

**Report to the
21st Session of the International Poplar Commission
Portland, Oregon, USA
September 24 – 28, 2000**

**ACTIVITIES RELATED TO
POPLAR AND WILLOW
CULTIVATION AND UTILIZATION
IN CANADA
1996 - 1999**

Prepared by Cees van Oosten
SilviConsult Woody Crops Technology Inc.
March, 2000

PRODUCED WITH THE ASSISTANCE OF
NATURAL RESOURCES CANADA, CANADIAN FOREST SERVICE

© POPLAR COUNCIL OF CANADA 2000

c/o Canadian Forest Service
5320 – 122 Street
Edmonton, Alberta, Canada
T6H 3S5

Telephone: (780) 435-7282
Fax: (780) 435-7356

TABLE OF CONTENTS

	PAGE
<u>INTRODUCTION</u>	4
<u>SUMMARY</u>	5
<u>POLICY AND LEGISLATION</u>	6
- BRITISH COLUMBIA	6
- ALBERTA	7
- OTHER PROVINCES	7
<u>STATISTICAL AND ECONOMIC DATA</u>	8
- FOREST INVENTORIES	8
- PRODUCTION OF AND PROVINCIAL REVENUES FROM ASPEN AND POPLAR	10
<u>TECHNICAL DATA</u>	12
- IDENTIFICATION, REGISTRATION AND CONTROL OF CLONAL VARIETIES	12
- CULTIVATION OF POPLAR	13
- SELECTION AND BREEDING	20
- HARVEST AND UTILIZATION	23
<u>GENERAL INFORMATION</u>	24
- GENETIC ENGINEERING OF POPLAR	24
- POPLAR COUNCIL OF CANADA/CONSEIL DU PEUPLIER DU CANADA	25
APPENDIX I Total <u>Volume</u> of <i>Populus</i> by Stand Type	29
APPENDIX II Total Area of Stands of <i>Populus</i> by Age Class	30
APPENDIX III Total Volume of <i>Populus tremuloides</i> (Trembling Aspen) by Age Class	31
APPENDIX IV Total Volume of <i>Populus balsamifera</i> , <i>P. deltoides</i> , <i>P.</i> <i>trichocarpa</i> & their naturally occurring interspecific hybrids by Age Class	32
APPENDIX V Total Area of Stands of <i>Populus</i> in Relation To Total Hardwoods and Conifers	33
APPENDIX VI Literature and Reference List	34
Personal Contacts	41
APPENDIX VII Poplar and Willow Culture: Meeting the Needs of Society and Environment	43

INTRODUCTION

East of Quebec, natural poplar stands are much less common than in the remaining provinces of Canada and form only a minor source of industrial wood. Inventory data for the provinces of Newfoundland (including Labrador), Nova Scotia, Prince Edward Island, and New Brunswick as well as the Yukon and Northwest Territories have been included in the Appendices (I, II, III, IV); further reference to these provinces and territories will not be made in the report.

More detailed information from the rest of the provinces, excluding Manitoba, has been incorporated in the report. Reporting bases differ from province to province and are reflected in the report (e.g. reporting years are either by calendar or by fiscal years). Manitoba Natural Resources (Forest Resources Management) have not been able to provide requested information.

The report distinguishes between the **aspen** *Populus* species (primarily *Populus tremuloides*; and some *P. grandidentata*) and **non-aspen** *Populus* species (e.g. *P. trichocarpa*, *P. deltoides* and *P. balsamifera*, and their natural interspecific hybrids). *Populus* and poplar are used interchangeably in the report. *Populus tremuloides* thus refers to Trembling Aspen or Aspen and vice versa. Other *Populus* or Poplar means *Populus trichocarpa* (Black Cottonwood), *P. deltoides* (Eastern or Plains Cottonwood) and *P. balsamifera* (Balsam poplar) and vice versa.

There is little mention of work with *Salix* in Canada. Interest in *Salix* is primarily in its potential use as a biofuel. Canadian Research and development work with this species is ongoing in Quebec and a short report on progress is included.

Appendix VI includes a list of relevant Canadian publications by both Canadian and foreign authors as well as foreign publications and papers by Canadian authors. This list was compiled for the period 1996 to 1999 and I do not claim that the list is comprehensive.

