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1 FOREWORD

This Report covers the period from 2008 to 2011 (inclusive). The information collected in this report summarizes the activities during this period, any changes from the previous 2008 report\(^1\) and highlights areas of new development and research, particularly in the area of environmental utilization. Some of the content completed for this report, ‘Activities Related to Poplar and Willow Cultivation and Utilization in Canada’, remains unchanged where no updates have been reported or occurred since the previous report. Where significant updates were needed, the original text has been altered; deleted or new text has been inserted to reflect such updates. No new Canadian Forest Inventory, which represented the sole basis of previous reports, has been published since 2001; therefore no new information from this source was available for this report\(^2\). Canada’s National Forest Inventory is only available on-line in topic specific data sets and it is only based on data up to 2006; none of the *Populus* tree species are separately identified in the data. Other more recent sources available for this report include the “The State Of Canada's Forests Annual Report 2011” and the “The National Forestry Database (NFD)” that was last updated in January 2012, but only contains partial information for 2010 and 2011 in relation to a very limited number of topics. However, these sources do not treat any of the *Populus* tree species separately. Overall it was extremely challenging to make use of the more recent statistical national data as the basis for this report.

\(^1\) *Canadian Report to the 23rd Session, Beijing, China – International Poplar Commission for the Period 2004-2007.*

\(^2\) *National Forest Inventory Reports*, Chapter 4, Canada, Mark D. Gillis, Paul Boudewyn, Katja Power, and Glenda Russo. 2009
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3  Message from the Chair of the Poplar Council of Canada

2008-2011 was a progressive and exciting time for poplars in Canada. Breeding and research programs developed, expanded and emerged as interest in species such as balsam poplar (*Populus balsamifera*) gained notice. As such, significant funds have been obtained for research through Genome Canada and other Genome centres across Canada, the forest industry and other government agencies such as the Natural Sciences Engineering Research Council of Canada.

In December of 2011, the Chair of the Poplar Council of Canada was requested to make a presentation to the Standing Senate Committee on Agriculture & Forestry titled: Poplar Plantations – A Canadian Opportunity. This presentation afforded the Poplar Council of Canada the opportunity to put forward the current advancements and opportunities as well as the challenges holding up development and utilization of poplars and willows across the county.

Within the council we have an active and committed pesticide working group who have worked with partner companies and obtained registration for several chemicals (see www.poplar.ca) to assist growers in yield production, competition and disease control. The genetics working group is developing fact sheets for released clones, a national breeding strategy document for poplars and willows and it will soon be time again to update our electronically available clone and seed directory for Canadian material.

In 2010, the PCC undertook a 2-day Strategic Planning meeting which set new direction for the council for the next 3-5 years. The meeting was well attended and areas of development identified included: communication and education; production and stand health; environmental services; genetics and breeding; carbon credits; bio-energy; administration. Teams currently work in each area and conference calls are held every 3-4 months to review and discuss advancements.

Our international meeting held in Edmonton Alberta in September of 2011, in conjunction with the IPC Environmental Applications working group and the Poplar Council of United States had participants from around the world and included 2 full days of field trips, 2 days of seminars and a 2-day post-meeting field tour to the oil sands region of north-eastern Alberta. The immense reclamation challenges of oil sands operations were discussed, viewed and debated.

As this document concludes its preparation, the cycle of growth appears to be waning. Genetic resources amassed over the last few decades may be at risk and new avenues must be sought to preserve these resources until the tide turns again regarding environmental, economic and industrial relevance. Canadian populations of both native and exotic poplars are unique and worthy of preservation for scientific, practical and industrial uses. The PCC will continue to promote the wise use and conservation of these species especially considering their wide range of application throughout the world.

Barb Thomas, PhD
Chair, PCC
4 INTRODUCTION

4.1 General Information

The words Populus (in this report Populus refers to the genus and not section, unless specifically mentioned), poplar or aspen can be used interchangeably in this report; however, where appropriate this report distinguishes between:

**Poplar** (non-aspen) species, such as *P. balsamifera*, *P. trichocarpa* (both native to North America), *P. maximowiczii*\(^3\) and *P. laurifolia* in the Tacamahaca section (Balsam poplars), and *P. deltoides* (native to North America) and *P. nigra* in the Aigeiros section (Cottonwoods and black poplar). Hybrid poplar thus refers to the natural or artificial interspecific and/or intersectional hybrids. *P. deltoides* and *P. trichocarpa* are frequently referred to as eastern cottonwood and black cottonwood respectively, or just cottonwoods and *P. balsamifera* is known as balsam poplar.

**Aspen** species, such as *Populus tremuloides*, *P. grandidentata* and *P. tremula* (not native to North America) in the Populus section, formerly Leuce (Aspens and *P. alba*). *Populus tremuloides* is commonly known as trembling or quaking aspen, or just aspen and is by far the dominant *Populus* species in Canada. It occurs mainly in the boreal region of Canada. Hybrid aspen thus refers to the artificial interspecific hybrids of *P. tremuloides* and *P. tremula* (including the variety *P. davidiana* or Chinese or Korean poplar).

**Willow** (*Salix* spp.) species, such as *Salix viminalis* (Basket willow) have seen use as sound and visual barriers and *Salix nigra* (black willow) as a fibre source for a while, a wider spectrum of species, including *Salix dasyclados*, *Salix exigua* (Coyote or Sandbar Willow, native to North America) and hybrids (e.g. *Salix viminalis* L.) have seen an increased use in bio energy and environmental application in a variety of habitats including riparian areas, wetlands, open forests and disturbed areas. Canadian research and development work with *Salix* is ongoing in the Prairie region, Québec and New Brunswick. The names *Salix* and willow are used interchangeably in this report.

The main regions with economically significant *Populus* stands are located from the Province of British Columbia to the Province of Québec. In the four Atlantic Provinces east of Québec (Newfoundland & Labrador, Nova Scotia, Prince Edward Island and New Brunswick), natural *Populus* stands are less common and less economically significant than in the remaining provinces of Canada and form only a minor source of industrial wood. This is even more the case for Nunavut, the Yukon and Northwest Territories in northern Canada.

Aspen and poplar have, in particular, seen an increase in cultivation for use as sources of fibre for the pulp and paper industry and for the composite wood industry, primarily Oriented Strand

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\(^3\) *Populus maximowiczii* is also colloquially referred to as ‘Max’.
Board (OSB). However, because of economic, regulatory and environmental reasons, this development has seen a sharp reversal very recently in spring 2012 with the closure or scaling down of fibre-oriented plantations. However at the same time the utilization of aspen and poplar for environmental purposes is seeing slow but steady growth. Therefore, this report contains sections dedicated to the different environmental applications, such as remediation, use in riparian areas and carbon sequestration.

This report frequently refers to short-rotation-intensive-culture or SRIC (hybrid) poplar and willow crops. These SRIC woody crops are established and managed using an agronomic approach to crop management on cleared (usually) agricultural land, requiring a short rotation (usually less than 25 years for poplar and 5 to 6 years for willow). SRIC woody crops could be compared to the ‘trees-outside-forests’ or TOF, a term used by the International Poplar Commission.

The use of the word ‘crop(s)’ refers to short-rotation-intensive-culture (SRIC) crops of (hybrid) poplar (or aspen) and/or (hybrid) willow. The words ‘plantation’ or ‘forest plantation(s)’ refer to plantations on forestland.

For readers not familiar with the term ‘Crown’ land: Crown land is owned and managed by the respective provinces or, in some cases, by the federal government. Any references to Crown and/or public land in this report are to Provincial Crown land.

There is frequent reference to the Prairie Provinces, which include Alberta, Saskatchewan and Manitoba. The Prairie region refers to these three provinces, as well as the northeast corner of British Columbia, located to the east of the Rocky Mountains.

An extensive listing of publications by authors residing in Canada and/or publications published in Canada and/or covering projects located in Canada complements this report; it includes articles, research papers as well as theses and technical reports. These listing have been compiled by a systematic search approach that has been documented in detail at the beginning of the section.
4.2 Map of Forest Cover in Canada

Map Legend

Percent Forest (%)

- 0 - 10
> 10 - 20
> 20 - 30
> 30 - 40
> 40 - 50
> 50 - 60
> 60 - 70
> 70 - 80
> 80 - 90
> 90 - 100

Source: National Forest Inventory 2006
5 SUMMARY

Canada has 10 percent of the world’s forests that cover 397.3 million hectares (ha) of forest, other wooded land and other land with tree cover, which represents 53.8 percent of its total surface area. Canada’s forest, other wooded land and other land with tree cover are made up of 347.7 million ha (87.5 percent) of forest, 41.8 million ha (10.5 percent) of other wooded land and 7.8 million ha (2 percent) of other land with tree cover. The predominant tree species on forest land are spruce (53.2 percent), poplar (11.6 percent) and pine (9.3 percent). The vast majority of the Populus inventory in Canada consists of natural stands.

Provinces in Canada have full jurisdiction over forest management and agriculture regulations, thus taxation on property and various forest and agriculture regulations are strictly a provincial affair. These provincial regulation and legislation if in existence at all vary widely across Canada in their approach and nature. Only the Province of British Columbia recognizes intensively-managed Populus and Salix plantations. The Province of Saskatchewan offers the most favourable property valuation and taxation rate that applies to rural, mostly agricultural land, regardless of what crop is grown; this includes tree or woody crops. As the provinces have jurisdiction over forest resources, provincial agencies carry out and maintain forest inventory systems. Standards for data collection and compilation differ between provinces and are not necessarily compatible. In addition, most inventory systems with the exception of the Province of Québec, do not specifically track any of the Populus tree species in their data systems.

The main regions with economically significant natural and plantation Populus stands are located in the Province of British Columbia, Alberta, Saskatchewan and Québec. The plantation stands have been mostly planted to serve as sources of fibre for the pulp and paper industry and for the composite wood industry. However because of economic, regulatory and environmental reasons this development has seen a sharp reversal in the last half year with the closure or scaling down of fibre-oriented plantations. At the same time, environmental research and the utilization of poplars for environmental purposes (such as remediation, use in riparian areas and carbon sequestration) are seeing slow but steady growth. In addition, a fair amount of consideration has been given to research and project development as it relates to poplars, including biomass production from Short-Rotation-Intensive-Culture plantations using hybrid poplar and willow trees.

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4 Natural Resources Canada.
5 Canada’s Forest Inventory 2001.
6 POLICY AND LEGAL FRAMEWORK

Provinces in Canada have full jurisdiction over forest management and agriculture regulations, thus taxation on property and various forest and agriculture regulations are strictly a provincial affair. Federal income tax rules apply nationwide and are administered by the Canada Revenue Agency (CRA). The federal income tax rules will not be discussed in this report, as there are no specific policies or federal tax incentives pertaining to *Populus* or *Salix*.

Two provinces, British Columbia\(^6\) (BC) and Alberta\(^7\), have regulations and standards that govern the deployment of (hybrid) clonal material and/or genetically improved material on Crown lands.

The only province with a specific property tax policy and supporting regulations pertaining to *Populus* and *Salix* management is BC, where intensively-managed *Populus*\(^8\) or *Salix* crops can be recognized as primary agricultural production. The incentives and regulations in BC apply to private land. Besides the policy for intensively-managed *Populus* and *Salix* on private land, BC also has property tax regulations that apply to privately-held managed forests and/or woodlots, as do Ontario and Quebec. The three Prairie Provinces, Alberta, Saskatchewan and Manitoba do not have specific tax policies for privately-held managed forestland or woodlots. The report will review the various policies and property tax arrangements for each of the western and central provinces and provide an overview of the Atlantic Provinces.

Property tax law and regulations generally do not apply to Crown land, except in BC for Crown lands leased for the purpose of farming or grazing, which theoretically could include poplar farming.

6.1 British Columbia

6.1.1 *Populus* and *Salix* as Primary Agricultural Production

Since 1995, BC’s *Standards for the Classification of Land as a Farm Regulation*\(^9\) under the Assessment Act\(^10\) recognize “*Populus* species and *Salix* species intensively cultivated in plantations”\(^11\) as primary agricultural production.\(^12\) Land that is privately owned or leased and is growing *Populus* or *Salix* species can be classified as a developing farm when:

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\(^7\) See http://www.abtreegene.com/images/STIA.pdf.

\(^8\) This includes SRIC aspen crops.

\(^9\) B.C. Reg. 411/95 (the “Regulation”).


\(^11\) Schedule A of the Regulation.

\(^12\) See also Farm Classification in British Columbia brochure (http://www.bcassessment.ca/public/Documents/10-055%20BCA%20Farm%20Classification%20Brochure.pdf or http://www.bcassessment.ca/public/Documents/farm_brochure.pdf).
“...in the case of products produced from primary agricultural production that...require 7 to 12 years to establish after planting, there is a sufficient area prepared and planted to meet the requirements of this regulation when harvesting occurs and the assessor determines that there is a reasonable expectation of profit from farming”\(^\text{13}\)\

The latter criterion of “a reasonable expectation of profit from farming” is similar to that used by the Canada Revenue Agency to allow certain deductions for farm expenses.

The regulations cover a variety of products and uses and are aimed at providing tax incentives for legitimate farming operations. For land to be classified as a farm, the owner must submit an Application for Farm Classification to the local assessment office. With his or her application, the landowner or lessee must submit a development plan and a map outlining crop details, area to be planted, date of planting, expected yields, anticipated selling prices and a date of harvest.

*Populus* and *Salix* species managed beyond the 12-year window do not technically qualify as primary agricultural production and neither do plantations that are not intensively managed, nor do natural stands.

Through an Order-in-Council, the Assessment Commissioner, who is the Chief Executive Officer of the British Columbia Assessment Authority, sets the valuation rates for farm use. These rates reflect the land capability and land use. The assessed value of farm land is usually lower than market value, especially in the more populated areas of the province, where market values are driven up by non-farm market pressures on the land base. In some rural areas, farm valuation rates are similar to assessed market values.

The tax rate for farm land is in a separate rate class. The farm rates are usually one of the lowest tax rates. Apart from a lower valuation and tax rate, there are several important exemptions from taxation of the school and hospital tax. An additional advantage for legitimate poplar or willow farms is the eligibility for an exemption from provincial sales tax\(^\text{14}\).

Although the regulations are beneficial to poplar and willow planting, the restriction of the rotation to 12 years has now proven problematic for poplar plantations. Yield plots in south-western British Columbia\(^\text{15}\) show that SRIC hybrid poplar crops planted at 1,100 or fewer stems per hectare do not culminate mean annual increment (MAI) within the 12-year period, especially when grown to produce saw logs or veneer logs at a reduced crop density. For the independent crop owner this may jeopardize the “reasonable expectation of profit from farming”, which is a key provision in both the Federal Income Tax regulations and the provincial farm assessment regulations. To change the restrictive rotation length to a more appropriate length can only be implemented through a political process; there is currently no regulatory mechanism to allow for such a change.

\(^{13}\) Ibid., pp. 28-29.


\(^{15}\) Information provided by Cees van Oosten.
A major advantage of classifying *Populus* and *Salix* species as primary agricultural production has been the flexibility of managing the crop without the regulations that apply to a more traditional forest crop. As a farming operation, there is also the added protection through BC’s *Farm Practices Protection (Right to Farm) Act*\(^\text{16}\). Under this act ‘farm operation’ means any of the following activities involved in carrying on a farm business:

- a) growing, producing, raising or keeping animals or plants, including mushrooms, or the primary products of those plants or animals;
- b) clearing, draining, irrigating or cultivating land;
- c) using farm machinery, equipment, devices, materials and structures;
- d) applying fertilizers, manure, pesticides and biological control agents, including by ground and aerial spraying; and
- e) conducting any other agricultural activity on, in or over agricultural land, including “intensively cultivating in plantations, any (i) specialty wood crops, or (ii) specialty fibre crops” (emphasis added).

This protection does not apply to forests in the Managed Forest Land class (discussed in further detail below).

One regulation that applies to more traditional forest crops also applies to SRIC woody crops grown on private farmland. All ‘timber’ produced in BC must be scaled and measured under the provisions of the *Forest and Range Practices Act*\(^\text{17}\) (‘timber’ includes logs and chips), regardless of its origin (Crown or private land). Owners of SRIC hybrid poplar and willow crops grown on farm land must obtain a private ‘timber mark’\(^\text{18}\) and must make provisions to have their harvest scaled by a licensed scaler\(^\text{19}\). What is unclear at this point is how biomass crops on very short coppice rotations will be handled under the *Forest and Range Practices Act*.

