 2007)*

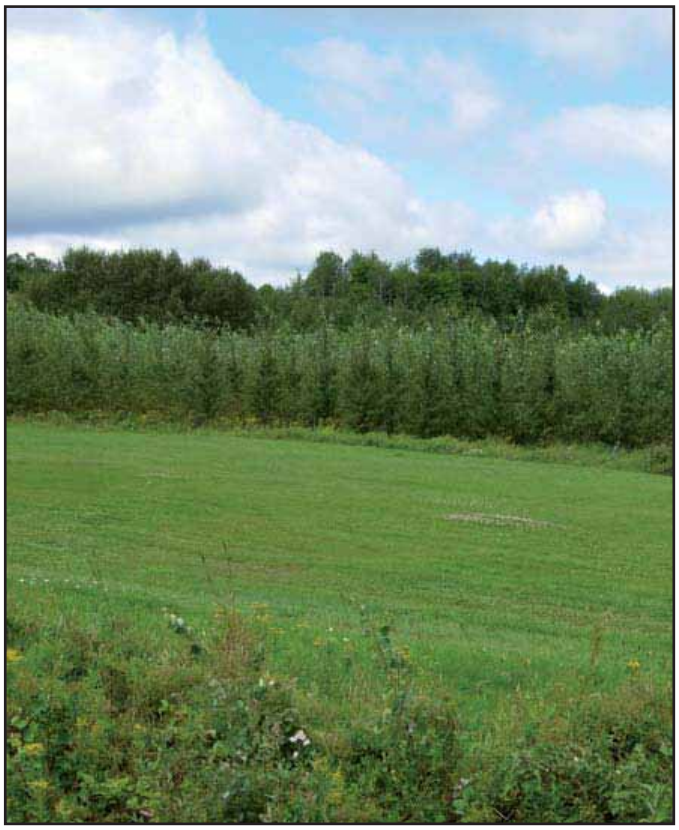
		Block 1		**Block 2**		**Block 4**	
Clone	**Hybrid**	**Mean H (m)**	**Mean DHP (mm)**	**Mean H (m)**	**Mean DHP (mm)**	**Mean H (m)**	**Mean DHP (mm)**
505508	M × DT	**6,2**	**76**	**5,6**	**63**	**4,6**	**47**
750316	M × T	**6,8**	**62**	**6,4**	**56**	**6,1**	**58**
915318	M × B	**7,1**	**74**	**6,9**	**62**	**5,6**	**51**

*: 9 measured trees by plot

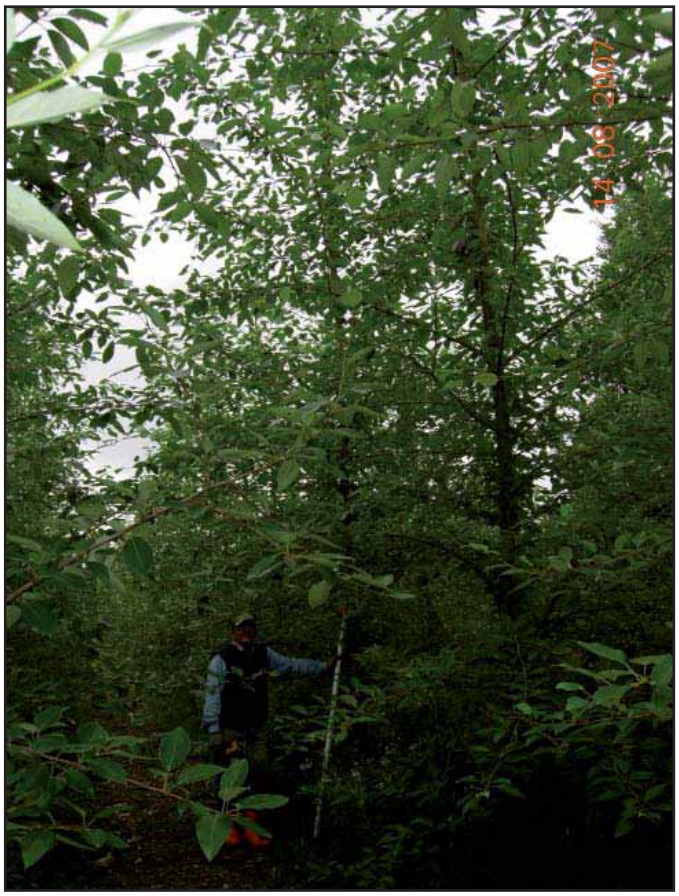
Partners:

Agence régionale de mise en valeur des forêts privées du Bas-Saint-Laurent, Corporation Agro-forestière Transcontinental inc., Denis Painchaud, and the Direction des forêts du Bas-Saint-Laurent (MRNF, Volet 1)





Photos 1 et 2. Hybrid poplar demo plantation at Packington, 5 years. (Photos Alain Fauchon)



Photos 3 et 4. Clones 505508 and 750316, 5 years in plantation at Packington. (Photos Alain Fauchon)

Liste des clones utilisés pour le dispositif

505227	M X DT
505326	M X DT
505508	M X DT
750301	M X DT?
750316	M X DT?
915004	B X M
915005	B X M

915314	M X B
915318	M X B
915319	M X B
915320	M X B
916401	E X M

PAC48103

Sous-région écologique: 4f-M

SECTEUR PACKINGTON

(Témiscouata)