The second part of Appendix VI includes a list of personal contacts that provided the information that makes up this report. I appreciate the assistance I received from the many contacts, sometimes on very short notice. In particular I want to thank Jim Richardson, Technical Director and past-chair of the Poplar Council of Canada, who was kind enough to review the draft report and provide valuable input and insight.

SUMMARY

Canada's inventory of *Populus* is estimated at 3.7 billion m³. The vast majority of this resource consists of natural stands of mixed species. Stands classed as "poplar stands" (*Populus* is the main component of these stands) contain 1.6 billion m³ of *Populus*, stands classed as "non-poplar stands" contain the balance, or 2.1 billion m³ of *Populus*.

Aspen makes up 79% of the total inventory. Alberta contains 31.3% of the total *Populus* inventory, followed by Ontario with 18.6% and British Columbia with 15.9%.

The *Populus* resource can be regarded as the "last frontier" for the forest products industry in Canada and has resulted in a new economic base for many rural communities, especially in the prairie regions of Canada.

Canada has a long and proud history of poplar research carried out by university and government organizations, mostly involving work in poplar selection and breeding. A considerable amount of effort involved developing and/or testing hybrids between *Populus deltoides* and *Populus nigra* (and to a lesser degree with *Populus maximowiczii*, *Populus trichocarpa* and *Populus balsamifera*). These research programs have yielded many valuable poplar varieties that have been used across the country.

Researchers and poplar growers still face considerable challenges with the Canadian climate and with some persistent disease problems that require solutions.

More recently work has been going on with *Populus tremuloides* by the Western Boreal Aspen Co-operative in the prairie region of Canada. This species also offers great opportunities for selection of superior genotypes for breeding of high-yielding hybrid varieties. Another important objective for the Co-operative is to develop management techniques that lead to successful plantation management of (hybrid) aspen.

POLICY AND LEGISLATION

In Canada the Provincial Governments have full jurisdiction over forest management and agriculture regulations. Only British Columbia has a tax policy and supporting regulations pertaining specifically to *Populus* and *Salix* management. Alberta is in the process of designing a tax policy for managed private woodlots, which will have a positive impact on management of poplar. Other provinces do not have specific policies pertaining to management of poplar or willow. For readers not familiar with the term **Crown land**: Crown land is owned and managed by the respective Provinces; it is public land.

- BRITISH COLUMBIA

Since 1995 **British Columbia** recognizes “*Populus species and Salix species intensively cultivated in plantations*” as primary agricultural production (Assessment Act – Standards for the Classification of Land as a Farm Regulation). Land (privately owned or leased) growing *Populus* or *Salix* species can be classified as a developing farm when:

“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.”

The regulations cover a variety of products and uses and are aimed at providing tax incentives for legitimate farming operations. The landowner or lessee must submit, with his application, 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 not intensively managed.

Although the regulations are beneficial to poplar planting, some issues are not addressed. For instance, there is currently no mechanism for the Assessment Authority of the Provincial Government to retroactively recover any foregone tax revenue from landowners who failed to meet the intent of the regulations for lands that originally qualified. Another issue is the restriction of the rotation to 12 years. Yield plots in Southwest B.C. show that intensively managed hybrid poplar does not culminate its Mean Annual Increment (MAI in m³/ha/yr) within the 12 year period, especially for plantations grown to produce saw logs or peeler logs. The BC Assessment Authority, in cooperation with the B.C. Ministry of Agriculture, Food and Fisheries, hopes to make improvements to the regulations soon to address these issues. There are indications that the regulations will cover other novel hardwood species in an attempt to broaden the income basis for B.C. farms.

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 the traditional forest industry, which is regulated through the B.C. Ministry of Forests. For instance, use of pesticides that are registered for use on poplar, is now possible without the need for permit application procedures that apply to forest management.

- ALBERTA

There is a major review going on of Alberta's municipal tax policy that may have important implications for woodlot management on private land. At present, woodlots are not considered agriculture. The Woodlot Owners Association in Alberta has been involved in formulating a new tax policy that would qualify privately held managed woodlots as agricultural land for taxation purposes. The qualification of land as an agricultural enterprise depends on the woodlot management plan. This policy would include private woodlots, owned and managed by corporations. There are several forest products corporations in Alberta that have started or are interested in poplar management, but are restricted in the amount of land they can actually own, because they are controlled by non-Canadian owners. The proposed policy intends to include privately held land leased to these corporations, thus creating an incentive for the landowner to bring land under management, while providing the corporations with the means to grow intensively managed poplar crops.