### 6.1.2 Managed Forest Land

Managed Forest Land\(^\text{20}\) (MFL) is privately-owned forest land subject to an acceptable and approved forest management commitment that complies with the *Private Managed Forest Land Act*\(^\text{21}\). Property owners in this class are obliged to provide good resource management practices such as reforestation, stand tending, protection from fire and disease and sound harvesting methods. The assessed forest land value is based on its capability for tree growth and therefore recognizes the land for its forest use value. The assessed value is not subject to other market

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\(^\text{16}\) R.S.B.C. 1996, c. 131.
\(^\text{17}\) S.B.C. 2002, c. 69.
\(^\text{18}\) A timber mark is an identifying mark that must be marked onto cut timber before it may be removed from the land where the timber was cut. A timber mark identifies the timber so that Forest Service personnel can determine the origin of the timber, whether stumpage payments are due to the government on that timber, and whether the timber may be exported. For more information, see “Timber Marks for Private Land” (http://www.for.gov.bc.ca/ftp/HTH/external!publish/web/timber-tenures/private-timber-marks/brochure-jul-24-2003.pdf).
\(^\text{19}\) Personal communication with Bruce Walder by Cees van Oosten. No further updates have been provided.
\(^\text{20}\) As defined in section 24 of the *Assessment Act*.
\(^\text{21}\) S.B.C. 2003, c. 80.
forces, such as its true market value for possible other uses. The valuation takes place in a two-step process:

1. BC Assessment determines the value of the land without trees, including other factors, such as growth capability, location, topography and accessibility. The assessor applies a schedule of regulated values to the bare land. At this stage, trees are not assessed a value.

2. After the trees are harvested, BC Assessment will add the assessed value of the harvested trees to the bare land value of the land. The value of the trees harvested in any year is added two years later to the property’s assessed value.

Poplar or willow crops not recognized as primary agricultural production, i.e. stands that exceed the 12-year rotation or stands that are not intensively-managed as a farm crop, can still qualify under the MFL class. Natural poplar stands could also qualify, provided they meet the above-mentioned conditions. There are size restrictions and to be classified as MFL, “the land must be at least 25 hectares and be managed as a single unit, or, if the land is 50 hectares or less, at least 70% of the land must be productive during the year ending on October 31. If the land measures more than 50 hectares, at least 50% of the land must be productive during the year ending on October 31”\(^{22}\).

Forest land classed as MFL offers several benefits:

a) owners are assured the right to harvest trees;

b) assessments are reasonably stable through years of no harvesting; and

c) increased assessments will apply only following a year in which tree harvesting occurs.

### 6.2 Alberta

There are no specific policies or tax measures promoting the management of *Populus* or *Salix* species in Alberta.

Rural land is generally valued as either agricultural, based on productive capability rather than market value, or as non-agricultural land, valued at market value. Privately-held forest land and woodlots are not considered agriculture and are generally assessed at market value, rather than productive capability. Property value assessment of forest land and woodlots at market value frequently leads to accelerated liquidation of the standing timber inventories in order to reduce the property tax burden.

Much of the private wood purchased by various companies thus comes from forests that are being liquidated for agricultural or other industrial development. This liquidation process reduces the opportunity to obtain fibre from these sources in the future. With projected increases in mill production and forecast reductions in land committed to sustainable fibre

\(^{22}\) See “Managed Forest Classification in British Columbia” (http://www.bcasessment.ca/public/Fact%20Sheets/Managed%20Forest%20Classification%20in%20British%20Canada.aspx).
production, the hardwood\(^{23}\) (i.e. aspen and poplar) fibre shortage is expected to increase. There are opportunities to retain and manage private forest lands and woodlots for sustainable fibre production by offering incentives to landowners through a more appropriate valuation and tax process. This will encourage sustainable management, rather than liquidation, of forested private land, and also afforestation of cleared farmland. This latter category is of increasing importance to several land owners and corporations, who are planning to establish or are currently establishing aspen and poplar plantations.

Alberta is divided into two main administrative areas, the White Area and the Green Area. Both areas are managed in a multiple use context; however, there are important differences between the primary uses of the two areas\(^{24}\):

a) The White Area, covering approximately 39% of Alberta (three-quarters of which is privately owned), is generally settled or suitable for settlement and is associated with uses such as agriculture, oil and gas development, tourism and recreation, urban centres, conservation of natural spaces, and fish and wildlife habitat. The authority to set regulations and make decisions with respect to the White Area rests primarily with municipal governments on private land and with the provincial government on public land.

b) The Green Area, covering approximately 61% of Alberta (most of which is publicly owned), is largely permanent forest and is associated with uses such as timber production, oil and gas development, tourism and recreation, conservation of natural spaces, watershed protection, and fish and wildlife habitat. Authority to set regulations and make decisions with respect to the Green Area rests primarily with the provincial government.

Much of the privately-held forest lands, woodlots and agricultural lands suitable for afforestation to aspen and poplar are located in the White Area, where several land owners and corporations are planning to establish or are currently establishing SRIC aspen and poplar crops. Alberta-Pacific Forest Industries Inc. (Al-Pac) is the only corporation in Alberta currently engaged in establishing and managing large-scale operational SRIC hybrid poplar crops on farmland. Ainsworth Engineered Canada LP has also started to establish SRIC hybrid poplar crops to provide a sustainable supply of wood for its OSB plant in Grande Prairie (Alberta).

Several years ago, Alberta was contemplating changing its property tax laws to recognize managed private woodlots, which would have had a positive impact on sustainable management of aspen and poplar. These proposals were part of an omnibus of legislative changes pertaining to agricultural assessment regulations, including regulations for intensive livestock operations. The unfortunate occurrence of a single cow with bovine spongiform

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\(^{23}\) The term hardwood is used throughout this report and refers to the deciduous or broadleaved species present in the inventory; it does not include deciduous species such as *Larix*. The terms hardwood and deciduous are used interchangeably.

\(^{24}\) For more information, see https://landuse.alberta.ca/Planning/WhyLandusePlanning/UnderstandingLandUseAlberta/Pages/GreenandWhiteAreas.aspx.
encephalopathy (BSE) changed all that, cancelling all of these legislative initiatives. Changes to Alberta’s property tax laws have yet to take place.

Land ownership rules in Alberta put restrictions on foreign-owned corporations leasing or owning land. A foreign-owned corporation can only lease less than 5 acres (2 hectares) for a period not exceeding 20 years. A 2004 Order-in-Council allowed Al-Pac to lease 25,000 hectares for up to 30 years, provided the land classification did not exceed a certain value, restricting such leases to lower farmland classes. In the fall of 2007, the Government dropped the restriction in land classification, thereby allowing Al-Pac to lease any and all classes of land. The Order-in-Council and the 2007 ruling only apply to Al-Pac; however, it sets a precedent for other foreign-owned corporations, should they be interested in leasing land for the purpose of growing a SRIC woody crop.

6.3 Saskatchewan

As in Alberta, there are no specific policies or tax measures promoting the management of *Populus* or *Salix* species in Saskatchewan.

Treating trees as a crop, particularly hybrid poplars, is relatively new to Saskatchewan. While the potential is large, constraints to implementation exist, including:

- The length of time it will take (from 15 to 20 years) to develop a mature wood supply with the requisite high front end costs. Loan programs and other financial risk sharing programs need development.
- The need to establish critical mass in production in any given region to ensure that the range of services, expertise, and local markets are available.
- The need for research and development into new commercial species.

For woodlots or other privately-held forest land there are no incentives for properties classified as “forest property” or managed as woodlots or tree plantations. Saskatchewan’s forest is not fully utilized. Canadian industry prefers long-term land tenure and secures wood supplies from

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25 Personal communication with Byron Grundberg and Larry Collins by Cees van Oosten, 2004. No further updates have been provided.
26 Personal communication with Al Bertschi by Cees van Oosten. No further updates have been provided.
27 Pursuant to the Agricultural and Recreational Land Ownership Act (Alberta) (Chapter A-9, R.S.A. 2000), no ineligible person or foreign controlled corporation may take or acquire an interest in certain controlled land, subject to various exceptions. Generally, controlled land includes all privately owned land outside urban boundaries (usually farm land or rural recreational land). Furthermore, any corporation that acquires or attempts to register an interest in Alberta land must be registered in Alberta (either as an Alberta corporation or as an extra-provincially registered corporation).
28 Personal communication with Randy McNamara by Cees van Oosten. No further updates have been provided.
Crown forests, therefore Saskatchewan does not yet have a scarcity of wood supply which would create a competitive market for privately held wood.

The Saskatchewan Assessment Management Agency (SAMA) assesses woodlots using agricultural land valuation. Rural land is assumed to be for an agricultural purpose, capable of agricultural crop production and proper tillage, and is assessed as such. Arable (cultivable) land is assessed at 55% and non-arable (non-cultivable) land at 50% of the assessed value, resulting in rural forestlands being in one of the lowest property tax classes. A recent change lowered the assessment rate for land growing grain that is converted to treed land (including SRIC woody crops) from 55% to 50%; the same applies to grain land converted to grassland. The actual tax savings are insignificant\(^{31}\). A 2004 study in Saskatchewan concludes that “results of the economic analysis in this study suggest that the actual impediment to afforestation and agroforestry arising from the cost of property taxation to the producer is very small relative to other economic disincentives that include high establishment costs and the substantial time lag until harvest. Property assessment for taxation purposes generally rates agricultural land at the lowest valuation rates”. The same study recommends “If property taxation incentives are to be applied, they should encourage producers to incorporate good management practices in their afforestation or agroforestry operations. Such practices develop long-term, sustainable industry and have demonstrable environmental benefit. Accordingly, we can conclude that a move towards a vigorous Management Plan regime for private land forestation in conjunction with target-specific property taxation adjustments that direct incentives to producers will lead to better profitability and resource management than is presently the case”\(^{32}\).

To date there are no new developments on this issue.

### 6.4 Manitoba

As in Alberta and Saskatchewan, Manitoba has no specific policies or tax measures promoting the management of *Populus* or *Salix* species. That situation has not changed since 2004\(^{33}\).

Land taxes for forest land are lower than for agricultural land and there are no incentives available for management of woodlots\(^{34}\).

### 6.5 Ontario

As in the Prairie Provinces, Ontario does not have specific policies or tax measures promoting the management of *Populus* or *Salix* species, but Ontario does offer a Managed Forest Tax Incentive Program to eligible forest land owners.

\(^{31}\) Personal communication with Douglas Currie by Cees van Oosten. No further updates have been provided.


\(^{33}\) Information provided by Shane Tornblom. No further updates have been provided.

\(^{34}\) Information provided by Patricia Pohrebiuk, 2004. No further updates have been provided.
6.5.1 Managed Forest Tax Incentive Program

“The Managed Forest Tax Incentive Program (MFTIP) is designed to encourage landowner participation in natural resource stewardship on private forest land in Ontario”\(^{35}\). The Ontario Woodlot Association defines the goal of the MFTIP program as bringing “greater fairness to the property tax system by valuing forestland according to its current use”\(^{36}\). The MFTIP allows for a reduction in property taxes to forest landowners who prepare an approved management plan and commit to good stewardship of their property. Recently, the term of the program was increased from five to 10 years on a renewable basis\(^{37}\). A five-year progress report needs to be filed in order to continue qualification under the program. The MFTIP is meant to remove financial barriers to good management by valuing the land for its current use. Eligible land is taxed at 25 percent of the municipal tax rate set for residential properties.

In Ontario, the Ministry of Natural Resources (MNR) administers the MFTIP and the Municipal Property Assessment Corporation (MPAC) is responsible to carry out property assessments, while the municipalities are responsible for the administration of the property tax system, including billing. Areas planted to and managed for *Populus* species are considered managed forests, provided there is an approved management plan; this applies to poplars planted on farmland (SRIC crops) and on forest land. It is unclear how this incentive program would affect SRIC willow crops.

Managed forest must meet several conditions:

a) The land owner must be a Canadian citizen, corporation, partnership or conservation authority;
b) The forest area must cover at least 4 hectares (10 acres) excluding all residences;
c) The forest must all be on one property with one municipal roll number;
d) There must be a minimum number of trees on each hectare (acre), depending on size;
e) The land cannot be subject to a ‘Registered Plan’ of subdivision or be licensed under the Aggregate Resources Act (note the recent change\(^{38}\)).

From a poplar-management perspective, the criterion of a minimum number of trees per hectare could cause some grief. The minimum number of stems per hectare (spha) is 1,000 at any time, but does decline as the diameter-at-breast-height (dbh) increases. A grower, who intends to establish e.g. 500 stems per hectare (spha) to manage the stand for the saw log or


\(^{38}\) Effective January 1, 2007, the regulations of the Act state that if “property is in a newly designated area under the Aggregate Resources Act or was previously zoned for extraction, but is not licensed (i.e., you are not extracting aggregate), your property may now be eligible for the program, subject to other program eligibility requirements” – source: http://www.ont-woodlot-assoc.org/forman_mftip.html.
veneer log market, runs the risk of the plantation not meeting the eligibility criteria until the average dbh is in excess of 12 cm\textsuperscript{39}.

The new assessment method caused numerous complaints of property taxes actually increasing and led to calls for the assessed value to revert to the subset of farm values as used before. The complaints resulted in a formal review under the \textit{Environmental Bill of Rights}\textsuperscript{40} (EBR), which provides that Ontario residents may apply to the Environmental Commissioner to request a review of a policy, act, regulation or instrument\textsuperscript{41}. The report summarizing the review made eight recommendations and certain changes were implemented as a result, including that “Managed Forest (MF) properties will be assessed in a manner similar to the method used for farmland, which is based on land productivity rates”\textsuperscript{42}. Under the new assessment approach, it is estimated that more than 80\% of the MFTIP properties will experience lower assessments when compared to the previous assessment procedure\textsuperscript{43}. Other changes to the MFTIP included: (i) increasing the term of MFTIP plans from five to 10 years; (ii) modifying the definition of eligible open area to better recognize the variability of the forested landscape, and (iii) requiring that purchasers of MFTIP properties wishing to keep a property in the program to have their plan approved by a Managed Forest Plan Approver\textsuperscript{44}.

### 6.6 Québec

The Province of Québec does not have specific policies for the establishment and management of \textit{Populus} or \textit{Salix} species on either public or private land. Most poplar is planted on private and public forestland with only approximately 3-4\% planted on cleared agricultural land\textsuperscript{45}. Public lands are governed by the \textit{Forest Act}\textsuperscript{46} («Loi sur les forêts»), which states that forests must be managed in a sustainable fashion and must meet several important criteria. Approximately 90\% of Québec’s forests are under public ownership and are managed on its behalf by the provincial government\textsuperscript{47}. Although the \textit{Forest Act} is not very explicit about how the rules affect private forestland, management criteria also apply to private forests and woodlots. Woodlot owners can obtain financial and technical assistance from the government to develop their forests. The private forest development agency programs provide the framework for

\textsuperscript{39} The criteria are: 1,000 spha any size of tree; 750 spha with dbh > 5 cm; 500 spha with dbh > 12 cm; 250 spha with dbh > 20 cm. See \textit{Ontario Managed Forest Tax Incentive Program (MFTIP) Guide} (January 2012), supra note 43 at p. 6.

\textsuperscript{40} O. Reg. 73/94.

\textsuperscript{41} Ministry of Natural Resources and Ministry of Finance – Managed Forest Tax Incentive Program (MFTIP), June 2004 – file name: EBR Review R2003005 (http://www.ontla.on.ca/library/repository/mon/8000/245333.pdf).

\textsuperscript{42} See Ministry of Natural Resources’ Managed Forest Tax Incentive Program (MFTIP) Program Enhancements: http://www.ontla.on.ca/library/repository/mon/11000/255087.pdf.

\textsuperscript{43} \textit{ibid}.

\textsuperscript{44} \textit{ibid}.

\textsuperscript{45} Information provided by Pierre Gagné. No further updates have been provided.

\textsuperscript{46} R.S.Q., chapter F-4.1.

\textsuperscript{47} http://www.mrn.gouv.qc.ca/english/forest/understanding/understanding-system.jsp.
assistance to private forest producers. The Assistance Program for the Development of Private Woodlots contributes on average 80% of afforestation expenses. However, only part of the agencies fund afforestation projects involving block plantations of hybrid poplar. Further, the program does not subsidize short-rotation intensive culture of willow, particularly because of the novelty of this type of crop and financial constraints.48

Following the Private Forest Summit of 1995, the Forest Act was amended to establish 17 private forest development agencies («Agence régionale de mise en valeur des forêts privées»). According to the Act, the purpose of the agencies is to guide and enhance the development of private forests in their region, especially through (i) preparation and implementation of a private forest protection and development plan (PPMV), and (ii) financial and technical support for the protection and development of private forests. The 17 regional private forest development agencies are therefore responsible for administering the assistance programs to certified forest producers in each of Québec’s administrative regions. Some of these regions have more than one agency.49 These agencies are composed of representatives of the private forest land owners, forest companies (forest companies are official members of the agency), local municipalities and the Ministry of Natural Resources and Wildlife, «Ministère des Ressources naturelles et de la Faune» (MRNF).50

6.6.1 Managed Forest Land

Planning of forest management activities on private land is scrutinized by the regional agency and is subject to public consultation. Regional agencies for private forest land (development) are responsible for forest protection planning and forest development planning that meet objectives of the Regional County Municipalities (RCMs). Agencies submit their plans to the RCM in whose jurisdiction they operate in order to reach an agreement. The regional agencies have nothing to do with the management of public land. Planning of all forest management is subject to public consultation for both private and public forest lands.51

Private forest land owners qualify for subsidies for site preparation, planting, tending and various silvicultural activities such as pruning, and these subsidies equally apply to forest land owners who plant and manage poplars; however, the number of treatments allowed for subsidies, the percentage paid by the landowner, the pruning height, etc. does vary from agency to agency.52 The subsidies include free-of-charge planting stock, including hybrid poplar,
supplied by the MRNF. One of the restrictive conditions of receiving these subsidies is that forest land owners cannot apply herbicides to control competing vegetation.