TEST DE DÉMONSTRATION

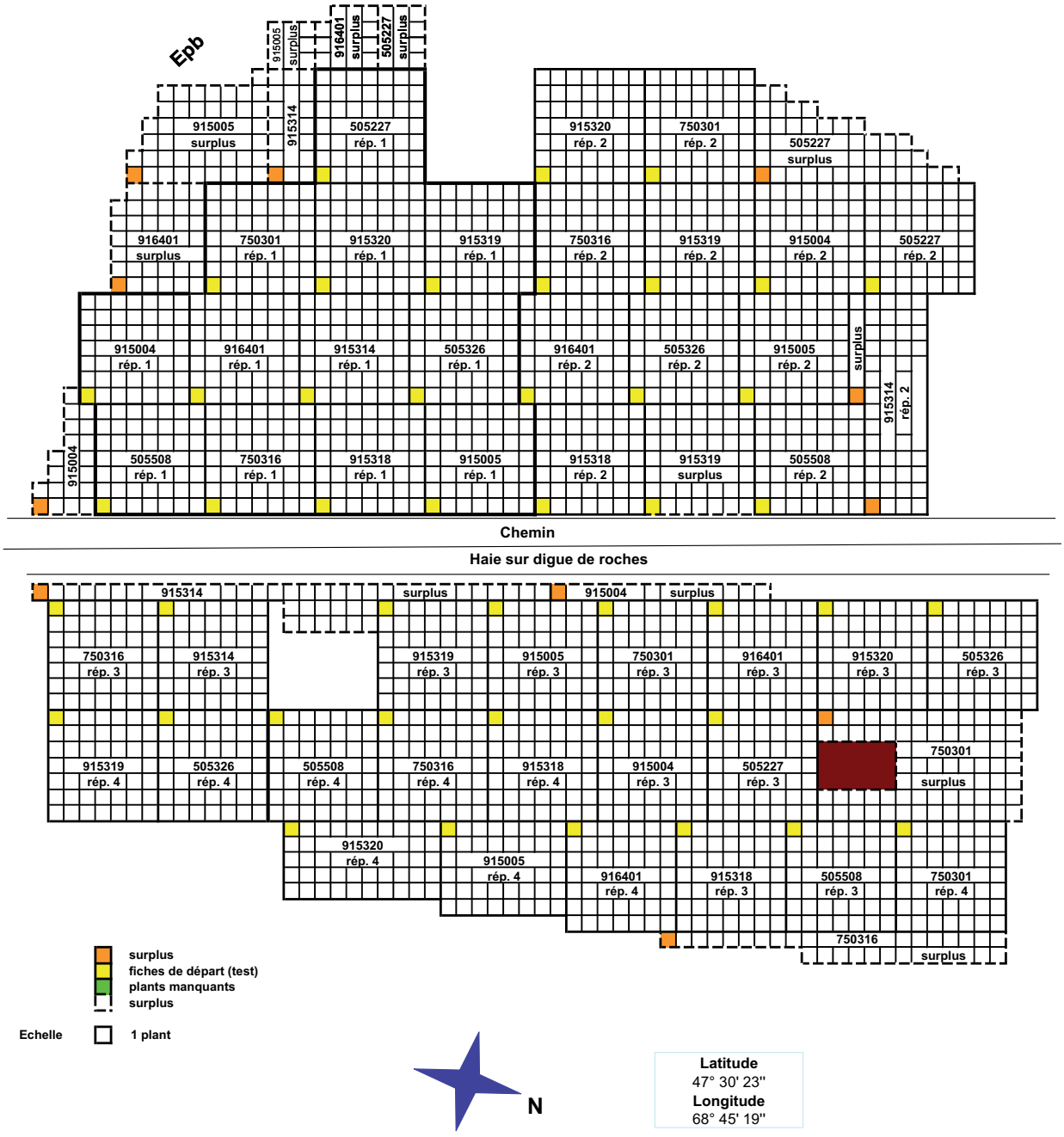
Nb de répétitions: 3

PARCELLES DE 49 ARBRES

ESPACEMENT : 3 m X 3 m

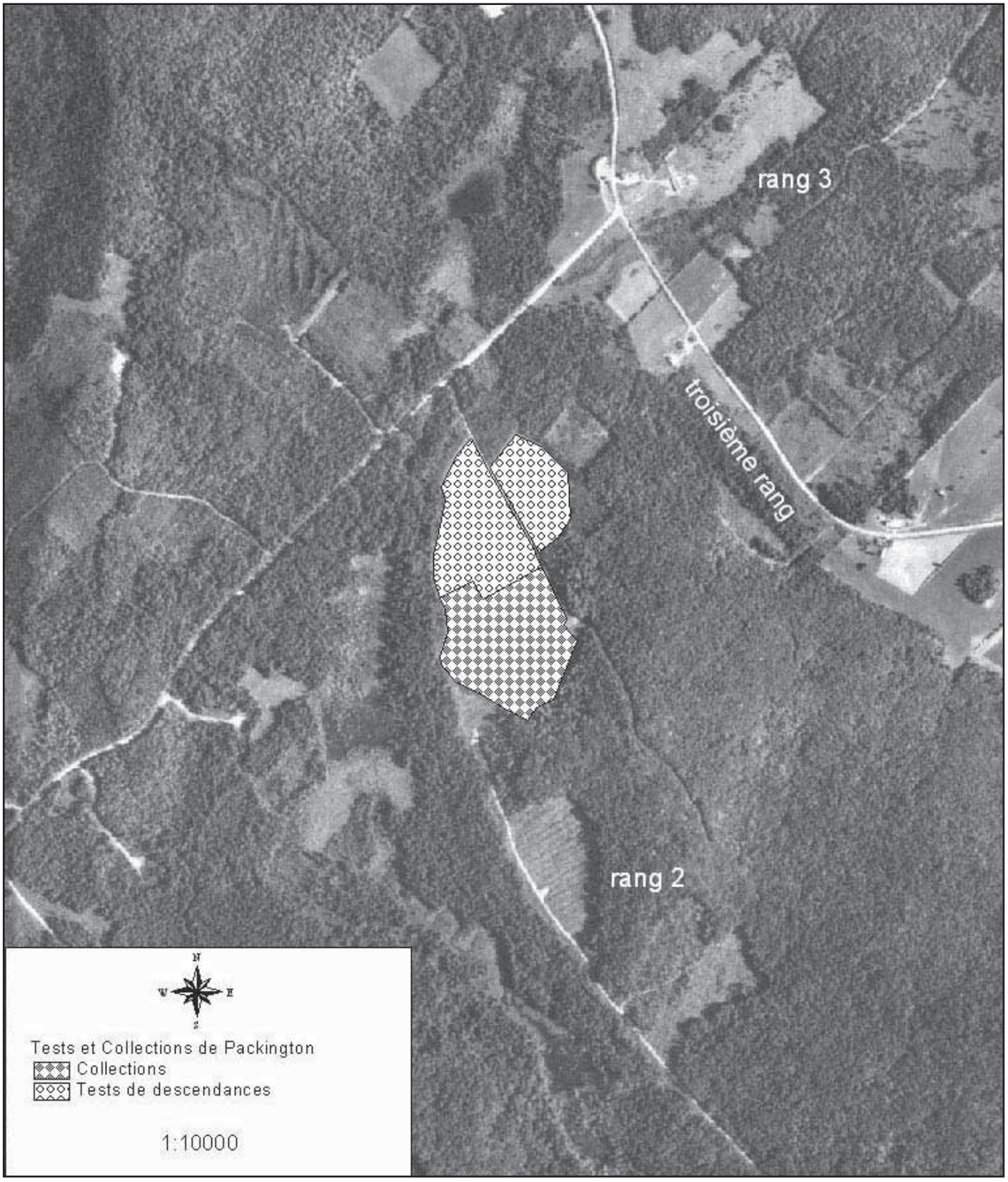
Nb de clones: 12

Nb plants total: 2 613

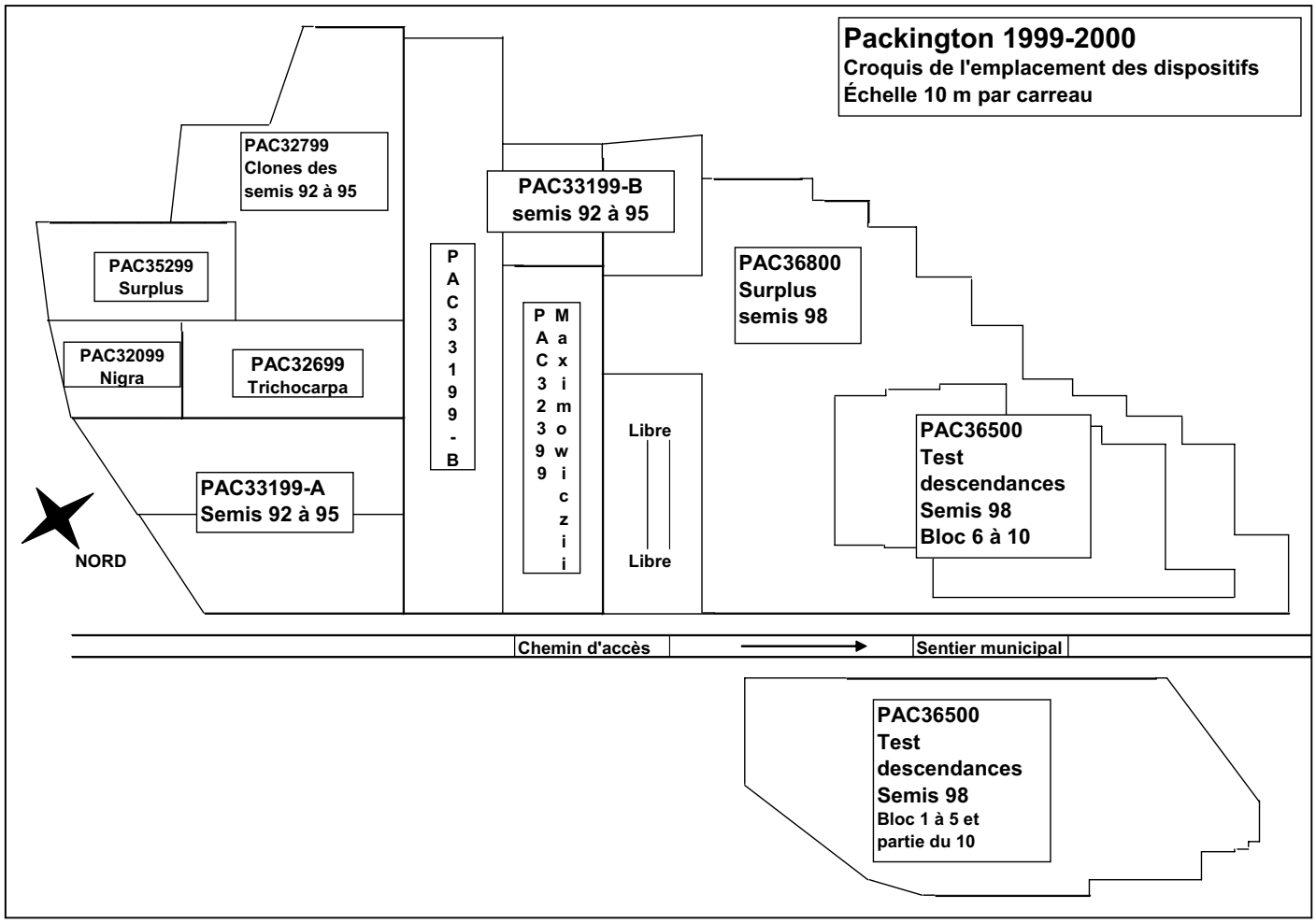


Latitude
47° 30' 23"
Longitude
68° 45' 19"

Day 2 – September 18
Stop 2, Packington



Tests and Collections at Packington.


Packington 1999-2000
Croquis de l'emplacement des dispositifs
Échelle 10 m par carreau
PAC32799
Clones des
semis 92 à 95
PAC33199-B
semis 92 à 95
PAC35299
Surplus
PAC32099
Nigra
PAC32699
Trichocarpa
PAC33199-A
Semis 92 à 95
NORD
PAC33199-B
PAC32399 Maximowiczii
Libre
Libre
PAC36800
Surplus
semis 98
PAC36500
Test
descendances
Semis 98
Bloc 6 à 10
Chemin d'accès
Sentier municipal
PAC36500
Test
descendances
Semis 98
Bloc 1 à 5 et
partie du 10

Day 2 – September 18

Stop 2A

Progeny Test of the 1998 Breeding Program – Technical sheet

Full-sib families bred in 1998 for the Bas-Saint-Laurent region. These families, introduced in 2000 at *Packington*, were also planted in colder regions of *Jetté* and *Tessier*, for clonal selection.

Test	**PAC36500**
Ecological region	4fM
Regional landscape unit (RLU)	63, *Lac Témiscouata*
Coordinates	Latitude: 47° 25' 21'' N Longitude: 68° 53' 47'' W
Altitude	320 m
Tenure	Public land
Former state of site	Total cut of a mixed wood stand around 1994
Soil	Silt loam to silty sand loam
Site preparation	Forest discing with a Crabe harrow: 2 cross-cultivations at the end of October 1998 and phytocide in August 1999.
Plant material	Bare-rooted seedlings (1-1) from 35 to 100 cm. Seedlings transplanted in 1999 at the *St-Modeste* nursery.
Year of establishment	Early May 2000
Number of progenies	238 families (among which 203 *Aigeiros Tacamahaca*)
Spacing	2.25 m × 3 m
Number of blocks or repetitions	10
Number of trees per plot	2
Number of trees - test	4,488 trees within the test (PAC36500) and 3,220 in left-over (PAC36800)
Total area	3.04 ha
Tending	Brush control in July 2004
Measurements	2000 (1 year) and 2004 (5 years)
Survival rate	53 % in 2004 (5 years)
Growth (5 years)	Mean height: 223 cm Mean diameter: 12 mm
Tree selection	August 2006 (7 years): 325 clones, out of which 243 selected within the test (PAC36500), from 99 progenies
Cuttings harvest	November 2006 (1,950 cuttings for stoolbed establishment at *St-Modeste*)

General observations:

This test wasn't established easily due to the 2-year delay between site preparation and planting in spite of the 1999 RoundUp treatment. Important grass competition reduced the survival rate and the growth of small-size seedlings.