6.6.2 Real Estate Refund Program

Private forest land owners can also qualify for a reduction in land taxes under the Real Estate Refund Program. This includes private forest land owners who plant and manage poplars. Eligible owners can qualify for a tax credit equivalent to 85% of the amount of real estate tax (municipal and school taxes) payable on forest land. Forest producers who are not Québec residents are also eligible to receive a real estate tax reimbursement\(^{53}\). Forest land qualifies if registered by the certified forest producer who owns it. A “Forest Producer’s Certificate” is issued by the MRNF\(^{54}\).

6.6.3 Farmland for Woody Crops

Few poplar growers contemplate establishing SRIC poplar or willow crops on private farmland. One of the main reasons is that transfer of farmland to grow a woody crop, rather than a traditional agricultural crop, is regulated in Québec and the practice is strongly discouraged on prime farmland. Agricultural land is protected for agricultural crops by law\(^{55}\) and SRIC poplar or willow crops are not considered agriculture. There are ongoing discussions in Québec that could lead to SRIC willow biomass crops being considered an agricultural crop production system\(^{56}\). In December 2007, the «Union des producteurs agricoles» (UPA) adopted a resolution to be presented to the Department of Agriculture, Fisheries and Food, «Ministère de l’Agriculture, des Pêcheries et de l’Alimentation du Québec» (MAPAQ) to recognize willow biomass crops as agricultural production\(^{57}\).

Before planting trees, landowners need to obtain authorization from MAPAQ to get an exemption from the act that regulates agriculture and agricultural zoning; this is negotiated at a regional level and both MRNF and MAPAQ are involved. It is interesting to note that the definition of agriculture specified in the Forest Act includes, among other things, “the cultivation of the soil and plants, leaving land uncropped or using it for forestry purposes...”. So according to the Act itself, agriculture does not automatically exclude use for forestry purposes\(^{58}\). Despite substantial interest from private land owners to plant hybrid poplar on farmland, obtaining authorization from MAPAQ to plant trees on agricultural land is very difficult\(^{59}\).


\(^{54}\) http://www.mrn.gouv.qc.ca/english/forest/reimbursement/index.jsp.

\(^{55}\) «Loi sur la protection du territoire et des activités agricoles, ou zonage agricole» (personal communication with Gisèle Bélanger by Cees van Oosten, 2004. No further updates have been provided.).

\(^{56}\) Personal communication with Michel Labrecque and Charles Provost by Cees van Oosten. No further updates have been provided.

\(^{57}\) Information provided by Charles Provost. No further updates have been provided.

\(^{58}\) Supra note 54, p. 16.

\(^{59}\) Information provided by Pierre Périnet. No further updates have been provided.
6.7 Atlantic Canada

In Atlantic Canada, agroforestry is still in its early stages. While there is growing awareness of agroforestry practices, none of the Atlantic Provinces has specific policies or tax measures promoting the management of *Populus* or *Salix* species. Interest is different in each province depending on local issues and emerging initiatives. The Eastern Canada Soil and Water Conservation Centre\(^6\) (ECSWCC) have been actively involved in developing and promoting agroforestry in the region. Along with its partners, the ECSWCC has encouraged the adoption of two important agroforestry systems for the Maritimes: windbreaks and forested riparian buffers.

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7 STATISTICS & TECHNICAL INFORMATION

7.1 Forest Inventories – Canada

Canada has 10 percent of the world’s forests that cover 397.3 million hectares (ha) of forest, other wooded land and other land with tree cover, which represent 53.8 percent of its total surface area. Canada’s forest, other wooded land and other land with tree cover are made up of 347.7 million ha (87.5 percent) of forest, 41.8 million ha (10.5 percent) of other wooded land and 7.8 million ha (2 percent) of other land with tree cover. The predominant tree species on forest land are spruce (53.2 percent), poplar (11.6 percent) and pine (9.3 percent)\textsuperscript{61}. The vast majority of the {}\textit{Populus} inventory in Canada consists of natural stands\textsuperscript{62}.

As the provinces have jurisdiction over forest resources, provincial agencies carry out and maintain forest inventory systems. Standards for data collection and compilation differ between provinces and are not necessarily compatible. On a federal level, no new Canadian Forest Inventory has been published since 2001. Canada’s National Forest Inventory is only available on-line in topic specific data sets and it is only based on data up to 2006 and none of the {}\textit{Populus} tree species are separately identified in the data. The other more recent sources available for this report include the “The State Of Canada’s Forests Annual Report 2011” and the “The National Forestry Database (NFD)”, which was last updated in January 2012 but only contains partial information for 2010 and 2011 in relation to a very limited number of topics. Unfortunately, the various data tables are not broken down by species and only list the species groups ‘Softwoods’ and ‘Hardwoods’. Therefore, production data for aspen and poplar are not available on a national or provincial basis from these sources.

There is also little consistency between provinces in how they keep records and report on forest inventories, if at all. This unfortunate situation has been made worse by federal and provincial budgetary cuts, especially in British Columbia. Therefore with the exception of Québec, no meaningful updated information from the last report is available.

7.2 Québec\textsuperscript{63}

Significant hybrid poplar cultivation began nearly 15 years ago in Québec with forest companies that are now actively managing poplar plantations. Besides forest companies, some small private landowners have also gotten involved in hybrid poplar cultivation in Québec.

\textsuperscript{61} Natural Resources Canada.
\textsuperscript{62} Canada’s Forest Inventory 2001.
\textsuperscript{63} This section is excerpted with edits from the paper \textit{Hybrid Poplar Yields in Québec: Implications for a Sustainable Forest Zoning Management System}, by Julien Fortier, Benoit Truax, Daniel Gagnon and France Lambert. 2012
In the province of Québec, approximately 9000 ha of fast-growing poplar plantations are industrially managed, while small private landowners have planted only 1000 ha. Most of these poplar plantations are established on clearcut forest sites (approx. 8000 ha). [...] Yields as high as 39.6 m$^3$ha$^{-1}$year$^{-1}$ were observed after 6 years in a riparian agroforestry system (2222 stems ha$^{-1}$) along a stream in a fertilised pasture in southern Québec. Very high yields were also observed in the St. Lawrence Valley, on abandoned farmlands (22.4 m$^3$ha$^{-1}$year$^{-1}$ after 8 years, Montérégie region; 16.4 m$^3$ha$^{-1}$year$^{-1}$ after 6 years, Lanaudière region) at intermediate stem density (833 stems ha$^{-1}$). Available data from four clearcut site hybrid poplar plantations show yields varying from 0.5 to 1.4 m$^3$ha$^{-1}$year$^{-1}$. These yields are lower than the mean yield of natural trembling aspen regeneration (3.4 m$^3$ha$^{-1}$year$^{-1}$). In addition, forest conversion to “exotic” poplar plantations is generally perceived as detrimental to biodiversity and soil carbon sequestration. In southern Québec, three factors are highly correlated to yield for clones of various parentages: NO$_3$ supply rate in riparian soils, elevation (or climate) and soil P availability in abandoned farmland soils. Many Québec forest sites, particularly in the boreal shield ecozone, have acidic soils and harsh climate, with low mineralization rates. These sites generally cannot fulfill the very high nutrient requirements of hybrid poplars. Within a forest zoning management system, hybrid poplar plantations and agroforestry should be located on priority sites in the southern Québec landscapes, with low remaining natural forest cover, and where intensive agriculture is the dominant land-use. Elsewhere, intensive trembling aspen regeneration silviculture could be a sustainable alternative to forest conversion into hybrid poplar plantations.

Since 2001, 1 to 1.5 million hybrid poplars have been delivered annually in Québec to establish new plantations, but also to create some agroforestry systems (riparian buffers, shelterbelts, windbreaks, intercropping systems). An important decline in hybrid poplar deliveries has been obvious since 2007 (see also Figure 1). This is not surprising given the economic recession that strongly affected the United States economy at the end of 2007. As with other Canadian provinces, Québec’s forest sector is strongly dependant on the US housing market$^{64}$. The recent collapse of the US housing market, along with the sharp decline in newsprint sales and the rise of the Canadian dollar$^{65}$ are all potential explanations for the decrease of investments in fast-growing plantations in Québec. Another important fact is that the vast majority of hybrid poplar plantations are established by the forest industry, whether on private or public land. Hybrid poplar deliveries to small private landowners represent only a very small fraction of total deliveries over the last 10 years. As part of this trend an overall decline in usage can be observed and the under harvesting below allowable cut levels continues from previous years (See Figure 2).

$^{64}$ Natural Resources Canada 2011.
$^{65}$ Natural Resources Canada 2011.
Figure 1

Evolution of hybrid poplar deliveries from nurseries (nb) to different users: industries that own private land (private - industries), small private landowners (private - landowners), industries operating in public forests (public forest) and all other users including watershed organisations, scientists, agro-environmental consultants, etc. (other users). Data obtained from the DPSP, MRNF.

Figure 2

Evolution of forest possibility, wood volume allocation and wood volume harvested in public forests of Québec during the 2000-2009 period (MRNF 2001-2010).
7.3 Identification, Registration and Control of Clones

Canada has no national regulations for the identification, registration or control of *Populus* or *Salix* clones. Although Canada has the 1990 *Plant Breeders' Rights Act*66, it only applies to certain species prescribed by its regulations. Neither *Populus* nor *Salix* are on this list. *Populus* and *Salix* clones can and are widely propagated vegetatively for various purposes without any legal protection of intellectual property rights for the breeder, unless specific contractual arrangements are in place. There is no regulatory mechanism to ensure the origin and clonal identities of *Populus* or *Salix* clones. However DNA fingerprinting is available to check clone identity and it has been used. Individuals, companies or nurseries can have it done. There is also a clone directory on the PCC site that although voluntary – digitized all material from a much older 1988 version and includes most material in Canada. Because of the lack of regulatory framework nursery-produced clonal planting stock has been known to be contaminated with unknown clones. This continues to be a common occurrence, primarily stemming from a lack of quality control at the nursery level. Several provinces in Canada have regulations pertaining to deployment of exotic species, e.g. hybrid *Populus* clones on Crown land.

7.3.1 Province of British Columbia

Hybrid poplar stock to be deployed on Crown lands in British Columbia must be registered67. The registration standards exempt hybrid poplar from the genetic diversity requirements, which permits it to be deployed in pure clonal blocks not exceeding 10 hectares in size68. Hybrid poplar can therefore be deployed on Crown lands in British Columbia, provided it meets the Ministry of Forests and Range recommendations for specified geographic areas69. The regulations do not cover *Salix* species as these are not considered a commercial forest species in British Columbia. There are no standards for private land and landowners can plant exotic and hybrid poplar and willow trees without restrictions.

7.3.2 Province of Alberta


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67 http://www.for.gov.bc.ca/hti/treeseed/tech.htm
68 Information provided by Dan Carson.
clear standards for all wild collections and deployment to seed zones as well. It also covers conservation requirements for any tree improvement programs. It lists specific standards for tree improvement and deployment for *Populus* – both aspen and poplar –, as well as *Picea* and *Pinus* species. The standards apply to Crown lands in the so-called Green Area. Hybrid poplars are not allowed to be planted on an operational scale on Provincial Crown land in the so-called Green and White Areas\(^{71}\). This restricts deployment of hybrid poplar and hybrid aspen to private lands only. Planting of monoclonal blocks (even of native material) is not permitted on Crown land; clones of native material can only be deployed in intimate clonal mixes, consisting of a minimum of 18 clones\(^{72}\). There are no such restrictions on private land.

### 7.3.3 Province of Québec

The Ministry of Natural Resources and Wildlife, «Ministère des Ressources naturelles, de la Faune et des Parcs» (MRNFP) in Quebec has been actively breeding and selecting hybrid poplar for use in the province since 1969 and keeps firm control of the hybrid poplar resource under its jurisdiction. Since the MRNFP provides free-of-charge hybrid poplar planting stock to companies that operate on Provincial public lands, as well as to eligible private forestland owners, it controls the production of planting stock and thus the deployment of hybrid poplar clones on both public and private land. Hybrid poplar clones are not made available to clients from outside the Province.

### 7.4 Conservation of *Populus* and *Salix* Genetic Resources

Several government agencies have been actively involved in the collection and conservation of genotypes of *Populus trichocarpa* (black cottonwood), *Populus balsamifera* (balsam poplar) and *Populus deltoides* (var. *monilifera*, a.k.a. *P. deltoides* var. *occidentalis* or Plains cottonwood).

#### 7.4.1 *Populus trichocarpa*

The British Columbia Ministry of Forests and Range (MOF), Research Branch in Victoria (British Columbia) completed a common-garden trial with coastal *P. trichocarpa*, and selected material that was subsequently planted in three distinct locations in British Columbia. The trials include selections from eight populations from Oregon, Washington and coastal British Columbia\(^{73}\). The MOF also collected *P. trichocarpa* from the interior of British Columbia and that collection was planted in one of the three locations in the Province\(^{74}\). The material will be utilized in the future for environmental purposes, such as riparian restoration, and will also be available for future breeding purposes.

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\(^{71}\) Information provided by Barb Thomas.

\(^{72}\) Information provided by Tim Gyllander.

\(^{73}\) Information provided by Chang-Yi Xie.

\(^{74}\) Information provided by Michael Carlson.
### 7.4.2 *Populus balsamifera* and *Populus deltoides*

The Agroforestry Development Centre, AAFC Agri-Environment Services Branch formerly called The Shelterbelt Centre of the Prairie Farm Rehabilitation Administration (PFRA) (combined AAFC-PFRA) at Indian Head, Saskatchewan made a range wide collection of *P. balsamifera* from across Canada and Alaska (the AgCanBaP collection). Clonebanks are being established at four locations across the country. The plan is to make selections from this collection based on local outplanting trials (clonal trials), followed by intra-specific hybridization between distinct populations. In early 2008 AAFC-PFRA collected *P. deltoides* var. *monilifera* (a.k.a. *P. deltoides* var. *occidentalis* or Plains cottonwood) along the South Saskatchewan River drainage in the southern Canadian Prairie Region. This collection was augmented with *P. deltoides* var. *monilifera* from the US Great Plains. Selections from this *P. deltoides* collection will be used for intra-specific hybridization between distinct *P. deltoides* populations. Besides the need for genotype conservation in both species, one of the objectives is to use the material for environmental projects, such as riparian restoration and shelterbelt use. This material will also be made available as breeding stock for SRIC hybrid poplar crops and poplar plantations.

### 7.4.3 *Salix* Species

Since 2004 the Canadian Forest Service (CFS), Atlantic Forestry Centre in Fredericton, New Brunswick has collected material of seven native willow species and has been studying the genetic variation between and within species populations\(^{75}\). The objectives are mainly aimed at ecological uses of native willow species in riparian zone restoration and phytoremediation. One interesting use is in bee pollination in blueberry production. The CFS is making willow clones available to blueberry farmers for bee pollination; willows are largely insect-pollinated and provide an early food source for bees. Also of great interest are traits related to biomass production. The Canadian Forest Service has exchanged material with several interested parties for field testing and further work, including future breeding and hybridization. The CFS is pursuing additional research objectives with the species and is very interested in cooperating with industry to advance the species as a source of biomass.

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\(^{75}\) Information provided by Alex Mosseler.
8 CULTIVATION

8.1 History of Growing Poplars in Canada

There is a long history of growing poplars in Canada, dating back from before the time of European settlement. People who came to Canada in the 17th and 18th centuries brought with them trees such as Lombardy poplar (P. nigra L. cv. Italica) and silver poplar (P. alba L.). They also took eastern cottonwood back with them to Europe where they hybridized spontaneously with the European black poplar (P. nigra L.) creating a hybrid that became known as ‘Canadian poplar’ (P. ×canadensis Moench). Much later, in the early 20th century, this hybrid was introduced to Canada and gave rise to the very widely planted ‘Carolina poplar’ grown in Ontario, Québec and the Lake States.