Partners:

Corporation Agro-forestière Transcontinental inc.,
Direction des forêts du Bas-Saint-Laurent (MRNF, Volet 1)

1998 Breeding Program – Sub-Population of 5 hybrids.
Number of progenies per hybrid from which 196 trees were selected in 2006.

Number of progenies and number of selected trees in 2006 for 5 different hybrids

Hybrid	No of Fam.	Selected Trees
M × B	**12**	**70**
B × T	**6**	**39**
D × M	**4**	**32**
M × T	**5**	**32**
M × DB	**11**	**23**
Total	38	196

Growth Data – Mean Height and Diameter of selected trees for a single family of 5 different hybrids

Hybrid	Fam. No	Selected Trees	Mean H* (m)	Mean DHP* (mm)
M × B	21194	**9**	6,5	62
B × T	21166	**18**	6,0	63
D × M	21150	**20**	6,4	63
M × T	21222	**8**	7,0	71
M × DB	21233	**6**	6,3	62

*: in 2006 (7 years)

Day 2 – September 18

Stop 2B

Progeny Collection of *Populus maximowiczii* – Technical Sheet

Populus maximowiczii collection introduced in *Packington, Jetté* and *Tessier* for selection of plus-trees which will served as parents for future breeding programs. This cutting-propagated collection represents the trees in *Villeroy* obtained from open-pollinated families of 3 high-altitude provenances in Japan.

Test	**PAC32399**
Ecological region	4fM
Regional landscape unit (RLU)	63, Lac Témiscouata
Coordinates	Latitude: 47° 25' 21'' N Longitude: 68° 53' 47'' W
Altitude	320 m
Tenure	Public land
Former state of site	Total cut of a mixed wood stand around 1994
Soil	Silt loam to silty sand loam
Site preparation	Forest discing with a Crabe harrow: 2 cross-cultivations at the end of October 1998
Plant material	1 year plants (75 to 150 cm)
Population	Cuttings collected at Villeroy on 10 year-old trees (half-sib families from Hokkaido, Japan)
Year of establishment	Early May 1999
Number of progenies	29
Spacing	1.5 m × 3 m
Number of blocks or repetitions	1 to 19
Number of trees per plot	10
Number of trees - test	1,580
Total area	0.71 ha
Tending	Brush control in July 2000 and July 2003
Measurements	1999 (1 year) and 2003 (5 years)
Survival rate	74 % in 2003 (5 years)
Growth (5 years)	Mean height: 312 cm Mean diameter: 19 mm

General observations:

Good survival and growth in comparison with Jetté and Tessier (colder areas). Future selection of vigorous and well-adapted trees from an introduced species not that cold-hardy. Strong nutritional effect of the stacking area on growth of the first-row trees along the road.

Partners:

Corporation Agro-forestière Transcontinental inc., Direction des forêts du Bas-Saint-Laurent (MRNF, Volet 1)

Day 2 – September 18

Stop 2C

Progeny Collection, 1992-1995 Breeding Programs – Technical Sheet

Miscellaneous population of full-sib families bred for regions of bioclimatic domains 2, 3, and 4 (regions of *Lac-Saint-Jean, Estrie, Beauce, Appalaches*, etc.). These families introduced at *Packington* for tree selection were also planted in colder regions of *Jetté* and *Tessier*.

Test	**PAC33199**
Ecological region	4fM
Regional landscape unit (RLU)	63, *Lac Témiscouata*
Coordinates	Latitude: 47° 25' 21'' N Longitude : 68° 53' 47'' W
Altitude	320 m
Tenure	Public land
Former state of site	Total cut of a mixed wood stand around 1994
Soil	Silt loam to silty sand loam
Site preparation	Forest discing with a Crabe harrow: 2 cross-cultivations at the end of October 1998
Plant material	1 year plants (75 to 100 cm) from cuttings harvested on 5 or 6 year-old plants
Population	78 full-sib families from the breedings of 1992 (8), 1993 (26), 1994 (36) and 1995 (8); plus 12 half-sib families (1992 and 1993)
Year of establishment	Early May 1999
Number of progenies	90
Spacing	1.5 m × 3 m
Number of blocks or repetitions	Variable 1 to 36 repetitions per families. Incomplete blocks
Number of trees per plot	10
Number of trees - test	6,200 trees within the test and 960 in left-over (PAC35299)
Total area	2.79 ha
Tending	Brush control in July 2000 and July 2003
Measurements	1999 (1 year) and 2003 (5 years)
Survival rate	84% in 2003 (5 years)
Growth (5 years)	Mean height: 307 cm Mean diameter: 19 mm
Tree selection	August 2006 (8 years), 196 clones selected from 56 progenies
Cuttings harvest	November 2006 (1176 cuttings for stoolbed establishment at *St-Modeste*)

General observations:

Good survival of southern populations. Good adaptation of clones to bioclimatic conditions of Domain 4 in comparison with colder areas of Jetté and Tessier.

Partners:

Corporation Agro-forestière Transcontinental inc., Direction des forêts du Bas-Saint-Laurent (MRNF, Volet 1)

1992-95 Breeding Program – Sub-Population of 5 hybrids.
Number of progenies per hybrid from which 136 trees were selected in 2006.

Number of progenies and number of selected trees in 2006 for 5 different hybrids

Hybrid	No of Fam.	Selected Trees
M × T	**9**	**56**
M × N	**14**	**48**
N × M	**1**	**4**
M × TD	**5**	**18**
(DN × B) × M	**4**	**10**
Total	33	136

Growth Data – Mean Height and Diameter of selected trees for a single family of 5 different hybrids

Hybrid	Fam. No	Selected Trees	Mean H* (m)	Mean DHP* (mm)
M × T	14265	**17**	10,5	93
M × N	14283	**6**	10,0	93
N × M	13934	**4**	88,9	84
M × TD	13885	**4**	10,1	89
(DN × B) × M	13670	**7**	8,9	81

*: in 2006 (8 years)

Day 2 – September 18

Stop 2D

Progeny Collection of *Populus nigra* – Technical Sheet

Open-pollinated families of *Populus nigra* introduced at *Packington*, *Jetté* and *Tessier* for selection of plus-trees which will served as parents for future breeding programs. Original provenance collection planted in Québec from Belgium, the Netherlands, Hungary, Yugoslavia, and Bulgaria.

Test	**PAC32099**
Ecological region	4fM
Regional landscape unit (RLU)	63, *Lac Témiscouata*
Coordinates	Latitude: 47° 25' 21'' N Longitude: 68° 53' 47'' W
Altitude	320 m
Tenure	Public land
Former state of site	Total cut of a mixed wood stand around 1994
Soil	Silt loam to silty sand loam
Site preparation	Forest discing with a Crabe harrow: 2 cross-cultivations at the end of October 1998.
Plant material	2 years plants (1-1) from 1.0 to 1.6 m; seedlings of 1997 transplanted at *St-Modeste* in 1998
Population	Half-sib families of *P. nigra* from *Sainte-Brigitte* and *Villeroy* plantations (seeds collected in 1996)
Year of establishment	Early May 1999
Number of progenies	36
Spacing	1.5 m × 3 m
Number of blocks or repetitions	4
Number of trees per plot	5
Number of trees - test	700
Total area	0.32 ha
Tending	Brush control in July 2000 and July 2003
Measurements	1999 (1 year) et 2003 (5 years)
Survival rate	80 % in 2003 (5 years)
Growth (5 years)	Mean height: 303 cm Mean diameter: 18 mm

General observations:

Good survival and growth in comparison with Jetté and Tessier (colder areas). Future selection of vigorous and well-adapted trees from an introduced species not that cold-hardy.

Partners:

Corporation Agro-forestière Transcontinental inc., Direction des forêts du Bas-Saint-Laurent (MRNF, Volet 1)

Day 2 – September 18

Stop 2E

Progeny Collection of *Populus trichocarpa* – Technical Sheet

Open-pollinated families of *Populus trichocarpa* introduced at *Packington*, *Jetté* and *Tessier* for selection of plus-trees which will served as parents for future breeding programs. IUFRO progeny collection planted in Québec from Oregon, Washington, Alaska and British Columbia.

Test	**PAC32699**
Ecological region	4fM
Regional landscape unit (RLU)	63, *Lac Témiscouata*
Coordinates	Latitude: 47° 25' 21'' N Longitude: 68° 53' 47'' W
Altitude	320 m
Tenure	Public land
Former state of site	Total cut of a mixed wood stand around 1994
Soil	Silt loam to silty sand loam
Site preparation	Forest discing with a Crabe harrow: 2 cross-cultivations at the end of October 1998
Plant material	2 years plants (1-1) from 40 to 100 cm; seedlings transplanted at *St-Modeste* in 1998
Population	Half-sib families of *P. trichocarpa* from *Rigaud* and *Villeroy* plantations (seeds collected in 1997)
Year of establishment	Early May 1999
Number of progenies	20
Spacing	1.5 m × 3 m
Number of blocks or repetitions	1 à 7
Number of trees per plot	10
Number of trees - test	770
Total area	0.35 ha
Tending	Brush control in July 2000 and July 2003
Measurements	1999 (1 year) et 2003 (5 years)
Survival rate	81 % en 2003 (5 years)
Growth (5 years)	Mean height: 270 cm Mean diameter: 17 mm

General observations:

Good survival and growth in comparison with Jetté and Tessier (colder areas). Future selection of vigorous and well-adapted trees from an introduced species not that cold-hardy. Less fertile sector (slope).

Partners:

Corporation Agro-forestière Transcontinental inc., Direction des forêts du Bas-Saint-Laurent (MRNF, Volet 1)

Notes

Day 2 – September 18
Stop 3 et 4, Saint-Eusèbe

As in the case of Packington, the municipality of Saint-Eusèbe (number 4 on map) is also located in the regional county municipality of Témiscouata and the Bas-Saint-Laurent Administrative Region (*see the forest characteristics of this administrative region: Day 1, Stop 1*).

The municipality of Saint-Eusèbe was established in 1906. The name was given in honour of Monsieur Eusèbe Sénéchal in recognition of his kindness of having provided rooms for the parish priest at the time. Tourists who adventure off the main roads will discover the pleasure of discovering the exceptional panorama offered by the steep-sided mountains that cross Saint-Eusèbe, dubbed the "Jewel of the Appalachians" for this reason.

Forests are very much in evidence in the area and contributed to the birth of Saint-Eusèbe. The Cabano River and Ruisseau Baker, better known as the 'concession six stream', offer fish-rich waters that fishermen adore. Hunters find small game, deer and moose.

The municipality's economy is based on several sectors: forestry, agriculture and business. Several cedar sawmills were established in Saint-Eusèbe over the years. There is also a factory producing decorative wood moldings, a wood pallet manufacturer and a mobile sawmill.

Today Saint-Eusèbe has a few large dairy farms, in contrast to the past when farms were smaller but far more numerous.

Sugar maple is becoming increasingly important economically.

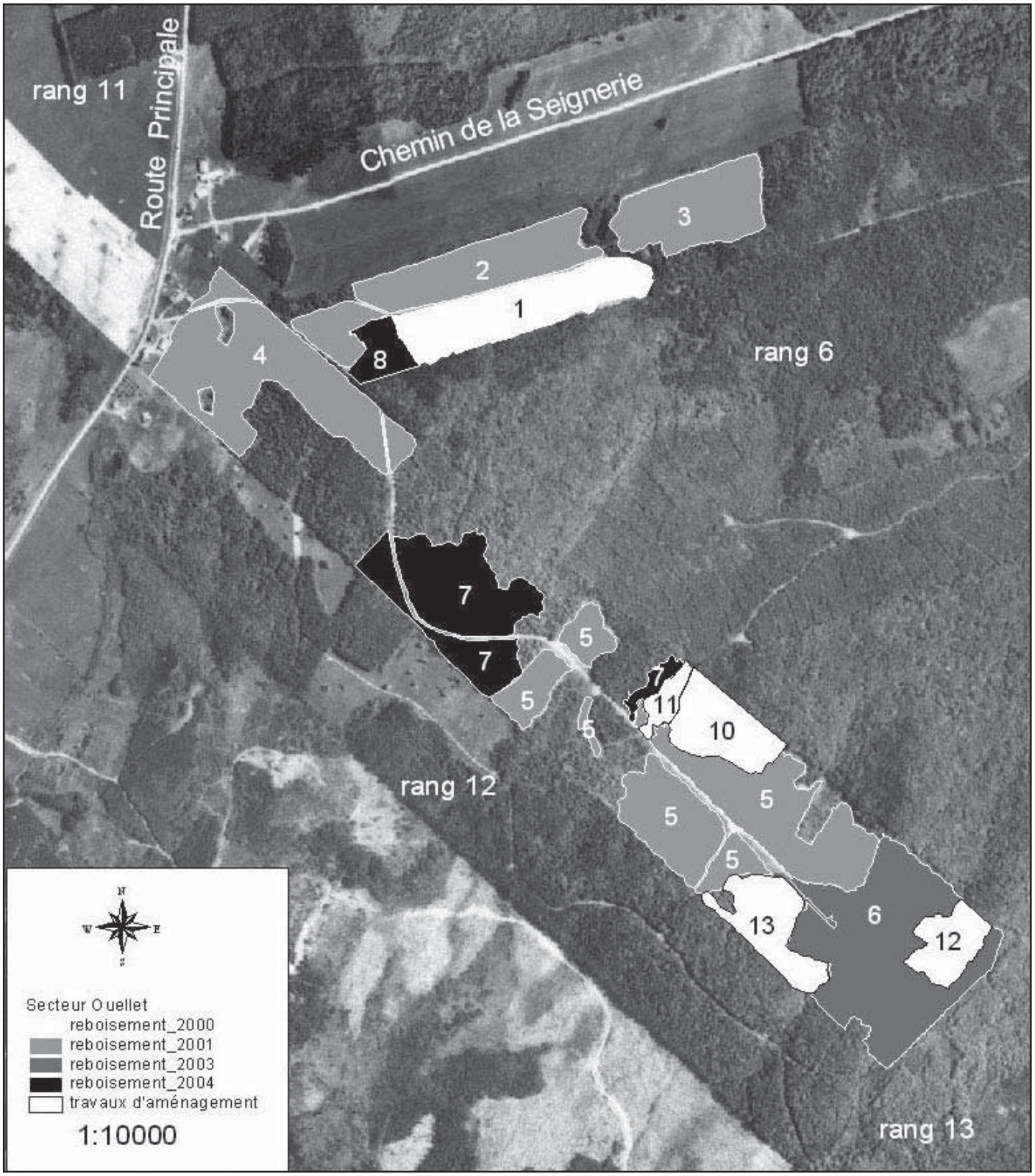
Information sources:

http://www.mrctemiscouata.qc.ca/Eusebe.html

Ministère des Ressources Naturelles, 2002. *Rapport sur l'état des forêts québécoises*, 1995-1999. 272 p.

Notes

Day 2 – September 18
Stop 3



Hybrid poplar plantations on private woodlots.

Stop 3, Norampac – Cabano, Ouellet Area – Plot 1

Plot 1 within the Ouellet area represents an operational hybrid poplar plantation mechanically established on farmland during spring 2000.

Table 1. Site

	Ouellet Area	Plot 1
Location	Saint-Eusèbe	
Area (ha)	84.7	4.7
Plantation (ha)	51.6	
Farmland (ha)	23.0	4.7
Forestland (ha)	28.6	-
Number of trees	43 786	5 222

Table 2. Plantation data

Site preparation -Vision herbicide and ploughing -Harrowing	 1999 2000
Mechanical planting	2000
Spacing	3 m x 3 m
Clones 3374 (B × M) 3375 (B × M) 505227 (M × DT) 505273 (M × DT)	4
Number of container plants (Polymoss 700 and 1000 cm^3)	**5 222**

Table 3. Tending schedule

Year	2000			2001			2002			2003			2004			2007		
Season	S	Su	F	S	Su	F	S	Su	F	S	Su	F	S	Su	F	S	Su	F
2 mechanical weedings with a toothed harrow		X																
Crown pruning of trees following snow damage				X														
Pruning				X									X			X		
2 mechanical weedings with a toothed harrow (*déchaumeuse*)					X			X										
Crown pruning													X					

Day 2 – September 18

Stop 3, Norampac – Cabano, Ouellet Area – Plot 5

Plot 5 of Ouellet Area corresponds to an operational hybrid poplar plantation established manually on a forested site during spring 2001. Since 2004, the plot also holds a fertilization trial.

Table 1. Site

	Ouellet Area	Plot 5
Location	Saint-Eusèbe	
Area (ha)	84.7	11.6
Plantation (ha)	51.6	
Farmland (ha)	23.0	-
Forestland (ha)	28.6	11.6
Number of trees	43 786	13 176

Figure 1. Plantation outline

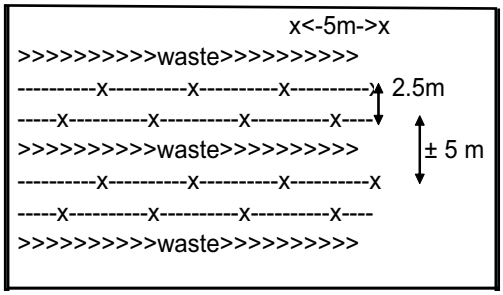


Table 2. Plantation data

Site preparation -Salvage cutting -Grubbing -Road construction	2000 2001
Manual planting	2001
Fill planting of stacking areas	2005
Spacing	2.5 m x 5 m
Clones	5
3374 (B × M)	
3375 (B × M)	
505227 (M × DT)	
505273 (M × DT)	
Fill planting 750316 (M × T)	
Number of bare-root plants	**13 176**

Notes on grubbing: Realised with a pelle en "V" which scalped the soil 10 to 30 cm deep all over the plot area. On a 2.7 m width, the soil has been cleared and prepared with a bulldozer D-4 equipped with two 40 cm long subsoiling teeth that were 2 m apart. These were used in order to facilitate rooted stock planting ± 25 cm deep. Rows of waste have a width of ± 2.3 m (see Figure 1).

Table 3. Tending and research (fertilization trial) schedules

Year	2003			2004			2005			2006		
Season	S	Su	F	S	Su	F	S	Su	F	S	Su	F
Brush control within a 1 m radius of poplar (10.9 ha) and cutting of other trees outside the 1 m radius that can interfere with poplar growth		X										
Brush control of 0.7 ha (50% crown, 50% total)								X				
Establishment of 2 fertilized plots				X								
Establishment of 2 control plots							X					
Fill planting of stacking areas							X					
Pruning										X		
Measurements of fertilized plots only							X		X			
Measurements of the 4 plots												X

Stop 3, Norampac – Cabano, Ouellet Area – Plot 7

Plot 7 of Ouellet Area corresponds to an operational hybrid poplar plantation established manually on a forested site during spring 2004. Since its establishment, the plot also holds a fertilization trial.