Selection and breeding of poplars for wood production in Canada began in the 1930s, largely stimulated by Carl Heimburger in Ontario. By the 1970s, there were active breeding programs in Ontario, Québec and to a lesser extent in British Columbia. They followed classical breeding procedures, making numerous crosses of promising native and introduced clones, and testing and selecting the best progeny, showing the beneficial effects of heterosis, for further crossing and testing. The Ontario and Québec programs had close associations with similar programs in the United States and Europe and there was considerable interchange of reproductive material (cuttings, pollen and seeds). Meanwhile, similar strategies were followed at the Prairie Farm Rehabilitation Administration (PFRA) Shelterbelt Centre in Saskatchewan with breeding goals of improved suitability and vigour for windbreak plantings on the Prairies. The Shelterbelt Centre program has a history which is now more than 100 years old. The program has developed numerous poplar hybrids and has released several which have been widely planted across the prairies and have proved exceptionally well-suited for the purpose for which they were originally selected.

Although poplar breeding has been conducted in Canada for decades, significantly more activity has taken place in [...] the more recent past (edit). This has occurred as forest companies look to secure fibre sources to meet future needs while recognizing that current fibre sources are coming from an ever-diminishing land-base. MacMillan Bloedel (now Weyerhaeuser) on Vancouver Island and Scott Paper (now Kruger) in the Fraser Valley of BC both relied heavily on earlier breeding work of Drs. Reinhard Stettler and Paul Heilman for their sources of hybrid planting stock. [...]Scott Paper has been looking at developing new hybrids for the Fraser delta region. New breeding efforts began on the Prairies when the PFRA Shelterbelt Centre reactivated their breeding program at the end of the 1990s after it had lain dormant for over a decade. A year later, a joint effort between Alberta-Pacific Forest Industries Inc. (Al-Pac) and

76 This section is excerpted from the paper Poplar Genomics to Poplar Production: Bridging the Gap for Best Use of our Resources and Knowledge, http://www.poplar.ca/pdf/g2ppaper.pdf
PFRA also commenced with the mandate to complete 3-4 years of new hybrid breeding based primarily on crosses between Aigeiros (cottonwood poplars) and Tacamahaca (balsam poplars) and their associated hybrids. In addition, Al-Pac has conducted some hybrid aspen breeding on its own, and the Western Boreal Aspen Corporation, also in Alberta, has also been actively breeding aspen and hybrid aspen since the late 1990’s. The Prairie Shelterbelt Program is now administered out of the AESB Agroforestry Development Centre and is part of the Agriculture and Agri-Food Canada’s Agri-Environment Services Branch (AAFC-AESB) (combined AAFC-PFRA). AAFC-PFRA is currently completing a range-wide collection of balsam poplar, and pure species programs for both aspen and balsam poplar have been undertaken by a number of companies in Alberta. In BC, a range-wide collection of black cottonwood has also been made by the BC Ministry of Forests. The most extensive long-term poplar breeding program in Canada is that of the Québec Ministry of Natural Resources (MRNFP), aimed at producing hybrid poplars suited to each of the different regions throughout Québec.

Canadian poplar breeding programs have specific mandates which range from producing shelterbelt trees for farm fields and riparian stabilization along stream edges, to intensive plantations of pure stands for deployment on private lands, to using in a mixed planting strategy with conifers on public lands. In addition, with the increase in interest in bioenergy, programs in the adjacent Pacific Northwest, e.g. Greenwood Resources, are working with the US Department of Energy to determine the energy values of different hybrid poplar clones and how best to develop breeding strategies to meet energy needs in the future.

8.2 Genomics

In Canada, the Populus resource represents an enormous source of economic and environmental potential and many in the poplar breeding and nursery community have high hopes that advances in Populus genomics will eventually lead to opportunities to develop techniques to assist in the selection and breeding of Populus clones with desirable traits. There are three main research groups focusing on tree genomics in Canada, Treenomix77 and the BC Genome POPCAN Project both at the University of British Columbia and Arborea78 at Laval University in Québec City, Québec, Canada. Treenomix concentrates on conifer forest health, and spruce (Picea) is its main interest, some projects also have considered Populus in the past. Genome BC also located at the University of British Columbia completed one Populus project called Optimized Populus Feedstocks and Novel Enzyme Systems for a British Columbia Bioenergy Sector79. The researchers aimed to use genomics to optimize breeding and selection of fast growing poplars to improve their potential as a biofuel resource. As a continuation, the POPCAN80 project looks at genetic improvement of poplar trees as a Canadian bioenergy

77 www.treenomix.ca.
feedstock with a specific focus on *P. trichocarpa* and *P. balsamifera*. Arborea concentrates on identifying “genes that govern naturally occurring phenotypic variation of commercially valuable traits in breeding populations of white spruce trees (*Picea glauca*).” From an operational viewpoint, the main emphasis of *Populus* tree selection and breeding is to create useful clones that realize significant heterosis (hybrid vigour), are very resistant or tolerant to diseases and pests, and are able to successfully withstand the rigours of the Canadian climate. Also considered in the clonal selection and testing are characteristic like fast growth, adaptability and potential for reforestation and reclamation in the energy sector. Other potentially important criteria, such as improved wood quality to meet specific demands for processing, are at this time still secondary considerations.

### 8.3 Nursery Stock Types and Production

*Populus* stock types vary depending on the region, the general availability of clones and the *Populus* species. For poplar (non-aspen), ease of rooting is one of the criteria that determine the choice of stock type for poplar. It varies with species; for instance *P. deltoides* is usually a problematic rooter, whereas *P. trichocarpa* is a very prolific rooter. Many of the hybrid clones are reasonable rooters; however, ease of rooting does vary by clone.

In British Columbia, the stock type of choice is a 1-year old unrooted, dormant cutting or whip. Cuttings (approximately 30 to 90 cm long) are used when establishing SRIC hybrid poplar crops, where site preparation and weed control can be optimized in a farm setting. For plantations that cannot be managed as intensively, e.g. forest plantations, unrooted whips (1.5 to 1.8 m long) are best when some height is needed to dominate the weed competition.

In the Prairie Provinces, Al-Pac is the corporation that has embarked on a large-scale SRIC hybrid poplar crop operation, using an agronomic approach to poplar crop farming. The company relies on rooted stock, preferably dormant bareroot stock and container-grown rooted stock (in that order). Experience with unrooted cuttings has been poor due to low soil moisture conditions after planting in the spring and early summer; this stock type is no longer in use. All stock is produced by private nurseries under contract with Al-Pac.

In Québec, the « ministère des Ressources naturelles et de la Faune » (MRNF) controls hybrid poplar nursery production and distribution. Since the vast majority of planting in Québec takes place on forestland and there is a ‘no-herbicide’ policy in place, large stock is required to ensure survival. The preferred stock type is a steckling, which is essentially the same as a set or rooted whip and varies from 1.2 to 1.8 m in length. The trees are grown in bareroot nurseries for one year from small unrooted cuttings. In the fall the stock is lifted, processed and cold-stored for outplanting the following spring. During the processing the roots are trimmed back to resemble a rough ‘bottle brush’.

*Salix* species are generally planted in high density SRIC biomass crops and are established using unrooted dormant cuttings. For aspen the stock type has to be a rooted plant, either a bareroot or container plant. Aspen does not root from an unrooted stem cutting and this is a distinct disadvantage from a tree improvement and an operational perspective. For tree improvement
and subsequent planting trials, it is critical to have access to uniform clonal material. To fully benefit from the yield gains through heterosis of selected hybrid clones, an efficient and low-cost vegetative mass propagation technology is required to allow operational clonal plantings.

8.4 Selection and Breeding

Hybrid poplars have been featured in a number of corporate selection and breeding programs. Examples of those companies are: Ainsworth Engineered Canada LP in Alberta, Al-Pac in Alberta and Kruger Products Limited in British Columbia. While these programs make very important contributions to the breeding stock they are shut down as fast as they are started based on market and corporate requirements. The orientation on practical application makes them an excellent resource for proven and reliable hybrid poplar clones. However their market orientation makes them long-term an unreliable resource to preserve and maintain hybrid poplar species. In terms of governmental organizations in Canada two organizations have been involved in the breeding of hybrid poplar clones, the Provincial Ministry of Natural Resources and Wildlife, «Ministère des Ressources naturelles, de la Faune» (MRNF) in Québec and the Agri-Environment Services Branch (AESB) Agroforestry Development Centre, formerly known as the Prairie Farm Rehabilitation Administration (PFRA) Shelterbelt Centre in Saskatchewan.

8.4.1 Ministère des Ressources naturelles, de la Faune

The MRNF has been involved in a hybrid poplar breeding and improvement program since 1969. The program has been producing superior hybrid poplar clones for deployment on both provincial public and private lands. Selected clones are suited to the highly varied growing conditions in Québec. The following selection criteria are used: Growth, cold tolerance, tree form, disease and insect resistance, site adaptability and wood quality. Five poplar species are used for hybridization: *Populus deltoides*, *P. balsamifera*, *P. maximowiczii*, *P. trichocarpa*, and *P. nigra*. Several hybrid aspen clones were also produced: *P. alba* × *P. grandidentata* and *P. tremula* × *P. tremuloides*. The MRNF has in excess of 5,000 clones under evaluation and the program has more than 40 operational hybrid poplar clones (Aigeiros-Tacamahaca hybrids) available for deployment. To maintain genetic diversity, the MRNF strives for 6-19 clones per planting region. For southern Québec the presence of *Septoria musiva* (stem canker) drives the breeding and selection of new clones. Eighteen clones of clone types 81 DN, TD, DNXM, NM and BM have been identified due to their resistance to *Septoria musiva*. Unfortunately, the fast-growing DM hybrid type is too susceptible to *Septoria musiva* to be planted in southern Québec and it is not cold tolerant enough to be planted in the northern regions where *Septoria musiva* is (still) absent. For the northern regions *P. maximowiczii* hybrids with *P. balsamifera* and *P. trichocarpa* are suitable.

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81 DN = *P. deltoides* × *P. nigra*; TD = *P. trichocarpa* × *P. deltoides*; DNXM = DN × *P. maximowiczii*; NM = *P. nigra* × *P. maximowiczii*; BM = *P. balsamifera* × *P. maximowiczii*; DM = *P. deltoides* × *P. maximowiczii*. 
8.4.2 Prairie Shelterbelt Program

The Agri-Environment Services Branch (AESB) Agroforestry Development Centre promotes the environmental and economic benefits of integrating trees with agricultural systems through research, extension and provision of seedlings to prairie farmers and other eligible clients. As a component of Agriculture and Agri-Food Canada’s Agri-Environment Services Branch (AAFC-AESB), the Prairie Shelterbelt Program (PSP) (combined AAFC-PFRA) provides technical services and tree and shrub seedlings for establishment of shelterbelts and other agroforestry, conservation and reclamation projects on agricultural and eligible lands in Manitoba, Saskatchewan, Alberta and in the Peace River region of British Columbia. The seedlings provided are an incentive to producers adopting beneficial management practices and environmental stewardship. The aim of the Prairie Shelterbelt Program is to improve the performance and sustainability of the agricultural sector by helping to achieve the social, economic and environmental benefits of agroforestry. Tree and shrub seedlings are provided to eligible landowners at no charge. AAFC-AESB has also been involved in breeding programs to create new hybrid poplars for SRIC hybrid poplar crops. The recent initiatives of genotype conservation of *P. balsamifera* and *P. deltoides* (var. *monilifera*) will eventually lead to intra-specific hybridization between distinct populations (within the species) as a first step.

AAFC-PFRA development strategy aims to develop a diverse pool of 10-15 operational genotypes within 10 years of breeding. These clone mixes are developed as dynamic groups into which new selections are regularly infused. The traits targeted are classified as either: *Agronomic* (e.g. biomass, stem form, pest resistance, tolerance of cold and drought, wind firmness, adventitious rooting) or wood quality (e.g. specific gravity, fibre length, cell wall thickness, lignin content). All these traits have exhibited varying magnitudes of genetic variation and respond well to clonal selection. Disease resistance plays a universal role of singular importance in defining all *Populus* ideotypes. The pathogens of most significant impact include *Melampsora* leaf rust and *Septoria* canker. The AAFC-AESB mandate is also to develop varieties for ecological applications. However, genetic variation is sufficiently broad that elite varieties are likely to be found in the same population for both agroforestry and poplar farming applications. Partnerships with Al-Pac and others are helping to facilitate development of a gene pool for poplar farming clones numbering currently more than 10,000 genotypes in field trials. New genotypes from the breeding program include: *P. deltoides* x *P. maximowiczii*, Walker x *P. maximowiczii*, Walker x *P. nigra*.

AAFC-AESB also engages in selection and breeding work with willow material originating from the Canadian Forest Service (CFS), Atlantic Forestry Centre in Fredericton, New Brunswick. AAFC-AESB interest in willows is focused on well adapted to the drier upland sites of riparian

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84 This section is excerpted with edits from Richard Hall, Iowa State University, Pierre Perinet, Ministère des Ressources naturelles et de la Faune, Québec and Brian Stanton, Greenwood Resources Inc. Conference presentation: *North American poplar breeding: good news/bad news* [http://www.poplar.ca/pdf/edmonton11perinet.pdf](http://www.poplar.ca/pdf/edmonton11perinet.pdf).
areas. Selection emphasis will be on growth performance, drought tolerance, cold tolerance and disease resistance (especially *Melampsora* leaf rust resistance or tolerance). The willow breeding program follows traditional strategies of selecting superior individuals from genetically diverse populations. The first step of the program will identify appropriate parent material by selecting native and introduced *Salix* species. The second step is to generate genetic variability and hybrid vigour within the breeding population through controlled breeding. The third stage is to subject progeny to testing and selection. Testing is done through observation and measurement of the progeny growing in field environments as well as laboratory screening. Selection is based on the observation of multiple traits. The last stage is increase of selected clones through vegetative propagation. Under the willow breeding domain, based on three years of screening in the field, superior individuals of *S. eriocephala* and *S. discolor* are being used to do crosses. In the ongoing breeding work we will generate a series F₁ hybrids of E x E, D x D. Beginning in spring 2013 the F₁’s planted into the field will be subjected to screening for growth, yield, phenology and pathogen resistance. Since 2008, the breeding program has generated 37 families with 1800 genotypes. In 2009, 118 of the best genotypes were selected on the basis of early biomass and planted in nursery trials.

### 8.4.3 Atlantic Forestry Centre

The Canadian Forest Service, Atlantic Forestry Centre in Fredericton, New Brunswick is providing seeds for *P. balsamifera* (balsam poplar), *P. grandidentata* (largetooth aspen) and *P. tremuloides* (trembling aspen). In addition, the organizations are also involved in the selection of willow and research into willow seedling handling. Since 2004 they have collected material of seven native willow species and have been studying the genetic variation between and within species populations. The objectives are mainly aimed at ecological uses of native willow species in riparian zone restoration, biomass and phytoremediation. Research topic examples are “Five years’ storage of seeds from three willow species” and “Collecting and processing Salicaceae seeds”. The CFS’s Atlantic Forestry Centre is cooperating with the AAFC-AESB collecting native willow species, primarily *Salix discolor* (a.k.a. pussy willow) from across Canada, and *Salix eriocephala* (heartleaf willow) over a range from Saskatchewan to the Atlantic Provinces. This collection is co-located at the CFS’s Atlantic Forestry Centre in Fredericton and the AAFC-AESB Shelterbelt Centre in Indian Head and is managed in common gardens.

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85 Source: AAFC-AESB Salix Breeding Program, William Schroeder, Raju Soolanayakanahally.
86 http://www.lib.unb.ca/Texts/Forest/english/.
9 FORESTRY

9.1 Planting

Depending on the region, the availability of stock and suitable clones for Populus stands – whether a dormant unrooted cutting, bareroot stock or container-grown stock – is planted in a systematic pattern on properly prepared farmland. In the Prairie region rooted stock is preferred due to dry soil conditions at planting time. Bareroot stock is preferred over container-grown stock due to lower costs and a higher proportion of coarse roots. In Québec the preferred stock type is a steckling, which is a rooted whip or set of 1.2 – 1.8 m in length. This stock type is particularly useful where weed control is not feasible, such as in forest plantations. Unrooted, dormant cuttings are typically 30 to 90 cm long and are used in British Columbia. The increase in cutting length to 90 cm is a fairly recent development adopted by Kruger Products Limited and is particularly useful in situations where complete site preparation is not possible (e.g. on second rotation crops on farmland) and weed control cannot be complete.

9.2 Short-Rotation-Intensive-Culture (SRIC) Crops

SRIC hybrid poplar crops are almost exclusively grown on existing farmland or newly-cleared agricultural class lands in private ownership, using agronomic methods (Table 1). The land is either owned or leased. Except for a few small private crops of hybrid poplar, currently almost all SRIC hybrid poplar crops in Canada are for the purpose of supplying pulp fibre or logs for engineered wood products, such as panel board or OSB. The cultivation approach for SRIC willow does not differ much from the cultivation of an SRIC hybrid poplar crop, in particular poplar stoolbed production systems. However most willow production is still in an experimental phase and the majority of applications fall under an environmental application.