Table 1. Site

	Ouellet Area	Plot 7
Location	Saint-Eusèbe	
Area (ha)	84.7	6.8
Plantation (ha)	51.6	
Farmland (ha)	23.0	-
Forestland (ha)	28.6	6.8
Number of trees	43 786	4 016

Table 2. Plantation data

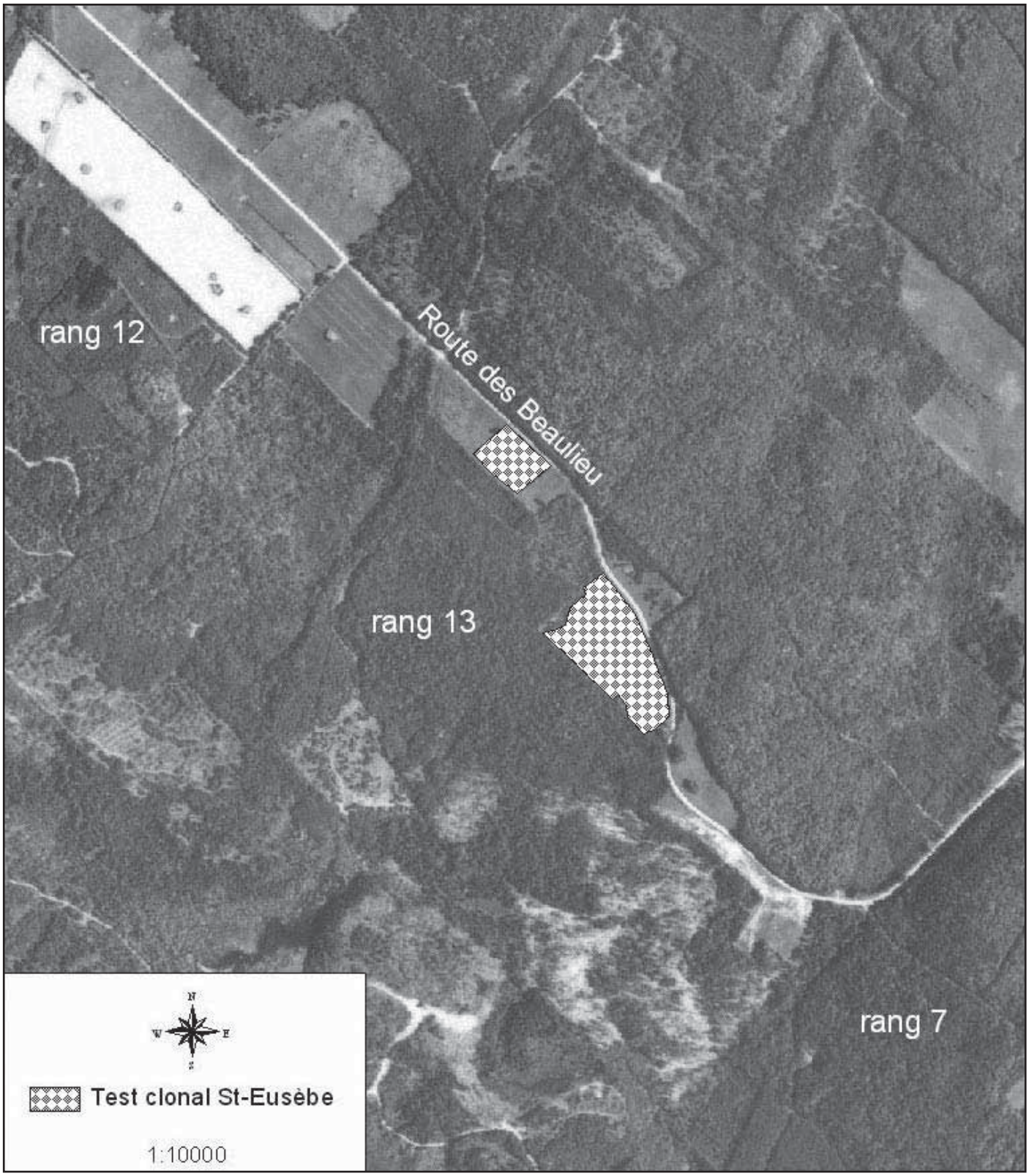
Site preparation -Salvage cutting -Mechanical preparation (*pelle en V*)	2003
Manual planting	2004
Fill planting	2005
Spacing	3 à 3.5 m x ± 5 m
Clones	4
505508 (M × DT)	
750301 (M × T)	
915318 (M × B)	
Fill planting 750316 (M × T)	*250 bare-root*
Number of sets	**4 016**

Table 3. Tending and research (fertilization trial) schedules

Year	2004			2005			2006			2007		
Season	S	Su	F	S	Su	F	S	Su	F	S	Su	F
Brush control by 2 m rows (1 m each side of the trees) and control plot fully released											X	
Establishment of fertilized plots (total of 10)	X			X								
Establishment of control plots (4)				X								
Establishment of the demo trial[1]				X								
Measurement of the fertilization trial plots				X		X			X			

[1]Fertilization of clones 750301 (14 lines) and 915318 (6 lines) (a line out of two) with 400 g/tree of 18-46-0 within a 50 cm-area around stems.

Stop 4, Clonal Test at Saint-Eusèbe (12 years) – Technical Sheet



Clonal test at St-Eusèbe.

Stop 4, Clonal Test at Saint-Eusèbe (12 years) – Technical Sheet

A clonal test planted in 1996 with cuttings under plastic mulch, representing mainly selected clones bred in 1985-86 and now used for planting.

Clonal test	**CAB21196**
Ecological region	4fT
Regional landscapte unit (RLU)	63, *Lac Témiscouata*
Coordinates	Latitude: 47° 31' 45'' N Longitude: 68° 53' 45'' W
Altitude	290 m
Tenure	Private land owned by Mr *Roger Roy*, *route des Beaux-Lieux*
Former state of site	Old fallow land
Soil	Silt loam to sandy loam
Site preparation	Ploughing / spring discing
Plant material	30 cm cuttings with a plastic mulch
Years of establishment	June 7, 1996
Total number of clones	253 (1985-1986 breeding programs and other clones)
Spacing	2 m × 3 m
Number of blocks or repetitions	11
Number of trees per plot	2
Number of trees - test	5,584 trees, 2,265 trees in 2005 after thinning
Number of trees - border	1,404
Total area	3.35 ha
Tending	3 cultivations – 1996, and herbicide in 1997 and 1998
Pruning	2001, 2003 (2.5 to 4.0 m) and 2006 up to 6 m
Thinning	2004
Measurements	1997, 2000 (5 years), 2003 (8 years), 2005 (10 years)
Growth (10 years)	Mean height (test): 12.7 m Mean diameter: 13.6 cm

Partners:

Corporation Agro-forestière Transcontinental inc., Roger Roy, and the Direction des forêts du Bas-Saint-Laurent (MRNF, Volet 1)

CAB21196 – Growth Data – Mean Height and Diameter in 2005 (10-year-old trees)

Clone No	Clone rank	Hybrid	Mean H (m)	Mean DHP (mm)	Tree Straightness	Epicormic Sprouts
750301	1	M × T	16.3	192	*	**
505372	3	M × (DT)	15.9	167	**	*
3442	5	D × M	15.5	177	***	
750316	8	M × T	15.3	162	**	**
915318	11	M × B	15.1	170	***	*
915311	18	M × B	14.5	164	***	
915308	22	M × B	14.5	165	***	*
915314	28	M × B	14.3	149	***	*
915303	31	M × B	14.2	154	**	
915320	40	M × B	14.0	163	***	
505299	44	M × (DT)	13.9	154	***	*
3729 (NM6)	49	N × M	13.8	160	**	*
505508	59	M × (DT)	13.7	175	****	*
915313	60	M × B	13.7	142	***	*
915302	65	M × B	13.5	137	***	
505227	78	M × (DT)	13.2	149	**	*

Tree straightness, * to **** : increasing levels of tree straightness, from curved to straight stem
Epicormic sprouts, * to *** : increasing numbers of dormant and adventitious branchs following pruning

CAB21196 – Single tree Growth Data Height and Diameter measurements for 19 clones in 2005 (10 years) and in 2007 (12 years)

Clone No	Hybrid	H (m) 2005	DHP (mm) 2005	H (m) 2007	DHP (mm) 2007	Gains	
						H (m)	DHP (mm)
750301	M × T	17,8	248	21,4	280	3,6	32
3729 (NM6)	N × M	15,6	212	18,6	241	3,0	29
3442	D × M	14,2	188	18,5	202	4,3	14
915318	M × B	14,7	193	18,4	210	3,7	17
505299	M × (DT)	14,5	165	18,3	208	3,8	43
505508	M × (DT)	14,7	205	18,3	241	3,6	36
750316	M × T	15,4	178	18,2	208	2,8	30
505372	M × (DT)	15,8	177	17,8	206	2,0	29
915308	M × B	14,1	164	17,6	220	3,5	56
915320	M × B	13,4	156	17,0	195	3,6	39
915313	M × B	14,0	162	16,8	188	2,8	26
915303	M × B	15,1	174	16,7	203	1,6	29
3375	B × M	14,3	138	16,7	158	2,4	20
915311	M × B	15,5	159	16,5	185	1,0	26
915508	DN × M	13,5	156	16,1	183	2,6	27
3374	B × M	13,3	153	16,0	166	2,7	13
915314	M × B	14,2	157	15,8	165	1,6	8
915302	M × B	14,8	167	15,7	190	0,9	23
505227	M × (DT)	12,9	145	15,7	170	2,8	25

Photos 1 and 2. Clonal test at Saint-Eusèbe, 12 years. (Photos Alain Fauchon)

Day 5 – September 21

Stops 1, 2, 3, 4. Duchesnay (Centre d'expérimentation et de greffage de Duchesnay) Portrait of the Capitale Nationale Administrative Region

The Duchesnay Tourism Station (N° 1 on map) is located on the shores of Lake Saint-Joseph, 30 minutes northwest of Québec City (N° 2 on map). Its forested area covers 89 km^2, comprised mainly of sugar maple stands. The station is located within the Capital City Administrative Region (AR). This administrative region covers an area of 19,601 km^2. The area of forested lands is 17,129 km^2 of which 70% is public land and 30% private. Productive and accessible forests on public lands total 10,631 km^2 and contain a gross merchantable volume of 79.8 Mm^3. Water and non-forested lands make up 5% and 8% of the area respectively, with protected areas, parks and ecological reserves totalling 1,237 km^2. Public forests in the Capital AR contain 66% of the gross merchantable volume available in the region. Softwood cover types are predominant. The average volume, all species combined, is 75 m^3/ha. According to cover type, the area of accessible forest on public lands is distributed as follows: hardwoods 17%, mixedwood 29%, softwoods 43% and non-forested 10%. As a function of volume, the cover type breakdown is: hardwood 23%, mixedwood 33% and softwood 44%. The majority of stands are relatively young, with stands younger than 60 years occupying 69% of the area. Gross merchantable volume is made up of 64% softwoods and 36% hardwoods. Softwoods are mainly represented by the fir/spruce/jack pine/larch group. Fir and spruce are the predominant two species, with hard hardwoods representing 31% of the hardwood cover type and poplars 5%.

Information source:

Ministère des Ressources Naturelles, 2002. *Rapport sur l'état des forêts québécoises*, 1995-1999. 272p.

Capitale Nationale Administrative Region.
Day 5 – September, 21
Duchesnay (N° 1 on the map) and Québec (N° 2)

Notes

Day 5 – September 21

Stops 1-4, Duchesnay
Black spruce and jack pine tree improvement programs in Québec

By Mireille Desponts

Black spruce (*Picea mariana* (Mill.) BSP) and jack pine (*Pinus banksiana* Lamb.) are the principal species in Québec's boreal forest. These are currently the most-harvested species in the northern part of the forest, and over three-quarters of reforested trees, or 120 million trees in 2006, are of these species. Given their economic importance, considerable efforts have been made for the last 35 years in developing tree improvement programs to increase plantation yields over their entire range.

From 1972 to 1984, several provenance tests (seed lots from a given area) were established in 17 arboretums throughout all the bioclimatic domains of Québec's commercial forest area. This was done to study the genecological characteristics of the two species and to obtain quantitative information on the phenotypic variability in relation to various pedoclimatic conditions. The results were used to delineate tree improvement zones that constitute the territorial basis for developing varieties adapted to different bioclimatic domains in Québec. There are five improvement zones for each of the species. From 1980 to 1990, networks of half-sib progeny tests and corresponding seed orchards, from plus trees selected in forest, were established throughout the territory (Figures 1 and 2). The latter were for the most part only thinned, that is, 30% to 50% of the poorest performing families were eliminated from the orchards, which now produce first-generation improved trees. These orchards meet 80 to 85% of our reforestation needs.

Since 1996, we have undertaken 2nd generation improvement for both species by selecting superior trees (as parents of the 2nd generation) among the progeny tests distributed over the most important improvement zones for the two species (2 zones for jack pine and 3 for black spruce). Selection intensity is high, since we chose 300 trees per improvement zone among populations varying from 44,000 to 127,000 individuals, representing over 1000 half-sibs. These trees were reproduced by cuttings (black spruce) or grafting (jack pine) to establish new clonal seed orchards and clone banks at the *Centre d'expérimentation et de greffage de Duchesnay*. These will be used to carry out controlled crosses. We have adopted an improvement strategy based on a core of highly performing trees (nucleus breeding). Crosses will be done intensively among the 100 best individuals making up the improvement population, strictly speaking, whereas a more limited number of crosses will be done with the 200 trees in the support population. Thus, 5 to 6 controlledcrosses will be done using the best individuals in the improved population, whereas a maximum of two directed crosses will be done with trees from the support population. We want to produce from 200 to 300 full-sib progeny per improvement zone, which will then be evaluated in two or three experimental plantations in their original territory in the forest. A polymix will be used on all the clones to evaluate their general combining ability in three to five experimental plantations in each improvement zone. The genetic gain in yield estimated for this new generation is from 13 to 15 m^3 ha^{-1} at 35 years for black spruce and from 9 to 14 m^3 ha^{-1} at 40 years for jack pine.

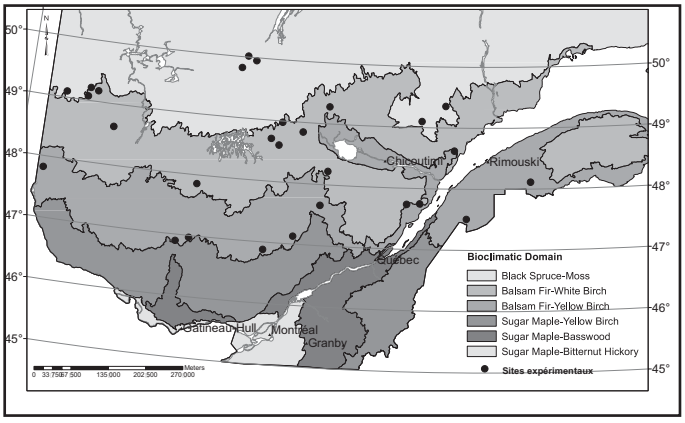


Figure 1. Location of experimental sites for the jack pine tree improvement program (map Olivier Noël).

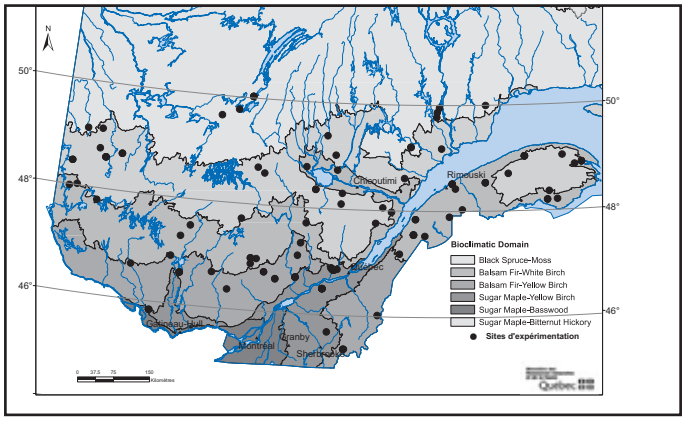


Figure 2. Location of experimental sites for the black spruce tree improvement program (map Gaétan Numainville).

Photo 1. Controlled crosses between selected trees in the black spruce clone bank at Duchesnay (photo Mireille Desponts).

Photo 2. Jack pine clone bank at Duchesnay, selected for the second generation (photo Fernand Gosselin).

Day 5 – September 21

Stop 1-4, Duchesnay
Norway Spruce in Québec

By Marie-Josée Mottet

In Québec, the initial plantings of Norway spruce *(Picea abies* (L.) Karst) were done early in the 20th century, around 1915, in the Saint-Maurice area. From 1964 to today, close to 200 million trees have been planted, with a maximum of 18 million trees in 1988. The species became very popular thanks to its fast growth in plantations, which usually surpasses the performance of indigenous spruces. On the best sites in southern Québec, its mean annual growth can almost reach 10 m^3/ha at 35 years. Because of its high productivity, significant volume can be harvested at the time of intermediate thinnings.

White Pine Weevil

Norway spruce is very susceptible to the white pine weevil (*Pissodes strobi* Peck), which causes growth reduction and stem deformations. This problem resulted in a reduced rate of reforestation during the 1990s, with levels now hovering between 2 and 3 million per year, mainly in the Bas-Saint-Laurent and Gaspésie regions. Recently, a study carried out with the Canadian Forest Service demonstrated that over the medium to long term, the production of lumber in Norway spruce plantations and its wood characteristics are very good, in spite of damage by the white pine weevil. In addition, in comparing two similar plantations, the amount and quality of Norway spruce lumber production was superior to white spruce that was not affected by the weevil. Also, work done in the past has allowed us to select trees with greater resistance to the weevil. The resistance of these clones will be validated by longer term tests. Currently, seeds produced from crossing some of these individuals are used to supply the Saint-Modeste cutting production centre, where 50,000 plants are produced annually. Also, variations observed among families in more recent tests open the door to longer term development of families with good resistance to or tolerance of the white pine weevil.

Tree Improvement Program Activities

Thanks to the results of the first provenance tests established in 1969, the best sources for reforestation were identified and plus trees were selected to establish first-generation seed orchards. When fully productive, 5.7 M deliverable seedlings annually is expected to be produced from these orchards. For each one of the three breeding zones, a dozen superior provenances were recommended. Information from the provenance tests helped prepare recommendations for seed movement guidelines.

Afterwards, results obtained from progeny tests established in each zone in the 1990s helped with revising recommendations for the best seed sources. Currently, seeds are harvested from trees belonging to the best source in 1) genetic tests located at Lac-Saint-Ignace and Valcartier 2) superior commercial plantations, 3) the breeding orchard, 4) the first generation seed orchards. Among the best sources are provenances from Russia, Latvia and Poland, as well as some commercial plantations such as Proulx at Grandes-Piles, Proulx – “Semis +” at Duchesnay, Gould in the Eastern Townships and Hudson’s Place at Petawawa, Ontario.

In 2006, selection and grafting of some 150 plus trees were completed in order to begin preparing a new breeding population for the Bas-Saint-Laurent–Gaspésie zone. This population represents a unique source that combines height growth gains and tolerance to the white pine weevil. Also, the wood density trait will be considered in the near future. Some of these trees will be included in a new seed orchard for this breeding zone. The height growth gain expected from this orchard, comprised of 50 clones, is estimated at about 13% in comparaison to the well-known superior Proulx (M.P.) provenance at Grandes-Piles.

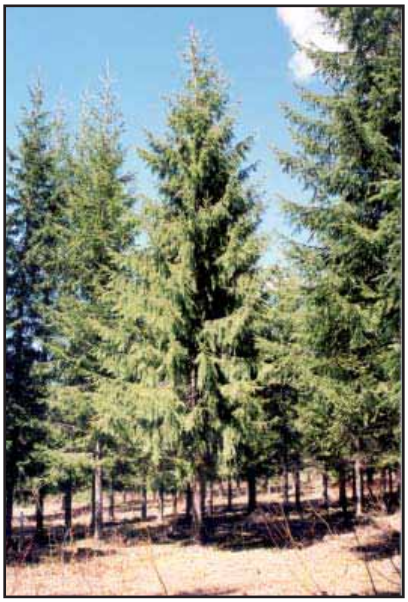


Photo 1. Test de provenances à l’arboretum de Lac Saint-Ignace, Gaspésie (Photo Marie-Josée Mottet).