Table 1 - Area of hybrid poplar short-rotation-intensive-culture (SRIC) crops in Canada that are reported to PCC by Operator.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kruger Products Ltd. - BC</td>
<td>70</td>
<td>1,070</td>
<td>123</td>
<td>3,411</td>
</tr>
<tr>
<td>Catalyst Paper Corp. - BC</td>
<td>0</td>
<td>200</td>
<td>0</td>
<td>Unknown</td>
</tr>
<tr>
<td>Alberta-Pacific Forest Ind. Inc. - AB</td>
<td>4,940</td>
<td>5,640</td>
<td>4,000</td>
<td>9000</td>
</tr>
<tr>
<td>Ainsworth Engineered Canada LP - Alberta</td>
<td>215</td>
<td>215</td>
<td>390</td>
<td>605</td>
</tr>
<tr>
<td>AAFC-AESB (‘)– SK</td>
<td>Unknown</td>
<td>9,030</td>
<td>1,470</td>
<td>10,500</td>
</tr>
<tr>
<td>Domtar Inc. – QC</td>
<td>0</td>
<td>2,500</td>
<td>suspended</td>
<td>4,000</td>
</tr>
<tr>
<td>Agro Énergie inc. - QC</td>
<td>Unknown</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRNF – QC</td>
<td>200</td>
<td>350</td>
<td>0</td>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5,425</strong></td>
<td><strong>19,005</strong></td>
<td><strong>5,9834</strong></td>
<td><strong>27,559</strong></td>
</tr>
</tbody>
</table>

(*) Agri-Food Canada’s Agri-Environment Services Branch Prairie Shelterbelt Program.
**9.3 Yield, Crop Density and Rotation Length**

Crop (stand) density of SRIC hybrid poplar crops depends on the end product. Most crops to date are intended to produce pulp fibre; however, one company has started planting SRIC hybrid poplar for the production of OSB feedstock. Pulp crops are planted at fairly high densities, usually around 1,111 stems per hectare (Table 2). Poplar growers make allowances for a percentage of crop mortality to arrive at the right number of stems per hectare at harvest. In British Columbia, Kruger Products Limited requires a larger piece size for its conversion facility, hence the lower stand densities.

**Table 2 - Yield, crop Density and rotation length - Short-rotation-intensive-culture (SRIC) crops.**

<table>
<thead>
<tr>
<th>Mean Annual Increment – MAI m³ ha⁻¹ yr⁻¹</th>
<th>Crop Density stems per ha (spha)</th>
<th>Rotation Length Year</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kruger Products Ltd. - British Columbia</td>
<td>25</td>
<td>550</td>
<td>15</td>
</tr>
<tr>
<td>Alberta-Pacific Forest Ind. Inc. - Alberta (*)</td>
<td>16</td>
<td>1,111 changed to 1,275 in 2011</td>
<td>18-20</td>
</tr>
<tr>
<td>Ainsworth Engineered Canada LP - Alberta(**)</td>
<td>Unknown</td>
<td>816</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

(*) These values are for hybrid poplar.
(**) Ainsworth recently decided to adopt a 3.5x3.5 m crop spacing for a crop density of 816 stems per hectare.

Source: Personal communication by Cees van Oosten with Kruger and Ainsworth in 2008 and personal communication with Barb Thomas for Alberta-Pacific in 2012.

In the Prairie Provinces, Al-Pac changed its planting density to 1,275 (2.8m x 2.8m) from 1,111 stems per hectare, making an allowance for approximately a 15% mortality during establishment and recognizing the columnar form of the Walker clone which does not close canopy nor fully capture the site at a 3m x 3m spacing. Al-Pac has also begun deployment of hybrid aspen on selected sites across their plantations. Ainsworth Engineered Canada LP in Alberta is a recent newcomer to the field of SRIC hybrid poplar crops. The company started planting at 1,111 stems per hectare at 3 x 3 m crop spacing. They recently changed this to 3.5 x 3.5 m crop spacing or 816 stems per hectare and based this on a crop density report commissioned by ForestFirst in Prince Albert, Saskatchewan.

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90 Information provided by Fred Radersma, 2008.
9.4 Forest Plantations

The vast majority of poplars planted on forestland are hybrids. This planting is classed as a reforestation activity. The establishment of the main forest plantations with *Populus* species takes place in British Columbia and Québec. In British Columbia Kruger Products Limited uses tall (1.5 to 1.8 m) dormant unrooted whips that are planted in the spring. It is the only company establishing significant hybrid poplar forest plantations in the province. Kruger Products refers to these plantations as ‘extensive’ plantations. The company frequently uses a small hydraulic excavator to create 440-450 individual planting spots per hectare by removing harvest debris, competing vegetation and mixing up the humus and mineral soil layers. Where soil conditions are unfavourable (wet ground), planting mounds are created to improve drainage and soil temperature; the stand density could be as low as 280 stems per hectare in this case. Shortly following planting, planters place a small amount of NPK (9-40-4, plus minor elements) fertilizer close to the root zone at shovel depth. Weed control is done as needed and registered herbicides may be used on plantations located close to the pulp mill near Vancouver. This plantation system has proven successful over time. The company manages about 3,300 hectares of these forest plantations in coastal British Columbia and plants an average of 75-85 hectares per year. In Québec hybrid poplar planting occurs on private and provincial public forestlands. The preferred stock type is a steckling (rooted whip or set) of 1.2 to 1.8 m in length. Plantations are established to augment wood supplies for pulp and paper mills or OSB plants.

9.5 Disturbances

A total of 13.7 million ha of all forested land in Canada were affected by insect defoliation in 2008 and 0.8 million ha were lost due to forest fires in 2009\(^1\). For the *Populus* stands the increasing use and expansion also comes with the effect that diseases and insects affecting those stands are expanding at the same rate if no counter measures are taken. This is especially apparent in intensive monocultures. One prominent example is *Septoria musiva* (stem canker), which has been steadily spreading across the Prairie region, due to an increase in the amount of established SRIC hybrid poplar crops. Also the northward shifting and changes in climate and eco-zones that are part of the climate change development, put additional pressure on *Populus* stands with challenges from insects and diseases that they previously where not exposed to, with devastating consequences. In light of these specific challenges, it is unfortunate that no systematic attempts have been made so far in Canada to use biological means to control agents of plant diseases and so besides breeding and selection for resistance, mostly traditional chemical-based approaches are used.

\(^1\) Natural Resources Canada.
Table 3 – Main *Populus* and *Salix* Diseases and Pests in Canada

<table>
<thead>
<tr>
<th>Name</th>
<th>Common name</th>
<th>New Area or Area of Persistent Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diseases</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Septoria musiva</em></td>
<td>Septoria stem canker</td>
<td>Québec, Ontario, Prairie region and British Columbia</td>
</tr>
<tr>
<td><em>Melampsora ×columbiana</em></td>
<td>(Hybrid) Leaf rust</td>
<td>British Columbia</td>
</tr>
<tr>
<td><em>Melampsora larici-populina</em></td>
<td>Eurasian rust</td>
<td>Québec</td>
</tr>
<tr>
<td><em>Marssonina</em></td>
<td>Leaf spot fungus</td>
<td>Alberta/Prairies</td>
</tr>
<tr>
<td><em>Melampsora</em> (unidentified)</td>
<td>Leaf rust spp.</td>
<td>Québec, BC</td>
</tr>
<tr>
<td><strong>Insects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cryptorhynchus lapathi</em></td>
<td>Poplar willow borers</td>
<td>Saskatchewan (southern) and coastal British Columbia</td>
</tr>
<tr>
<td><em>Hamamelistes spinosus</em></td>
<td>Witch hazel gall aphids</td>
<td>Alberta</td>
</tr>
<tr>
<td><em>Lygus lineolaris</em></td>
<td>Tarnished plant bug</td>
<td>Quebec (southern Quebec) - nursery</td>
</tr>
<tr>
<td><em>Popilia japonica</em></td>
<td>Japanese beetle</td>
<td>Quebec (southern Quebec) - nursery</td>
</tr>
<tr>
<td><em>Caelifera</em></td>
<td>Grasshopper</td>
<td>Alberta, Saskatchewan</td>
</tr>
<tr>
<td><em>Nematus sp</em></td>
<td>Sawfly</td>
<td>Alberta</td>
</tr>
<tr>
<td><em>Aphid spp.</em></td>
<td>Aphid / Plant lice</td>
<td>Quebec (southern Quebec) - nursery</td>
</tr>
</tbody>
</table>

9.5.1 *Septoria musiva*

*Septoria musiva* causes leaf blight and, more importantly, necrotic lesions (cankers) that often result in stem breakage. In 2006, *Septoria musiva* stem canker was positively identified in southwestern and south coastal British Columbia (Fraser Valley and one coastal river drainage about 100-200 km north of Vancouver). This new disease in British Columbia has affected several SRIC hybrid poplar crops as well as stoolbeds at one nursery in the eastern Fraser Valley. This was the first documented presence of the disease west of the Rocky Mountains in North America. *Septoria musiva* is thought to have been present for at least 11 years. A survey in 2007 by the BC Ministry of Forests, Lands and Natural Resource Operations, in cooperation with the University of BC (UBC) Department of Forest Sciences, conducted field surveys to assess the extent of the distribution of *S. musiva* on hybrid and native *Populus spp*. This survey identified several ‘epicentres’ and determined that most hybrids with a *P. maximowiczii* parent are at risk; however, there were notable exceptions (clone NM6, *P. nigra* × *P. maximowiczii* and clone 265-

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28, *P. trichocarpa × P. maximowiczii*). The survey work is continued with roadside collections from black cottonwood. Results of the 2008 and 2009 roadside collections resulted in two important findings; 1), *S. musiva* leaf spots occurred outside of the hybrid nursery, and 2), *S. musiva* occurred on native *P. trichocarpa*, however, the incidence appears very low93.

*Septoria musiva* stem canker infections are on the rise in the Prairie region as a result of increasing number of SRIC hybrid poplar crops. One of the issues there is the heavy reliance on one female clone (‘Walker’, a three-way cross between a *P. deltoides* female and a hybrid male clone of *P. nigra × P. laurifolia*). ‘Walker’ has been seen in the past as having a susceptibility to the disease. However more recent reports from Alberta indicate greater resistance as compared to performance in Saskatchewan. Besides steadily spreading across the Prairie region *Septoria musiva* is also present in Québec, in some areas of that province representing a major selection criteria and in Ontario, where it has shut down most projects in that province.

### 9.5.2 Marssonina

It is difficult to quantify the impacts of *Marssonina*. Each year it is present in Alberta plantations although the incidence and severity of infection varies by clone as well as based on weather conditions. *Marssonina*, especially in combination with additional stresses, can contribute to reduced growth. Negative impacts of *Marssonina* are often most evident in nursery stoolbeds where infection levels are regularly high.

### 9.5.3 Melampsora Rust Species

*Melampsora larici-populina* has been reported in at least one nursery and several stands of hybrid poplar in Québec94. After a temporary absence, the hybrid rust *Melampsora ×columbiana*, a hybrid rust between *M. occidentalis* and *M. medusae*, is continuing its onslaught in southwestern coastal British Columbia and therefore rust resistance has become the primary selection criteria for disease in the Pacific Northwest region. It is primarily affecting *P. trichocarpa × P. deltoides* hybrids. The area of SRIC willow crops is still small and most crops are still experimental in Canada. Disease and insect problems have yet to get established; however, one willow farmer in Québec reports that *Melampsora* leaf rust (exact species unknown) has become a problem95.

### 9.5.4 Insects

Poplar willow borers (*Cryptorhynchus lapathi*) have been reported in southern Saskatchewan96 and southwestern coastal British Columbia. The borers in British Columbia affected a crop of eight-year old SRIC hybrid poplars, which turned out be an inadvertent mix of three clones of *P. trichocarpa × P. deltoides*. One of these clones was very susceptible and was killed by the borer.

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94 Information provided by Pierre Périnet.
95 Information provided by Francis Allard.
96 Information provided by Larry White.
attack; the crop was harvested prematurely in 2007 to recover the wood. Alberta-Pacific Forest Industries Inc. reported that several young SRIC hybrid poplar crops in Alberta were affected by Witch hazel gall aphids (*Hamamelistes spinosus*); however, damage appears to be limited. The aphids were also present in poplar nurseries in Alberta. Québec reported a problem with Japanese beetle (*Popilla japonica*) in one of their poplar nurseries. This insect is not normally associated with poplar. Other nursery problems were reported with the tarnished plant bug (*Lygus lineolaris*) and aphid species. Sawfly and grasshopper have been deemed to have a significant enough impact on plantations to warrant EUR (Emergency Use Registration) of insecticides for their control. In 2009, 13% of the spring planted hectares at Al-Pac were destroyed by grasshoppers. In 2011, under EUR, about 500 hectares of plantations were treated immediately prior, or just after, planting to limit crop damage. In 2010, a 52 hectare plantation experienced 70% defoliation as a result of sawfly. In 2011, under EUR, about 200 hectares of plantations were treated to limit crop damage (M. Sulz, Pers. Com.).

### 9.5.5 Pesticides

The Poplar Council of Canada (PCC) has established the Pesticide Working Group (PWG) with the objective of expanding the range of available pesticides and fungicide products for use in SRIC (hybrid) poplar crops, including aspens, poplars and their hybrids and willow. The PWG has been successfully promoting SRIC (hybrid) poplar and SRIC willow crops on farmland as agronomic crops. The goal is to apply for ‘User Requested Minor Use Label Expansion’ (URMULE) applications to the Pest Management Regulatory Agency (PMRA) of Health Canada, to obtain labeling for useful pesticides and fungicide. Since 2004 the PWG partnership joined the Prairie Pesticide Minor Use Consortium (PPMUC) as a member. The PPMUC is a consortium of various agricultural crop producer organizations and provides administrative, technical and analytical services to its members. The PPMUC deals with all the chemical companies (called the product ‘Registrants’), obtains their agreement to support minor use labeling of their products for our uses, and handles all the business dealings with the PMRA. Almost all PWG work dealing with pesticide registration runs through the PPMUC.

PCC has also established a Disease Working Group as a sub-group of the Pesticide Working Group (PWG); it was founded in 2010. It has 2 primary objectives:

- To establish a network of pathology labs across Canada able to provide disease identification services to the exact species level, using DNA technology where required. This service will be offered on a ‘fee-for-service’ basis to poplar and willow growers, breeders etc.
- To ensure disease identification methodology for poplar and willow uses standardized protocols and results meet certain quality standards.

It is expected that the first pathology lab to offer this service will commence in 2012.

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97 Information provided by Al Bertschi.
98 Information provided by Roger Touchette.
99 PMRA is part of Health Canada. PMRA regulates the registration and use of pesticides in Canada.
10 HARVESTING AND UTILIZATION

In most cases, *Populus* stands are harvested by clear-cutting using all-tree harvesters in plantations and specially constructed machinery for short rotation biomass plantations.

10.1 Pulp & Paper

The value of naturally growing native aspen (*P. tremuloides*) in pulp and paper manufacturing is well recognized in North America. Currently, aspen is used by several large pulp mills in Alberta and pulp & paper mills in Québec\(^1\). Most pulp mills accept a certain percentage of poplar (balsam poplar and cottonwood) in their wood supply. Aspen pulp is manufactured using the Kraft (chemical) process; or CTMP\(^\text{101}\) process.

Use of *Populus* species for pulping requires less bleaching chemicals in the Kraft process and less brightening chemicals in the CTMP process. The end products are many and include high quality paper, for use in photographic grades and high gloss magazines. One mill in British Columbia makes groundwood pulp for its tissue business\(^\text{102}\), using black cottonwood (*P. trichocarpa*), balsam poplar (*P. balsamifera*), as well as hybrid poplar from its forestlands and SRIC hybrid poplar crops from leased farmlands. Plantation or SRIC (hybrid) aspen and hybrid poplar prove to be very suitable replacements for the aspen stock currently used. FPInnovations\(^\text{103}\) – Paprican (Pulp and Paper Research Institute of Canada) has carried out research into the use of SRIC hybrid poplar fibre in the manufacturing of pulp and paper. The results are very encouraging and the fibre offers similar advantages to that of naturally growing native aspen.

10.2 Solid Wood & Composite Wood

There has been a growing interest in use of naturally growing native aspen (*P. tremuloides*) for higher-value lumber products and several small entrepreneurs have been experimenting with lumber recovery, drying and manufacturing. Previous National Reports to the IPC\(^\text{104}\) reported on the developmental work with hybrid poplar for products ranging from tongue & groove wall paneling, window and wall mouldings, to furniture and decorative boxes. FPInnovations - Forintek\(^\text{105}\) was involved in much of the wood-technical assessments. Native aspen is the preferred stock for the manufacture of Oriented Strand Board (OSB) and TimberStrand®

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\(^1\) Daishowa-Marubeni International Ltd., Alberta-Pacific Forest Industries Inc. and Millar Western Forest Products Ltd. in Alberta; Catalyst Paper Corporation in British Columbia; Domtar Inc. in Quebec.
\(^\text{101}\) CTMP = Chemi-thermo-mechanical pulp.
\(^\text{102}\) Kruger Products Limited.
\(^\text{103}\) FPInnovations “brings together FERIC, Forintek, Paprican, and the Canadian Wood Fibre Centre of Natural Resources Canada, to create the world’s largest private, not-for-profit forest research institute”. http://www.fpinnovations.ca/index.htm.
\(^\text{104}\) The Canadian Reports to the 21st and 22nd Sessions of the International Poplar Commission in Seattle (Wa), USA and Santiago, Chile respectively.
\(^\text{105}\) http://www.forintek.ca/.
laminated strand lumber (LSL). OSB has largely displaced plywood as a building product used in sheathing in North American construction; TimberStrand® is used for structural (indoor) use. As in the pulp and paper business, there has been increased interest in use of SRIC hybrid poplar wood for composite wood products. Much of this development work was carried out by FPInnovations - Forintek. Several products were manufactured from SRIC hybrid poplar and the test results were very encouraging. Products made and tested include OSB, Laminated Veneer Lumber (LVL), Medium Density Fibreboard (MDF) and plywood. High quality aspen and poplar veneers can be covered with expensive veneers for cabinetry.

10.3 Biomass

Biomass refers to biological material that comes from living or recently living plants, including trees. Biomass provides the basis for renewable bio-energy, bio-fuels and other bio-products that are increasingly being used in place of fossil-fuel based products. With its vast resources, Canada’s forests represent an abundant source of biomass, including the following:

- residues or by-products left over from manufacturing processes;
- biomass plantations (for example, poplar or willow species);
- harvest residues;
- trees killed by natural disturbances such as fire, insects or disease.

Canadian research is underway to develop new products and technologies to maximize the value derived from forest biomass along the entire forest industry value chain. Through initiatives such as the Transformative Technologies Program (being delivered by FPInnovations on behalf of Natural Resources Canada), new and innovative products are being developed.

As one of the fastest-growing species of trees, hybrid poplars (Populus spp.) are well suited for the production of bio-energy (e.g. heat, power and transportation fuels), fibre (e.g. pulp and paper) and other bio-based products (e.g. organic chemicals and adhesives). While Canada’s largest source of biomass energy is waste from sawmills and pulp and paper mills, governments and industry are looking at the potential of fast growing plant crops such as poplars and willows to boost the availability of biomass-derived energy in Canada.

In 2011, a project was announced to enhance the development of clean energy by using genomics to enhance breeding and selection of poplar trees to improve their potential as a bio-fuel resource. To help meet new federal and provincial requirements for renewable fuel content in gasoline, Genome Canada, Genome BC, and other partners have funded a $9.8-million research project known as "POPCAN: Genetic Improvement of Poplar Trees as a Canadian Bioenergy Feedstock".

106 http://www.weyerhaeuser.com/Businesses/WoodProducts/TimberStrand. Timberstrand was a product innovation by MacMillan Bloedel Limited of Vancouver, B.C., Canada. MacMillan Bloedel was obtained by Weyerhaeuser in 1999.
The current production of bio-fuels, which are almost exclusively derived from agricultural residues, is insufficient to produce the requisite volume. Researchers at the University of British Columbia are using genomics to study tree growth at the molecular level, as well as wood traits associated with bio-fuel suitability in *P. trichocarpa* and *P. balsamifera*. Their aim is to develop short-rotation, fast-growing trees that can grow in a variety of climates across Canada and produce wood that can be more readily converted to biofuel while minimizing the ecological footprint. Concurrent with the genomics research, a team of economists led by Dr. Marty Luckert at the University of Alberta is looking into the economic benefits of changing forestland to fast-rotation poplar plantations. The potential payoff from a new energy crop could include job creation and stability in rural communities.

At the Murdoch Lake Agroforestry Demonstration Site in Northern Alberta, a number of research and demonstration projects have taken place since 2002. Among the projects is a planned silvopasture system in one of Al-Pac’s hybrid poplar plantations, which was started in 2011 by a group of agrologists and foresters.

Beyond energy production, researchers are also studying how poplars might be turned into liquid fuel, or ethanol. Currently, ethanol is primarily produced using sugars in corn that are fermented to produce alcohol, which is then blended with petroleum products. Researchers are looking to use cellulosic feedstocks, which include not just corn stover, but also wood chips. Findings from such research could help advance the fledgling cellulosic ethanol industry. The process for producing cellulosic ethanol involves extracting sugars from the cell walls of plant material, otherwise known as biomass. As most plants contain more biomass than grain, cellulose could potentially provide more ethanol than grain. With trees, the biomass volume is even larger than it is with most row crops. Poplar trees offer advantages over other species as a cellulosic ethanol feedstock. In particular, poplars can be vegetatively propagated and poplar trees are very efficient at photosynthesis. To address some of the challenges of growing poplars as an ethanol feedstock – including the removal of sugars from cell walls and large-scale planting and harvesting – U.S. researchers are looking to develop genetically modified poplar varieties that have altered lignin composition and content.\(^{107}\)

\(^{107}\) In May 2011, Purdue University began a five-year study to determine the viability of poplar species as an ethanol feedstock and cash crop for Indiana farmers. (http://www.purdue.edu/newsroom/research/2011/111020MeilanPoplar.html).
11 ENVIRONMENTAL APPLICATIONS

11.1 Remediation

The use of poplar and willow trees in environmental remediation applications continues to be studied and explored in Canada. By planting vegetation such as poplar and willow on site, pollutant concentrations from contaminated sources can be removed and this process is referred to as phytoremediation. Although phytoremediation has been successfully tested in many locations, full-scale applications are still limited in Canada.

11.1.1 Selected Current Projects

One area of application has been the remediation of abandoned contaminated mine sites. In eastern Ontario, the Provincial Ministry of the Environment is using hybrid poplar trees to help remediate the tailings area of the Deloro Mine Site. This tailings area is 13 hectares in size and is contaminated with arsenic, cobalt, copper, nickel, and low-level radioactive materials. The remediation strategy is to cover the existing limestone cap with an engineered cap measuring 1.75 metres, and to plant 20,000 hybrid poplar trees as well as grasses. It is anticipated that these measures will prevent 90 percent of precipitation (surface water) from infiltrating the tailings area.\(^{108}\)

A non-governmental organization in Saskatchewan called HELP International has installed the first forestation landfill caps and landfill forest filters in Canada in the City of Weyburn, as well as in the towns of Halbrite and Stoughton, among others. The project involves planting high water usage trees in urban communities to decontaminate soils and waters before they reach water sources.\(^{109}\)

In Alberta phytoremediation has been used in the reclamation of oil sands mining sites. For example, Syncrude has successfully reclaimed a mining operation site, which initially consisted of a 30 meter deep hole from the top of the oil sands down to the limestone. Twelve years ago Syncrude replaced the over-burdened back to the mine site, contoured the land and put reclamation soil on top, and as part of their standard reclamation process, planted trees including poplar about two years later. The result has been the creation of a wetland complete with naturally forming bulrushes and willows.\(^{110}\)

Two phytoremediation projects by Passive Remediation Systems (PRSI) in British Columbia have focused on using poplar trees in the remediation of landfill sites. In Armstrong, a poplar plantation now in its seventh growth season, remedies on well over one acre effluent/leachate

every year from the North Okanagan Regional District landfill operation. The plantation is utilizing five different clones: D-TAC7, D-TAC8, TXD 52-229, TXD 53-242 and NM 6. The best varieties of the five have emerged. D-TAC7 (from older stocks), is the top performer, but has the highest incidence of Septoria canker. They seem however to own the best root system as none have blown over in wind storms. They have lesser brittleness causing top and branch breakage. The NM6 clone has also developed a good root system, but are brittle and show the most breakage of any clone on that site. The next best performer was the TXD 53-242 clone. They are somewhat brittle and suffer some blow over but seem to handle stress of the untreated landfill leachate quite well or equally as well as D-TAC7. D-TAC8 lack consistency in their growth patterns. TXD 52-226 performed poorly in height and size. They showed stress and are weak. In Salmon Arm, 1100 hybrid poplar trees were planted in 2011 at the Columbia Shuswap Regional District decommissioned landfill. This phytoremediation system has treated around 1.1 million liters of leachate, and the plantation is irrigated with recycled leachate. In addition, there is a methane gas recovery system underneath the cap which provides natural gas heating in hundreds of homes in Salmon Arm.111

11.1.2 Selection of Phytoremediation Service Providers

Nature Works Remediation Corporation with offices in British Columbia and Ontario specializes in the treatment of contaminated wastewater through bioremediation technologies112.

RPM Ecosystems Canada based in Toronto offers RPM trees, which are trees grown under a process that nurtures individual plants to optimize root growth. Because of their extensive root systems, the RPM trees are able to survive in the poorest soil conditions, making them ideal for remediation projects113.

LandSaga Biogeographical Inc. based in Ontario, offers remediation services of contaminated soils and groundwater for landfill and industrial site management114.

Waterloo Environmental Biotechnology Inc. in Ontario offers phytoremediation services of soils impacted by organic contaminants, salt and metals. Their remediation systems are based on multiple complementary techniques and target petroleum and salt impacted soils115.

Pollutech Group of Companies also out of Ontario, offers phytoecology assessments of polluted sites, and as part of their approach they investigate the potential role of plants in the remediation of these contaminated sites116.

Passive Remediation Systems based in British Columbia, is applying phytoremediation technology to landfill leachate by way of irrigating hybrid poplar orchards in the landfill buffer zones. It also offers remediation of old mine sites and stream side remediation.

111 www.prsi.ca.
112 www.nature-works.net.
113 www.rpmecosystems.ca/phytoremediation-and-phytostab.
115 www.waterlooenvironmentalbiotechnology.com/services.html.
11.1.3 Selected Research Projects:

In Québec, Bergeron, Lacombe, Bradley, et al. (citation 23) examined the effects of tree-based intercropping systems using hybrid poplars to capture nutrients in alley crops thereby reducing soil nutrient leaching. Two study sites were used, one in Saint-Rémi, Québec where three hybrid poplar clones (P. trichocarpa x P. deltoides TD-3230, P. nigra x P. maximowiczii NM-3729, P. deltoides x P. nigra DN-3308) along with black walnut and white ash trees were studied. The second site was located in Saint-Édourd-de-Maskinongé, Québec where two hybrid poplar clones (P. deltoides x nigra DN3333, P. deltoides x P. nigra DN3579) alternating with red oak, red ash, and white ash were studied.

Guidi and Labrecque (citation 97) studied the effects of varying water supply levels on 1-year-old potted willow and poplar plants in order to assess, among other things, their performance in removing N and P from contaminated wastewater. The research was done at the Montreal Botanical Gardens, and P. maximowiczii x P. nigra (clone NM5) and S. viminalis (clone SQV 5027) were used.

A trial test by Teodorescu, Guidi, and Labrecque (citation 286) experimented with a new planting technique for willows being used to remedy environmental problems. The experiment was conducted on former agricultural land owned by the Municipality of Boisbriand, Québec, and the three willow clones were: Salix miyabeana clone SX64, and clone SX67, and Salix viminalis clone Sv 5027.

In Hendon, Saskatchewan, Gunderson, Knight, and Van Rees (citation 100) conducted an experiment which studied the relationship between hybrid poplar (P. deltoides X P. xpetrowskyana C.V. Griffin) fine root production, and soil nutrients across a hydrocarbon-contaminated site.

In Saskatchewan, afforestation projects on former agricultural lands are being advanced. Hybrid poplar plantations offer remedies to environmental problems on these lands as well as the potential to provide timber for the forest industry. In support of such projects, Pinno and Bélanger (citation 222) examined the response of hybrid poplar plantations to competition from weeds. The study took place in central Saskatchewan near the cities of Saskatoon and Prince Albert, and used three different, genetically related clones: Assiniboine, Hill, and Walker.

11.2 Riparian Areas

11.2.1 Riparian Buffer Areas

Hybrid poplars are being studied for their ability to protect water sources in riparian habitats. Riparian areas are the buffer zones between soil and water sources, and play a vital role in healthy landscape ecology. The trees and shrubs provide soil stability, and keep potential pollutants from entering water sources. Riparian buffer areas offer a microclimatic zone where shade and lower temperatures attract diverse wildlife, and help keep healthy algae levels in the water, things which are important to maintaining water quality levels and providing fish habitats. Hybrid poplars are uniquely qualified for the creation, restoration, and enhancement of riparian buffer zones. Hybrid poplars are quick growing, offer rapid biomass accumulations of
nutrients from the soil, have been shown to be able to break down certain pesticides and denitrify nitrogen, and can quickly stabilize soil. When used in buffer strips poplar roots, stems and leaves are effective nutrient sinks. They are also a flood tolerant species, and are able to efficiently absorb water from the soil, offering further defences in maintaining water source nutrient levels. These characteristics of hybrid poplars qualifies them to be preferred in riparian areas adjacent to agricultural lands in order to both improve these environments and also to provide biomass for energy production as an additional revenue crop. Riparian buffer zones keep non-source pollutants specific to agricultural lands, such as pesticides, fertilizer, and manure, from travelling out of the soil and into the aquatic environment. Poplars offer the additional possibility of being used as a source of biomass for energy production because they can be harvested after 5-10 years compared to 15-20 years for lumber. This can be a mitigating factor in the potential prohibitive costs of creating riparian zones on agricultural lands. In addition these buffers have the potential to offer both water quality and carbon sequestration objectives to the agricultural industry in general.

11.2.2 Current Projects and Selected Research

In the Eastern Townships of southern Québec, a riparian hybrid poplar buffer system model, which was implemented in 2003, continues to be studied and assessed. Fortier, Gagnon, Truax and Lambert (citation 84) compared the C and nutrient sequestration by five unrelated hybrid poplar clones growing in the riparian zones of four agroecosystems with free-growing (unmanaged) herbaceous buffer strips. The four buffer sites were located in Magog, Bromptonville, St-Isidore-de-Clifton, and Roxton Falls, and in the year of study, the buffers had accumulated 6 years of growth. The five hybrid clones used in the study were: *P. trichocarpa* Torr. & Gray x *P. deltoides* cv. Boelare (*P. xgenerosa*, TxD, 3230), *P. deltoides* Bartr. ex Marsh. x *P. nigra* L. (*P. xcanadensis* Moench, DxD, 3570), *P. xcanadensis* x *P. maximowiczii* (DNxM, 915508), *P. nigra* L. x *P. maximowiczii* A. Henry (NM6, NxM, 3729) and *P. maximowiczii* x *P. balsamifera* L. (MxB, 915311). The same scholars (citation 85) also measured understory plant biomass and species richness, along with canopy openness in the hybrid poplar riparian buffer strips of two unrelated clones: [*P. deltoides* x *P. nigra* (DxD-3570)] and [*P. maximowiczii* x *P. balsamifera* (MxB-915311)].

Duchemin and Hogue (citation 71), also in Québec, evaluated both the initial efficacy of grass/tree filter strips in terms of enhancing runoff and drainage water from grain corn plots fertilized with liquid swine manure. They also investigated the use of vegetative filter strips as a mitigation measure for agricultural non-point source pollution. This experiment was located in Saint-Lambert-de-Lauzon on the IRDA’s (Institut de Recherche et de Developpement en Agroenvironnement Inc.) experimental farm, and used the hybrid poplar tree (Clone 3230 *P. trichocarpa* x *P. deltoides* cultivar ‘Boelare’) along with a variety of grasses.
The Canadian Forest Service\textsuperscript{117} has an ongoing project investigating the key barriers to large-scale use of short-rotation plantations and agro-forestry energy systems. In one aspect of their analysis of these barriers, they looked at studies of willow or poplar based riparian buffer systems which provide not only protection to water sources but also a source of biomass feedstock.

Concerned about fish habitat, the Cottonwood Project, run by Trout Unlimited Canada\textsuperscript{118} seeks to protect and enhance existing riparian areas along the Bow River in Alberta to ensure fish habitats are not destroyed. As part of the enhancement project, Cottonwood trees were wrapped with wire mesh to protect them from overgrazing by beavers, which can cause soil instability and lead to erosion. In addition the Cottonwood Project workers removed weeds along with any unwanted debris.