Photo 2. Progeny test at Biencourt, Bas-Saint-Laurent (Photo Jean-Sébastien Joannette).

Photo 3. Proulx plantation at Grandes Piles (about age 80) (Photo Johanne Claveau).

Information sources:

Daoust, G., M.-J. Mottet. 2006. *Impact du charançon du pin blanc (*Pissodes strobi *Peck) dans les plantations d'épinettes de Norvège (*Picea abies *(L.) Karst.)* - Partie 1: Productivité et qualité des sciages. For. Chron. 82(4): 538-549.

Daoust, G., M.-J. Mottet. 2006. *Impact of the white pine weevil (*Pissodes strobi *Peck) on Norway spruce plantations (*Picea abies *[L.] Karst.).* Part 1: Productivity and lumber quality. For. Chron. 82(5): 745-756.

Mottet, M.-J., G. Daoust, S. Y. Zhang. 2006. *Impact du charançon du pin blanc (*Pissodes strobi *Peck) dans les plantations d'épinette de Norvège (*Picea abies *(L.) Karst.).* Partie 2: Propriétés du bois des sciages. For. Chron. 82(5): 712-722.

Mottet, M.-J., G. Daoust,S. Y. Zhang. 2006. *Impact of the white pine weevil (*Pissodes strobi [*Peck]) on Norway spruce (*Picea abies *[L.] Karst.) plantations.* Part 2: Lumber properties. For. Chron. 82(6): 834-843.

Day 5 – September 21

Stops 1-4, Duchesnay
The white spruce tree improvement program in Québec

By André Rainville

The initial efforts made to learn about white spruce (*Picea glauca* (Moench) Voss.) genetics date back to the end of the 1950s. At that time, the Canadian Forest Service (CFS) established ten provenance trials in several regions of Québec, which included each of the Ontario, Maritimes and Québec provenances. These trials were completed in the 1970s and 1980s by adding eight new tests that were composed of several hundred families, mainly from Québec. Among other things, the information obtained from these two series of tests helped identify the superior provenances those from the Great Lakes, which showed a volume gain of 19 to 53% in relation to Québec sources. They also led to the delineation of two seed source transfer zones for white spruce in Québec (Figure 1), as well as acquiring information on the density of plantation wood and its behaviour when dried (warping, flexion, shrinkage), in concert with Laval University and Forintek Canada Corp. (Beaulieu *et al.* 2002; Beaulieu *et al.* 2006).

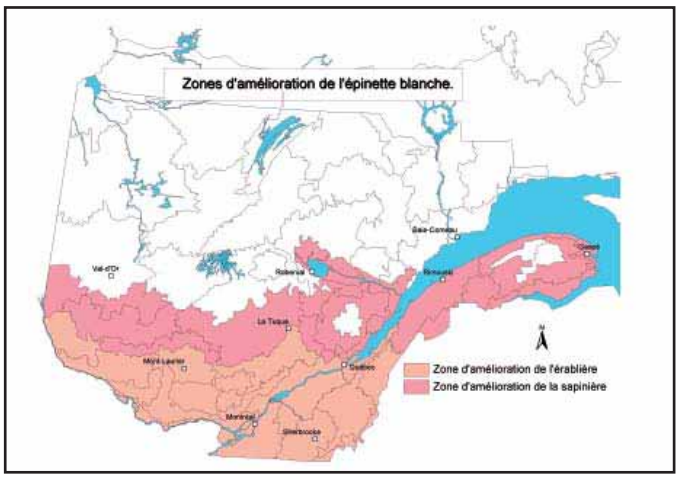


Figure 1. White spruce tree improvement zones (map Guildo Gagnon).

For its part, the *ministère des Ressources naturelles et de la Faune du Québec* (MRNF) launched an ambitious reforestation program in Québec in the early 1980s. In order to produce the required improved seeds to meet the needs of the planting program, between 1983 and 1991 it established a network of 17 1st generation white spruce seed orchards. Because the tree improvement work carried out by the CFS was not yet advanced and knowledge was still fragmented, the trees used to establish these seed orchards were mainly selected on a regional basis in natural forests. At the same time, the MRNF worked to develop a vegetative reproduction technique (cuttings), and financed the development of somatic embryogenesis by a team of researchers at Laval University.

In 1996, the mission of the CFS took a different orientation, henceforth being focused on basic leading edge genetics research and on genetic engineering. For white spruce, this redirection signified that the MRNF now had the sole responsibility for tree improvement in Québec. It redoubled its efforts and established, with the material left by the CFS, several experimental plantations produced by controlled crosses between selected trees (ST), then two 2nd generation clonal seed orchards. The Direction de la Recherche Forestière (DRF) also undertook work to determine the genetic value of the clones in the 1st generation orchards; over a period of five years, the clones in each orchard were evaluated in three progeny trials two field tests and **an early test, similar to the one located in block 12 at the Centre d'expérimentation et de greffage de Duchesnay (CEGD)**. In 2002 and 2003, the DRF also undertook several hundred controlled crosses in a new ST population. All the trees that are selected in tree improvement experiments located throughout the province are reproduced by grafting and brought together at the CEGD to continue the improvement work. The improved 2nd generation white spruce population in Québec is therefore comprised of 240 ST. In coming generations, when controlled crosses are done to determine the genetic value of these trees, we will use a polymix (balanced mix of pollen) composed of 20 trees for which the crossing value is zero; that is, it will provide a more accurate evaluation of the selected trees. **This pollen will be collected in block 11 at the CEGD**.

Photo 1. Second generation white spruce seed orchard, Berthier nursery. (Photo Régis April).

Just how are these efforts coming along, in terms of the proportion of improved seedlings and plantation yields? Firstly, white spruce is the third most important species in Québec, in terms of the number of trees planted (Figure 2). A high proportion (87%) of them are from improved sources, principally 1st generation orchards,

but the 2nd generation orchards, established in 1999, have already started to produce seeds. The expected yields in plantations established with improved white spruce are presented in Figure 3. At a more advanced level of improvement, if we choose to make crosses among the selected trees rather than let them reproduce in a seed orchard by open pollination, the expected yield from plantations established using this material is 5.6 m^3 ha^{-1} yr^{-1} in the balsam fir domain, or 25% greater than for plantations established using seeds from natural stands, and 6.9 m^3 ha^{-1} yr^{-1} in the sugar maple domain. Starting in 2007, the DRF is seriously involved in multi-clonal forestry. In fact, the will to capitalize on the growth difference that exists between seeds from the same controlled cross led to planting the first clonal tests. A large number of clones will also be continuously evaluated (about 200 clones per year).

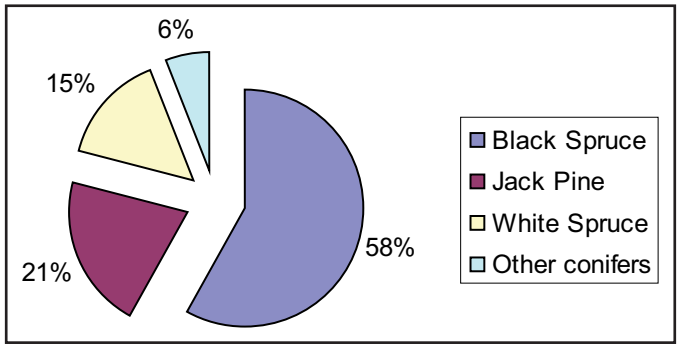


Figure 2. Seedling production in 2007, by species.

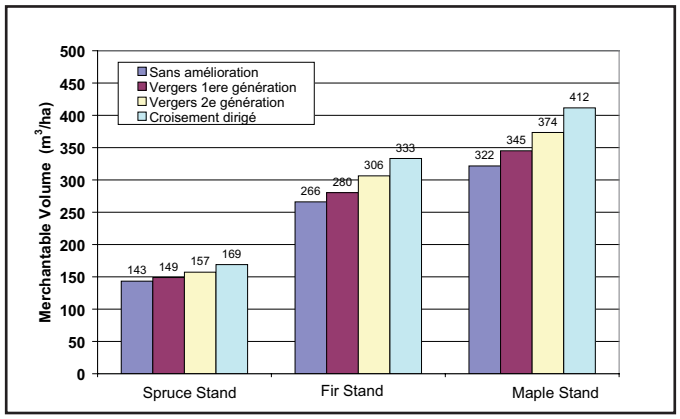


Figure 3. Estimated merchantable volume at 60 years total age for white spruce plantations by ecological domain, and the degree of genetic improvement (without selecting the best sites; percentile rank 75).

Today Québec's white spruce tree improvement programs are the basis of new collaborative projects. For example, new powerful tools are now being developed, among others those in genomics, to permit selecting trees that will have better yields and which will produce more wood of better quality, while reducing the time required for selection (marker-aided selection). With adequate silviculture, Québec is well positioned to increase its forestry production and set milestones that will help us increase the areas devoted to conserving our genetic resources.

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Beaulieu, J., S. Y. Zhang, Q. Yu, A. Rainville. 2006. *Comparison between genetic and environmental influences on lumber bending properties in young white spruce*. Wood and Fibre Science, 38 (3): 553-564.

Beaulieu, J., B. Girard, Y. Fortin. 2002. Effect of drying treatments on warping of 36-year-old white spruce seed sources tested in a provenance trial. Ann. For. Sci. 59: 503-509.

Day 5 – September 21

Stops 1-4, Duchesnay

Managing second-generation seed orchards and integration of somatic embryogenesis in orchard management

By Fabienne Colas, Mohammed S. Lamhamedi and Mireille Desponts

Part 1. Management of 2nd generation Seed Orchard

*Black spruce (*Picea mariana *(Mill.) BSP) top-grafting trial (in collaboration with M. Desponts).*

Principal objective

Develop an outdoor grafting technique for black spruce plantations to infill gaps at the least cost in 2nd generation seed orchards.