### 11.3 Shelterbelts\textsuperscript{119}

Shelterbelts at the edge of pastures, near feedlots, and near dairy, hog and poultry facilities provide a variety of significant benefits to the farming industry and in the area of environmental protection while at the same time representing important eco systems habitats for many species. When planted as shelterbelts, trees can reduce wind velocity, greatly diminishing the effect of cold temperatures on livestock. This can significantly lower stress on animals and, consequently, reduce feed energy requirements. The benefits to livestock producers and ranchers include better animal health, lower feed costs, and greater financial gain. During the summer months, trees can reduce livestock stress by providing cool shade and protection from hot winds. The benefits to the landowner will last throughout the life of the shelterbelt. [...] Crop yield increases in fields adjacent to shelterbelts have been reported in many studies. These increases occur because of reduced wind erosion of topsoil and wind damage to crops, improved microclimates and better snow (moisture) retention. [...] Trees filter dust from tillage operations or roads, and buffer traffic or machinery noise. Shelterbelts also provide essential habitat for wildlife. Many species of birds and animals will benefit from the added protection trees provide. By planting a variety of tree and fruit-bearing shrubs, a diversity of wildlife will be attracted to the farm or ranch.

By far the most important and prominent shelterbelt program in Canada is the AAFC-AESB\textsuperscript{120} Prairie Shelterbelt Program that is administered out of the Agroforestry Development Centre at Indian Head, Saskatchewan. The program has been on-going since 1901. The AAFC-PFRA Prairie Shelterbelt Program produces trees and shrubs that are provided at no cost for agroforestry plantings on agricultural land in Alberta, Saskatchewan, Manitoba and in the Peace River region.

\textsuperscript{117} http://cfs.nrcan.gc.ca/projects/134/2.
\textsuperscript{119} This section is excerpted with edits and additions from the Agri-Environment Services Branch (AESB) Agroforestry Development Centre on-line documentations http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1186517615847&lang=eng.
\textsuperscript{120} http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1286907236630&lang=eng.
of British Columbia. While a great variety of tree and shrub species is desirable in shelterbelts for environmental reasons, single tree species plantings are easier to establish and to maintain. Hybrid poplar feature prominently among the tree species utilised for shelterbelts in the AAFC-PFRA Prairie Shelterbelt Program. The clone and species recommended and offered by the program for shelterbelt plantations from within the Populus group are: Assiniboine Poplar, Mixed hybrid Poplar, Walker Poplar, and for Salix include: Acute Willow and Silver-leaf Willow.

11.4 Carbon Sequestration

Climate change is having, and will continue to have, a profound impact on forest ecosystems. As a result, governments are starting to recognize that climate strategies must address the role of globally significant forest assets. Internationally, strategies under development include a number of voluntary, and some regulatory, frameworks. Many of them contain carbon trading measures that enable the transfer of offset credits from project developers to entities seeking to offset their emissions. Most of these systems include forests. According to Ecosystem Marketplace, as of 2010, forest carbon transactions now represent more than 40% of the total voluntary over-the-counter carbon market by volume\textsuperscript{121}. The average price for offsets across the primary forest carbon markets\textsuperscript{122} rose from $3.8/tCO\textsubscript{2}e (tons of carbon dioxide equivalent) in 2008, to $4.5/tCO\textsubscript{2}e in 2009, and up to $5.5/tCO\textsubscript{2}e in 2010.\textsuperscript{123} Prices continue to vary widely across both voluntary and regulatory markets, as each market deals with unique supply- and demand-side drivers along with distinct project-level characteristics.

Given Canada’s wealth of forestry resources, forest carbon is becoming an increasingly significant component of climate action. In the absence of a national strategy to deal with climate change, many provinces have made commitments to reduce their greenhouse gas emissions through various initiatives, including reductions through afforestation, avoided deforestation and reforestation projects. To quantify the amount of carbon that can be attributed to forestry-related activities and that would therefore be eligible to receive credits, the use of an approved quantification protocol is required. Both BC and Alberta have introduced forestry-related protocols to facilitate the creation of carbon offset credits. In addition, not-for-profit organizations are starting to recognize the need for high quality forest carbon offsets. For example, Tree Canada has developed its own offset protocol for forestry projects – Tree Canada Afforestation, Reforestation and Urban Tree Planting Projects\textsuperscript{124} – to be able to provide greater assurance to individuals and organizations of the GHG impact of its plantings.

\textsuperscript{122} The primary market refers to original transactions of credits directly from a project; the secondary market refers to all ensuing transactions.
\textsuperscript{123} Supra note 122.
11.4.1 British Columbia

In August 2011, the Government of British Columbia issued the Protocol for the Creation of Forest Carbon Offsets to guide the design, development, quantification and verification of BC forest carbon offsets from a broad range of forest activities on private and public land in the province. Four project types are eligible under the protocol:

1. **Afforestation Projects.** Afforestation means the direct human-induced conversion of land that has not been forest land for at least 20 years prior to project commencement to forest land through planting, seeding and/or restoration. Areas that may be suitable for afforestation projects include marginal productivity land, urban land, or degraded industrial lands such as mine sites.

2. **Reforestation Projects.** The re-establishment of trees on land through planting, seeding of natural seed sources. The project lands must have been forest land in the recent past (i.e. within the last 20 years; otherwise, see the afforestation project definition) or must still be forest land, and must have reduced tree cover as a result of significant natural disturbance or harvesting. There can be no legal requirements to reforest the project lands. If reforestation is part of an overall improved forest management approach, then it should be considered an improved forest management project.

3. **Improved Forest Management Projects.** “Improved Forest Management” means a system of practices for stewardship and use of forest land which reduces GHG emissions and/or increases GHG sinks/carbon pools. Eligible management activities may include one or more of a variety of approaches:
   - increasing long-term carbon storage in forests (e.g. through conservation areas, reduced harvesting);
   - increasing sequestration rates (e.g. through restoration practices); and
   - reducing emissions (e.g., through reducing burning, reducing new road widths).

4. **Conservation/Avoided Deforestation Projects.** Conservation or avoided deforestation means preventing the direct human-induced conversion of forest land to a non-forest land use. Avoided land uses could include, but are not limited to, residential, commercial, industrial, and agricultural uses. Avoided harvesting or conservation of forest lands is not included in this category; it comes under improved forest management projects.

In January 2012, the Pacific Carbon Trust submitted the protocol for formal recognition under the Verified Carbon Standard (VCS). Recognition of the protocol as an approved methodology under the VCS program will increase opportunities for BC forest carbon offset project developers to sell offsets internationally. It is anticipated that the protocol will reach VCS final review and approval by June 2012.

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11.4.2 Alberta

In September 2007, Alberta Environment produced a protocol for afforestation projects\textsuperscript{126} to assist in the process of defining and quantifying the opportunity for generating carbon offsets that arise from the reduction of GHG emissions through carbon sequestration by increasing the carbon stock (planting trees) on traditionally non-forested lands such as cropped or forage land, urban land, agro-forestry operations and possibly industrial lands that have been reclaimed. More detailed protocols from other jurisdiction, e.g. BC, specify land with no forest stand for the last 20 years (see above). However because of the less specific nature of this Alberta quantification protocol it is currently under review. In general the Alberta Offset System rules allowed for projects to claim credit for past action (from 2002 onwards) and there was no deadline for accounting for past offsets as long as they could be verified. However a new go-forward date for crediting was brought into place for January 2012. In addition, Alberta Environment released the \textit{Quantification Protocol for Direct Reductions in Greenhouse Gas Emissions Arising from Changes in Forest Harvesting Practices}\textsuperscript{127} in June 2011. This protocol describes the process for quantifying annual GHG emission reductions/removals arising from a change in forest harvesting practice from full tree harvesting with tree length hauling and chipping in a wood room at the mill to chipping using portable chippers. Emissions reductions are achieved by improving harvest and transportation efficiency as well as reducing the amount of harvest debris disposal when compared to the baseline condition.

11.4.3 Program of Activities

The Program of Activities (PoA) is a modality of project development under the Clean Development Mechanism (CDM) of the United Nations Framework Convention on Climate Change (UNFCCC). Traditionally, the CDM has used a project-by-project process for registering and verifying projects. This approach involves very high transaction costs, a long time to market, and a high risk of non-registration. In order to reduce transaction costs and to expand the CDM’s applicability to smaller project activities, the CDM Executive Board launched the Program of Activities modality. Under this modality, a PoA coordinating entity (which may include a government agency, NGO or business) develops a PoA which defines broad parameters for project activities (referred to as CDM Program Activities or CPAs) which are eligible for inclusion in the PoA. Whereas standalone CDM projects must be approved individually by the CDM Executive Board (CEB), a PoA needs to be registered only once. Following registration, an unlimited and unspecified number of individual CPAs can be included without recourse to the CEB.

In an effort to further expand the BC carbon market and to enable the development and realization of future offsets from a large number of similar small GHG reduction projects, the

\textsuperscript{126} Available online: http://www.assembly.ab.ca/lao/library/egovdocs/2007/alen/164684.pdf. Please note that as of April 2012, this protocol is under revision.

\textsuperscript{127} Available online: http://environment.gov.ab.ca/info/library/8390.pdf.
Pacific Carbon Trust (PCT) has developed a draft guidance document\textsuperscript{128} to support the creation of programmatic offset projects, thereby allowing for and supporting the grouping of small-scale projects. Programmatic offset projects facilitate large-scale reductions by allowing for multiple, small emission reduction and/or removal enhancement activities that are similar in nature to join a program over time. As poplar tree projects are often small scale in nature, and yet have the potential to generate large-scale emission reductions, the development of a guidance document for programmatic offset projects will provide greater opportunities for poplar tree projects to realize offset credits in the future, particularly in the BC market.

The first project of this kind is currently being developed in BC by GHG Accounting Services Ltd.\textsuperscript{129}, a GHG quantification and carbon management service provider, on phytoremediation projects established by Passive Remediation Systems Inc. (PRSI). The projects involve the sequestration of municipal land fill effluent and leachate in hybrid poplar plantations. The current project sites are located within the north Okanagan region, but the program provides the opportunity to expand to similar phytoremediation projects in other regions of BC. During the second phase, the program is expected to expand to certain kind of shelterbelts (Knicks\textsuperscript{130}) with additional environmental and habitat benefits\textsuperscript{131}.

Aerial Photo of Award Winning project with phytoremediation poplar stand set up by Passive Remediation Systems Inc. on top of a land fill\textsuperscript{132}.

\textsuperscript{129} www.GHGAccounting.ca.
\textsuperscript{130} http://schleswig-holstein.nabu.de/naturvorort/knicks/knickpflege/02852.html.
\textsuperscript{131} http://schleswig-holstein.nabu.de/naturvorort/knicks/lebendigerknick/02789.html.
\textsuperscript{132} http://www.prsi.ca/salmon_arm_landfill.html.
12 POPLAR COUNCIL OF CANADA/CONSEIL DU PEUPLIER DU CANADA

12.1 General Information

The Poplar Council of Canada (PCC) was established in 1978 and is an incorporated not-for-profit organization that functions as the National Poplar Commission of Canada. PCC is representing the Canadian perspective nationally and internationally in all matters dealing with growth, production and utilization of poplars and willows. PCC’s work is committed to the wise use, conservation and sustainable management of Canada’s poplar resources. The PCC Secretariat is located in offices of the Canadian Forest Service, Natural Resources Canada in Edmonton, Alberta.

PCC contact information is as follows:

Address: Poplar Council of Canada
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          c/o Canadian Forest Service
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Phone: +1 780 430-3843
Fax: +1 780 435-7356
E-mail: poplar@poplar.ca
Website: www.poplar.ca

12.2 PCC Administration

The work of PCC is governed and carried out by an elected Board of Directors assisted by two part-time staff members, an Executive Assistant and a Technical Director. The Board of Directors and the Executive Council coordinate programs and services. The Board of Directors is made up of the Executive Council; Working Group Chairs; and Directors at Large.

The Executive Council:

<table>
<thead>
<tr>
<th>Chair</th>
<th>Barb Thomas</th>
<th>Genstat Consulting</th>
<th>Edmonton, AB</th>
<th><a href="mailto:chair@poplar.ca">chair@poplar.ca</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Past Chair</td>
<td>John Doornbos</td>
<td>Canadian Forest Service</td>
<td>Edmonton, AB</td>
<td><a href="mailto:pastchair@poplar.ca">pastchair@poplar.ca</a></td>
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<tr>
<td>Vice-Chair West</td>
<td>Cees van Oosten</td>
<td>SilviConsult Woody Crops Technology Inc.</td>
<td>Nanaimo, BC</td>
<td><a href="mailto:silviconsult@telus.net">silviconsult@telus.net</a></td>
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<tr>
<td>Vice-Chair East</td>
<td>Annie Desrochers</td>
<td>Université du Québec en Abitibi-Témiscamingue</td>
<td>Rouyn-Noranda, QC</td>
<td><a href="mailto:annie.desrochers@uqat.ca">annie.desrochers@uqat.ca</a></td>
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<tr>
<td>Secretary-Treasurer</td>
<td>Dan Carson</td>
<td>Kruger Products</td>
<td>New Westminster, BC</td>
<td><a href="mailto:dan.carson@krugerproducts.ca">dan.carson@krugerproducts.ca</a></td>
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<tr>
<td>Executive Assistant</td>
<td>Deb Brenton</td>
<td>Poplar Council of Canada</td>
<td>Edmonton, AB</td>
<td><a href="mailto:poplar@poplar.ca">poplar@poplar.ca</a></td>
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<tr>
<td>Technical Director</td>
<td>Jim Richardson</td>
<td></td>
<td>Ottawa, ON</td>
<td><a href="mailto:jrichardson@on.aibn.com">jrichardson@on.aibn.com</a></td>
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</table>
Working Group Chairs:

<table>
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<tr>
<th>Genetics and Breeding</th>
<th>Bill Schroeder</th>
<th>AESB Shelterbelt Centre</th>
<th>Indian Head, SK</th>
<th><a href="mailto:bill.schroeder@agr.gc.ca">bill.schroeder@agr.gc.ca</a></th>
</tr>
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<tbody>
<tr>
<td>Genetics and Breeding</td>
<td>Pierre Périnet</td>
<td>Direction de la recherche forestière Ministère des Ressources naturelles</td>
<td>Sainte-Foy, QC</td>
<td><a href="mailto:pierre.perinet@mnr.gov.qc.ca">pierre.perinet@mnr.gov.qc.ca</a></td>
</tr>
<tr>
<td>Newsletter Advisory Group</td>
<td>Deb Brenton</td>
<td>Poplar Council of Canada</td>
<td>Edmonton, AB</td>
<td><a href="mailto:poplar@poplar.ca">poplar@poplar.ca</a></td>
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<td>Pesticides &amp; Disease</td>
<td>Cees van Oosten</td>
<td>SilviConsult Woody Crops Technology Inc.</td>
<td>Nanaimo, BC</td>
<td><a href="mailto:silviconsult@telus.net">silviconsult@telus.net</a></td>
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Directors at large:

<table>
<thead>
<tr>
<th>Director at large</th>
<th>Grant Harrison</th>
<th>Pacific Regeneration Technologies</th>
<th>Prince Albert, SK</th>
<th><a href="mailto:grant.harrison@prt.com">grant.harrison@prt.com</a></th>
</tr>
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<tr>
<td>Director at large</td>
<td>Ken van Rees</td>
<td>University of Saskatchewan</td>
<td>Saskatoon, SK</td>
<td><a href="mailto:ken.vanrees@usask.ca">ken.vanrees@usask.ca</a></td>
</tr>
<tr>
<td>Director at large</td>
<td>Jared LeBoldus</td>
<td>North Dakota State University</td>
<td>Fargo, ND, USA</td>
<td><a href="mailto:jared.leboldus@ndsu.edu">jared.leboldus@ndsu.edu</a></td>
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</tbody>
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12.3 PCC Activities

The information and services provided by the PCC cover all aspects of the poplar and willow resource. The PCC undertakes studies and reviews of poplar resources, management and utilization. A newsletter is published twice a year with highlights from coast to coast, special research notes, fact sheets, a clone directory, member profiles, and general interest articles. Special publications, annual meeting proceedings, field tours, and workshops are among the activities arranged by the PCC and its members. Some of the publications are available on its website. The PCC also assist in the process of research on poplar issues through contract administration, lobbying for funding, member contacts, and technological committees to evaluate projects and knowledge gaps. Although not a research agency, the PCC regularly publishes current information from research for its members. The PCC is a full member of the International Poplar Commission (IPC) and participates in their meetings and elected boards of officials. The International Poplar Commission (IPC) is a Statutory Body of the Food and Agriculture Organization (FAO) of the United Nations. Through IPC, PCC has links with poplar and willow scientists throughout the world.
Specific events that the PPC has organized or participated-in included:

**Poplar Council of Canada Genetics Workshop and Annual Business Meeting, Quebec, August 21-23, 2012**

Organized by the Genetics Working Group of the Poplar Council and the Direction de la recherche forestière, Ministère des Ressources naturelles et de la Faune du Québec, this event will include a 1-day workshop meeting in Ste-Foy focused on genetics (followed by the PCC Annual Business Meeting of members) and 2 days of field tours to the Chicoutimi and Rimouski areas.

**Boreal Mixedwoods 2012, "Ecology and Management for Multiple Values" Edmonton, Alberta, June 17-20, 2012.**

Hosted by the Canadian Wood Fibre Centre, the University of Alberta and the Western Boreal Growth and Yield Association, the conference will involve invited keynote speakers, volunteer papers, discussion session, volunteer poster session and an optional 2-day post-conference technical field tour.


A joint event of the Poplar Council of Canada, International Poplar Commission 'Environmental Applications' Working Party (WP6) and the Poplar Council of the United States. The program included technical presentations, discussion and several days of field visits.

**8th Biennial Meeting of Short Rotation Woody Crops Operations Working Group (including Poplar Council Annual Meeting 2010), Sheraton Syracuse University Hotel and Conference Centre, Syracuse, NY, 17-21 October, 2010**

This meeting was hosted by the State University of New York willow biomass group. The theme was 'Short Rotation Woody Crops in a Renewable Energy Future: Challenges and Opportunities'. Poplar Council of Canada held its 2010 annual meeting in conjunction. The meeting included a day and a half of plenary and concurrent technical sessions, and field visits in the Syracuse area, as well as a 2-day post-conference field tour of biomass establishments, and poplar and willow plantations in Northern New York State and eastern Ontario.
Selected examples of national and international conference contributions of PCC members:


13 GLOSSARY

Glossary of frequently used terms

**AAC**
- See - Allowable annual cut

**Agroforestry**
- Agriculture in which there is integrated management of trees or shrubs along with conventional crops or livestock.

**Allowable annual cut**
- Allowable annual cut - The regulated amount of annual harvest.

**Aspen**
- Aspen is the common name for *Populus* species, such as *Populus tremuloides*, *P. grandidentata* and *P. tremula* (not native to North America) in the *Populus* section – formerly Leuce – (Aspens and white poplars). Hybrid aspen thus refers to the artificial interspecific hybrids of *P. tremuloides* and *P. tremula* or *P. davidiana* (Chinese or Korean poplar).

**Clone**
- An individual or group of individuals reproduced asexually from a single organism, and therefore genetically identical to the parent.

**Cutting**
- Unrooted stem or root section originating from a plant and used for vegetative (asexual) propagation. Cuttings are usually dormant when used.

**Hybrid aspen**
- Aspen plant (or group of plants) created by crossing two distinct species of aspen.

**Hybrid poplar**
- Poplar plant (or group of plants) created by crossing two distinct species of poplar (or two individuals within one species with very distinct characteristics).

**Intersectional hybrids**
- Interspecific hybrids created between species from different sections. For instance between the eastern cottonwood (*Populus deltoids*) of the Aigeiros section and the balsam poplar (*Populus balsamifera*) of the Tacamahaca section.

**Interspecific hybrids**
- Hybrids created between different species, e.g. between black cottonwood (*Populus trichocarpa*) and eastern cottonwood (*Populus deltoids*), designated as *Populus trichocarpa* (♀) × *P. deltoids* (♂), or simply TxD or TD; ♀ is the symbol for female and ♂ is the symbol for male.

**Intraspecific breeding or improvement**
- Crosses created between trees from the same species, e.g. between *Populus trichocarpa* trees, designated as *Populus trichocarpa* (♀) × *P. trichocarpa* (♂), or simply T × T or TT.

**Poplar**
- Poplar is the common name for all non-aspen species, such as *P. balsamifera*, *P. trichocarpa* (both native to North America), *P. maximowiczii* and *P. laurifolia* in the Tacamahaca section (Balsam poplars), and *P. deltoids* (native to North America) and *P. nigra* in the Aigeiros section (Cottonwoods and black poplar). Hybrid poplar thus refers to the natural or artificial interspecific and/or intersectional hybrids.

**Populus**
- The genus *Populus*, which includes poplars, aspens and cottonwoods

**Salix**
- The genus *Salix* (willows).

**Set**
- Rooted whip. Also referred to as stecklings in Quebec.

**SRIC**
- Short-rotation-intensive-culture. Poplar crops that are established and managed using an agronomic approach on cleared (usually agricultural) land.

**Steckling**
- A set, or rooted whip used in Québec or rooted aspen cuttings

**TOF**
- Trees outside forests.

**Whip**
- Unrooted stem or shoot originating from a plant and used for vegetative propagation. The size is usually between 1.5 and 2.0 m (5.0-6.5 ft.). A set is a rooted whip.

**Willow**
- Trees in the genus *Salix*, including its many hybrids
14 LITERATURE REVIEW AND REFERENCES

General note: search term results were reviewed and those that did not meet the specified search criteria for this report were eliminated from the final results list.

14.1 2008-2011 Publication Search Methodology

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### Agricola

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<td>Aspen</td>
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### Natural Resources Canada website: forests

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14.2 Summary Listings of all Searches by Author:


228. Pitre, F. E., Lafarguette, F., Boyle, B., Pavy, N., Caron, S., Dallaire, N., et al. (2010). High nitrogen fertilization and stem leaning have overlapping effects on wood formation in poplar but invoke largely distinct molecular pathways. Tree Physiology, 30(10), 1273-1289.


15 Appendix I

Summary stands in ha by species and classifiers ecozone based on the 2006 National Forest Inventory area and volume estimates derived from forest stands where the dominant, or lead species are either poplars or willows:

| Eco Zone         | P. BAL | P. BAL | P. DEL | P. GRA | P. SPP | P. TRE | P. TRI | SALI BEB | SALI NIG | SALI SPP | Total   |
|------------------|--------|--------|--------|--------|--------|--------|--------|---------|----------|----------|---------|---------|
| Atlantic Maritime| 14,393 | 8,570  | 73,402 | 1,119,999 |        |        |        |         |          |          | 1,216,364 |
| Boreal Cordillera| 135,772|        |        |        |        |        |        |         |          |          | 1,712,418 |
| Boreal Plains    | 217,610| 527,442|        |        |        |        |        |         |          |          | 16,109,580|
| Boreal Shield    | 67,411 |        | 96,836 | 12,160,840 | 3,916,926 | 8,280 | 632    |         |          |          | 16,250,926|
| Hudson Plains    |        | 95,145 | 7,629  |        |        |        |        |         |          |          | 102,774 |
| Mixedwood Plains | 11,109 | 291    | 8,378  | 276,746 | 61,412 |        | 470    | 9,496   |          |          | 367,903 |
| Montane Cordillera| 128,719|        | 1,499  | 1,228,438 | 7,298  |        |        |         |          |          | 1,365,954|
| Pacific Maritime | 57,670 |        | 85,424 | 15,004  |        |        |        |         |          |          | 158,098 |
| Prairies         | 699,638|        |        | 1,774,591 |        |        |        |         |          |          | 2,474,229|
| Taiga Cordillera |        | 10,292 |        |        |        |        |        |         |          |          | 10,292  |
| Taiga Plains     | 102,511|        |        | 4,031,030 |        |        |        |         |          |          | 4,133,540|
| Taiga Shield     | 28,118 |        |        | 1,152,018 |        |        |        |         |          |          | 1,180,136|
| Total            | 1,462,950| 527,442| 291    | 113,784 | 12,639,730 | 30,296,079 | 22,302 | 8,280   | 10,884   |          | 45,082,213|

Source: Natural Resources Canada, Canadian Forest Service
### 16 Appendix II

**Summary of the Questionnaires, n=7**

Table 1: Total area of poplars and willows 2011 by main forest categories, forest function and area planted from 2008 to 2011 (area change over the last 4 years).

<table>
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<tr>
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<th>Total Area 2011 (ha)</th>
<th>Total area by forest function in %</th>
<th>Area planted from 2008-2011 (reforestation and afforestation) (ha)</th>
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<td></td>
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<td>Production</td>
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<tr>
<td></td>
<td></td>
<td>Industrial roundwood (%)</td>
<td>Fuelwood biomass (%)</td>
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<tr>
<td>Indigenous</td>
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<tr>
<td>Poplars</td>
<td>1,207,157</td>
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<td>10</td>
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<tr>
<td>Willows</td>
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<td></td>
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<tr>
<td>Mix of P&amp;W</td>
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<td></td>
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</tr>
<tr>
<td>Total</td>
<td>1,207,157</td>
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<tr>
<td>Planted</td>
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<tr>
<td>Willows</td>
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<td></td>
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<td>Grand Total</td>
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Table 2: Mean Annual Increment (MAI), rotation lengths, and wood removals 2011 by forest category, species, cultivar or clone.

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<th>Forest category and species, cultivar or clone</th>
<th>Avg MAI m³/ha/yr</th>
<th>Average rotation length (yrs)</th>
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<td></td>
</tr>
<tr>
<td>Poplars</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. tremuloides + P. balsamifera</td>
<td>2.5</td>
<td>60-80</td>
<td></td>
</tr>
<tr>
<td>P. tremuloides</td>
<td>2.5-3.0</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>P. balsamifera</td>
<td>2.5-3.0</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>P. tremuloides</td>
<td>15</td>
<td>33</td>
<td>80</td>
</tr>
<tr>
<td>Willows</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. myabeana (SX67)</td>
<td>36</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>S. myabeana (SX 64)</td>
<td>36</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Planted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poplars</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hybrid poplar</td>
<td>16</td>
<td>18-20</td>
<td></td>
</tr>
<tr>
<td>P. tremuloides</td>
<td>2.5-3.0</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>P. balsamifera</td>
<td>2.5-3.0</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>TXD 53 242</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D TAC 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. tremuloides</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Willows</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None reported</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3: Main cultivars/clones in use in planted forests.

<table>
<thead>
<tr>
<th>Main cultivars/clones in use</th>
<th>Originates from certified germplasm</th>
<th>Major end-use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Poplars</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) ‘Walker’ hybrid poplar</td>
<td>No</td>
<td>Pulp</td>
</tr>
<tr>
<td>2) ‘Okanese’ Hybrid poplar</td>
<td>No</td>
<td>Pulp</td>
</tr>
<tr>
<td>3) ‘Northwest’ hybrid poplar</td>
<td>No</td>
<td>Pulp</td>
</tr>
<tr>
<td>4) ‘P38P38’ hybrid poplar</td>
<td>No</td>
<td>Pulp</td>
</tr>
<tr>
<td>5) Hybrid aspen (T x Ta)*</td>
<td>No</td>
<td>Pulp</td>
</tr>
<tr>
<td>6) NM-6</td>
<td>No</td>
<td>Pulp</td>
</tr>
<tr>
<td>7) DTAC 7</td>
<td>No</td>
<td>Pulp</td>
</tr>
<tr>
<td>8) TD 52-226</td>
<td>No</td>
<td>Pulp</td>
</tr>
<tr>
<td>9) TD 15-29</td>
<td>No</td>
<td>Pulp</td>
</tr>
<tr>
<td>10) D Tac 7</td>
<td>Yes</td>
<td>Remediation</td>
</tr>
<tr>
<td>11) TXD 53 242</td>
<td>Yes</td>
<td>Remediation</td>
</tr>
<tr>
<td>12) NM6</td>
<td>Yes</td>
<td>Remediation</td>
</tr>
<tr>
<td>13) Walker</td>
<td>Yes</td>
<td>Agro Forestry</td>
</tr>
<tr>
<td>14) Assiniboine</td>
<td>Yes</td>
<td>Agro Forestry</td>
</tr>
<tr>
<td>15) Okanese</td>
<td>Yes</td>
<td>Agro Forestry</td>
</tr>
<tr>
<td>16) Katepwa</td>
<td>Yes</td>
<td>Agro Forestry</td>
</tr>
<tr>
<td>17) CanAm</td>
<td>Yes</td>
<td>Agro Forestry</td>
</tr>
<tr>
<td>18) Populus tremuloides</td>
<td>No</td>
<td>Orientated Strand Board</td>
</tr>
<tr>
<td>19) Populus balsamifera</td>
<td>No</td>
<td>Orientated Strand Board</td>
</tr>
<tr>
<td><strong>Willows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) SX 67 Salix Miyabeana</td>
<td>Yes</td>
<td>Biomass</td>
</tr>
<tr>
<td>2) SX 64 Salix Miyabeana</td>
<td>Yes</td>
<td>Biomass</td>
</tr>
<tr>
<td>3) Owasco/Salix viminalis x S. miyabeana</td>
<td>Yes</td>
<td>Biomass</td>
</tr>
<tr>
<td>4) SX 61 Salix Sachalinensis</td>
<td>Yes</td>
<td>Biomass</td>
</tr>
<tr>
<td>5) Tully Champion/Salix viminalis x S. miyabeana</td>
<td>Yes</td>
<td>Biomass</td>
</tr>
<tr>
<td>6) Otisco/Salix viminalis x S. miyabeana</td>
<td>Yes</td>
<td>Biomass</td>
</tr>
<tr>
<td>7) Fabius /Salix viminalis x S. miyabeana</td>
<td>Yes</td>
<td>Biomass</td>
</tr>
<tr>
<td>8) Fischcreek /Salix purpurea</td>
<td>Yes</td>
<td>Biomass</td>
</tr>
<tr>
<td>9) Sherburne /Salix sachalinensis x S. miyabeana</td>
<td>Yes</td>
<td>Biomass</td>
</tr>
<tr>
<td>10) acutifolia</td>
<td>Yes</td>
<td>Agro Forestry</td>
</tr>
<tr>
<td>11) alba sericea</td>
<td>Yes</td>
<td>Agro Forestry</td>
</tr>
<tr>
<td>12) amygdaloides</td>
<td>Yes</td>
<td>Agro Forestry</td>
</tr>
</tbody>
</table>

*P. tremuloides x P. tremula
Table 4: Tree ownership in 2011.

<table>
<thead>
<tr>
<th>Forest category</th>
<th>Public ownership</th>
<th>Private corporate ownership</th>
<th>Private smallholder ownership</th>
<th>Other ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pro</td>
<td>Prot</td>
<td>Other</td>
<td>Pro</td>
</tr>
<tr>
<td>Indigenous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poplars</td>
<td>90</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planted</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poplars</td>
<td>32.5</td>
<td>.5</td>
<td>.5</td>
<td>32.5</td>
</tr>
<tr>
<td>Willows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agrofor./TOF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poplars</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Table 5: Forest products from poplars and willows.

<table>
<thead>
<tr>
<th>Forest category</th>
<th>Fuelwood chips</th>
<th>Industrial roundwood (logs, pulpw.)</th>
<th>Wood-pulp (mech. or chem.)</th>
<th>Particleboard fibreb. (MDF, hardboard)</th>
<th>Veneer sheets</th>
<th>Plywood</th>
<th>Sawn-timber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indigenous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From poplars</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From willows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From poplars</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From willows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agrofor./TOF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From poplars</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From willows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6: Foreign trade with poplars and willows in 2011.

<table>
<thead>
<tr>
<th>Imports of poplar and willow products 2011</th>
<th>Countries of origin</th>
<th>Estimated share of country of origin in p&amp;w imports of this product (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuelwood, chips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial roundwood (logs, pulpwood)</td>
<td>7,000</td>
<td>USA</td>
</tr>
<tr>
<td>Wood pulp (mech. or chem.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particleboard, fibreboard (hardboard, MDF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veneer sheets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plywood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sawn timber</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exports of poplar and willow products 2011</th>
<th>Destination countries</th>
<th>Estimated share of the destination country in p&amp;w exports of this product (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuelwood, chips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial roundwood (logs, pulpwood)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood pulp (chem. or chem.)</td>
<td>1) United States</td>
<td>1) ~38%</td>
</tr>
<tr>
<td></td>
<td>2) Korea</td>
<td>2) ~22%</td>
</tr>
<tr>
<td></td>
<td>3) China</td>
<td>3) ~22%</td>
</tr>
<tr>
<td>Particleboard, fibreboard (hardboard, MDF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veneer sheets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plywood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sawn timber</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 7: Your opinion is important to us! Please reflect on the prevailing trends until 2020 in the development of poplars and willows in your country!

<table>
<thead>
<tr>
<th></th>
<th>increase</th>
<th>decrease</th>
<th>remain as it is</th>
<th>don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>The conversion of <strong>natural</strong> poplar and willow forests to other land uses will...</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>The area of <strong>planted to</strong> poplar and willow forests will.....</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>The area of poplars and willows for bioenergy plantations will .....</td>
<td>5</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Investments in poplar and willow tree breeding programs will .....</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Government investments in the poplar and willow sector will ...</td>
<td>3</td>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Private investments in the poplar and willow sector will ...</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>The significance of poplars and willows for <strong>productive</strong> purposes will .......</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>The significance of poplars and willows for <strong>environmental</strong> purposes will .......</td>
<td>6</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>The rejection by environmental groups of <strong>planted</strong> poplar and willow forests will .......</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>The acceptance by the general public of poplars and willows being important natural resources will.......</td>
<td>2</td>
<td></td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>