Material

- Root stock: black spruce cuttings planted in 2001.
- Scions: sampled on 8 trees selected and harvested in 4 tests in the Côte Nord black spruce breeding zone. Depending on the clone, the number of copies grafted is between 7 and 21.

Method

- Grafting was done in May 2005, before root stock budbreak. If possible, the choice of root stock should provide good diameter compatibility between the terminal shoot and the scion;
- The classic side veneer grafting method was used. The grafted area is protected by a white plastic bag for one to two weeks;
- Root stock is regularly pruned to ensure that the graft takes.

The high failure rate is mainly due to poor compatibility between the diameter of the scions and the root stock. However, the first flowering was observed in May 2007, two years after grafting.

Part 2. Integration of somatic embryogenesis in orchard management

*Black spruce (*Picea mariana *(Mill.) BSP) plantation. Plants grown from seeds off clones produced by somatic embryogenesis (collaboration of M.S. Lamhamedi).*

Photo 1. a) Black spruce after grafting in the plantation. The graft, done in May 2005, flowered in 2007. b) Black spruce graft with female flowers (see arrows) two years after grafting. (Photos Fabienne Colas).

Since 2001, we have female flowering in a black spruce clonal test established in 1997, produced by somatic embryogenesis. This plantation is part of the first demonstration clonal tests (from clones) established in Québec.In 2003 and 2004, 8 clones were pollinated with a mixture of pollen collected from 1999 to 2002, from a 1st generation seed orchard. Pollen was held in a pollen bank belonging to the *ministère des Ressources naturelles et de la Faune*. In all, for the two pollination years, we produced 16 seedlots, of which the female parent was a clone produced by somatic embryogenesis. The seeds were extracted and classified according to the international standards of the ISTA (1999).

The plants were grown in IPL 25-350 containers at the Saint-Modeste (Bas-Saint-Laurent, Québec), forest tree nursery, using standard production methods. Control seedlings were produced using seeds from three

Results

Tree N°	Number of grafts	N° of living grafts May 07	Success (%)	N° of grafts flowering in 2007
1419	22	7	31,8	2
1421	19	7	36,8	0
1435	7	1	14,3	0
1440	21	5	23,8	1
1467	16	5	31,3	0
1476	17	5	29,4	1
1484	17	8	47,1	0
1490	17	5	29,4	1

1st generation seed orchards currently being used for seedling production in Québec.

During the two years of nursery production, we evaluated several of the plants' morpho-physiological variables (growth, mineral nutrition, etc.). Two-year-old plants were planted in May 2007 in a plot at the Centre d'expérimentation et de greffage de Duchesnay. Spacing between trees is 3.5 x 2 m. The plot is divided into six complete randomized blocks. In each block, we planted four plants/seedlot in a row. These were distributed randomly within each block.

Our preliminary results indicate that the growth, morpho-physiological quality and development of the plants produced from seedlots that were produced by clones are comparable to those grown from seeds produced in seed orchards. Preliminary results from this project were presented at the poster session of a IUFRO Tree Seed Symposium. The poster and the abstract are available on the Symposium's CD.

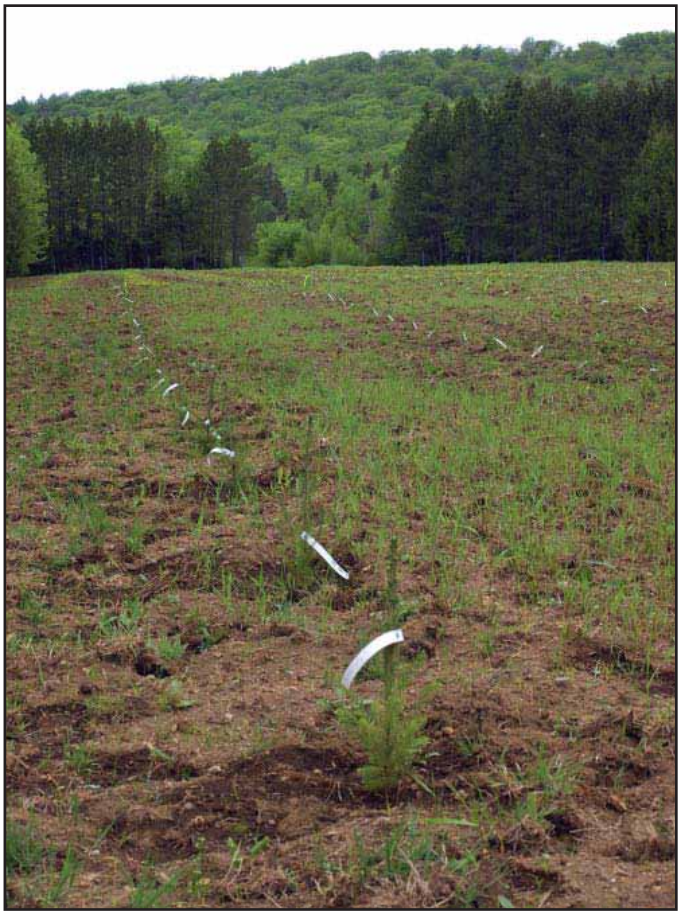

Photo 2. Plantation of black spruce (*Picea mariana* (Mill) BSP) plants in June 2007. The plants were produced from seeds of trees grown by somatic embryogenesis (Photo Fabienne Colas).

Reference:

ISTA. 1999. *Règles internationales pour les Essais de Semences 1999*. Seed Sci. & Technol. 27 (Supplément 1): 1-362

Information source:

Colas F., M. S. Lamhamedi, 2006. *Quality of seeds produced from different black spruce (*Picea mariana*) somatic clones*. Affiche et résumé présentés au IUFRO Tree Seed Symposium, Fredericton (Nouveau-Brunswick), 18-21 juillet 2006.

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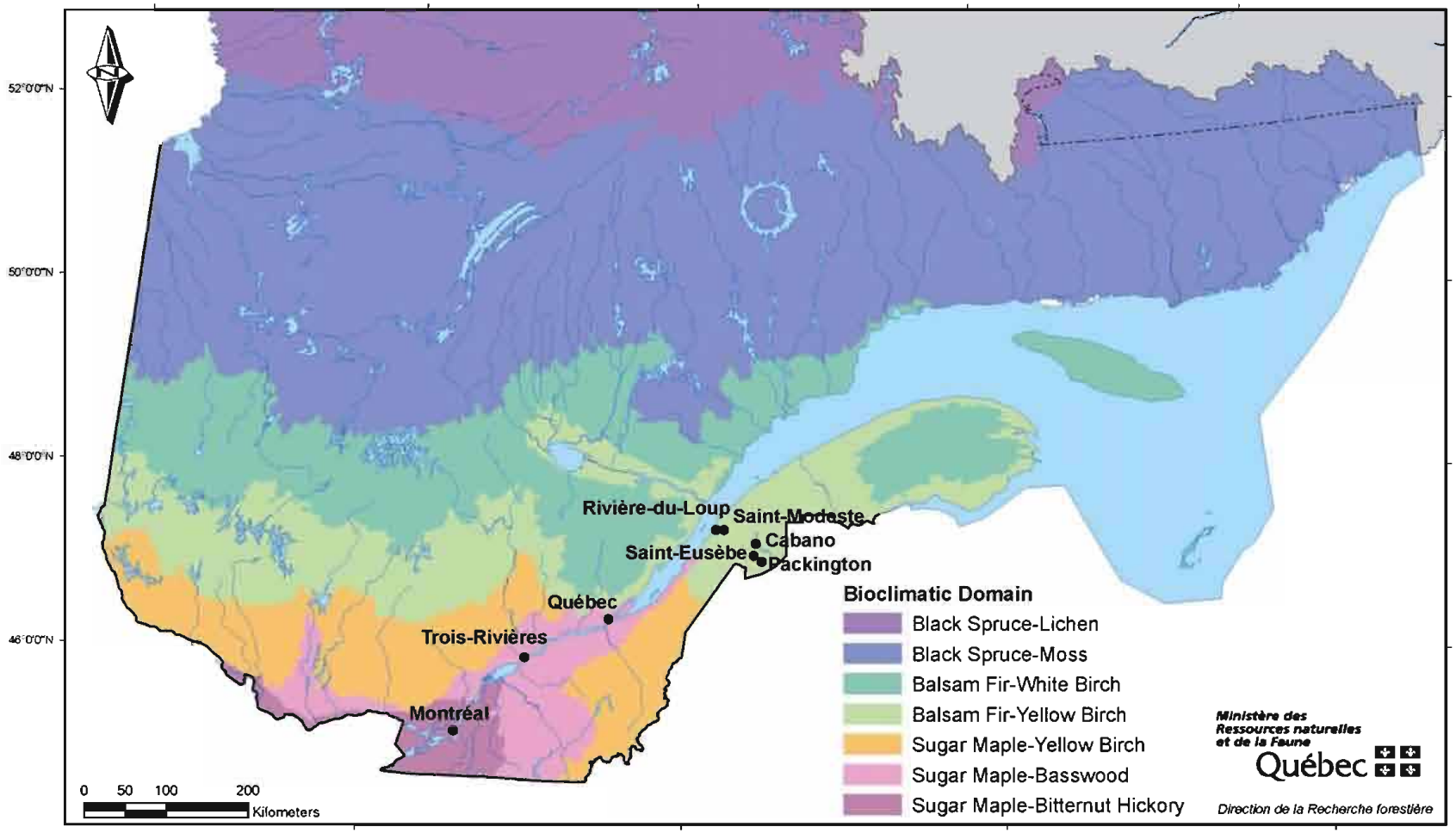
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Trois-Rivières
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Bioclimatic Domain
Black Spruce-Lichen
Black Spruce-Moss
Balsam Fir-White Birch
Balsam Fir-Yellow Birch
Sugar Maple-Yellow Birch
Sugar Maple-Basswood
Sugar Maple-Bitternut Hickory
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