An important feature of the proposed policy is to recognize any tree species as a valid tree crop without restrictions on the rotation length. Hybrids can be planted on private land, but are unacceptable on Crown land. The provincial authorities are concerned with the impact hybrids might have on the natural poplar gene pool. They plan to set up a tree improvement council to develop a risk-assessment model and review the results, after which a policy will be formulated. As is the case in British Columbia, there will be the flexibility of managing the crop without the many regulations and restrictions that apply to traditional forest management on Crown and private lands in Canada.

- OTHER PROVINCES

None of the other provinces have specific policies favouring management of poplar.

In 1995 the Ontario Ministry of Natural Resources closed down its Fast Growing Hardwoods Group (located in Brockville), which ended the co-operative agreement it had with Domtar Papers (Cornwall) to intensively manage hybrid poplar plantations on Domtar private and leased properties in Eastern Ontario. Domtar has now assumed management responsibilities on these plantations. Currently intensively managed poplar plantations are not considered farms, but a forest management activity. Under the Managed Forest Tax Incentive Program private forestland qualifies for a reduced residential tax, but requires a silviculture plan that is approved and audited by the Ontario Ministry of Natural Resources. No pesticide use permits are needed when using a pesticide approved and registered for use on poplar.

Quebec encourages planting of fast growing poplars on farmland and makes various subsidies available to private landowners, but the province does not have a specific policy to support this. Although poplar growers can use the herbicide glyphosate on their private land, the use of it disqualifies them from any government subsidies that are available. This reduces the options for weed control in poplar plantations.

STATISTICAL AND ECONOMIC DATA

- FOREST INVENTORIES

Each province in Canada has full jurisdiction over its forest resources and consequently each province established and maintains its own forest inventory system. The Canadian Council of Forest Ministers (CCFM) has established the National Forestry Database Program (NFDP) to compile a comprehensive national forestry database to which the provinces and territories contribute. The Canadian Forest Service (CFS) is charged with the management and maintenance of the database. There is a yearly update of data with the intent to compile forest inventory data every five years; however, the last compilation took place in 1990 and 1991, with the exception of the Quebec data, which were processed in 1994. For additional information please refer to: <http://nfdp.ccfm.org>.

There are inventory data for poplar, but no data for willow. In most cases willow is considered a shrub species and disregarded or else combined with other hardwoods in a separate category. The origin of the poplar inventory data varies from province to province. Most data originate from the original inventories, some are based on inventory plots and are reported by age class, while other data are based on aerial photo interpretation and cannot be reported by age class. None of the data distinguish between natural and planted poplars; natural stands form the overwhelming majority of the inventory.

Detailed Inventory data can be found in the Appendices to this report. The area data presented in **Table 1** (and Appendix II) pertain to stands in which the genus *Populus* forms the **majority** of these stands (so-called “*poplar stands*”). Consequently the 17.8 million hectares of *Populus* include other species. Appendix V shows that poplar accounts for 33% of the total hardwood area of stands that have the genus *Populus* as the main component. It seems reasonable to assume that the “unspecified broadleaved” category contains all of the species listed in Appendix V, as well as the “other broadleaved” species. The area of the “unspecified broadleaved” species could therefore be re-allocated proportionally to poplar, birch, maple and other broadleaved species. This would bring the total *Populus* area to 22.7 million hectares, or **42%** of the area of all hardwoods when applied to the total national picture - 8.1% of the total productive forestland base in Canada.

Table 1

Total Area of Stands^{*)} of *Populus* by Age Class
Area in **'000' hectares** of stocked, productive land

Thousands of Hectares by Age Class									
Age Class	0-20	21-40	41-60	61-80	81-100	101-120	121+	Other ^{**)}	Total
Total	445	2608	5407	3640	2160	1153	614	1774	17801

Source: Canada's National Forest Inventory (CanF191, V.94)

*) *Populus* is the **main component** of the forest stands included

**) Uneven-Aged and Undetermined Age Classes

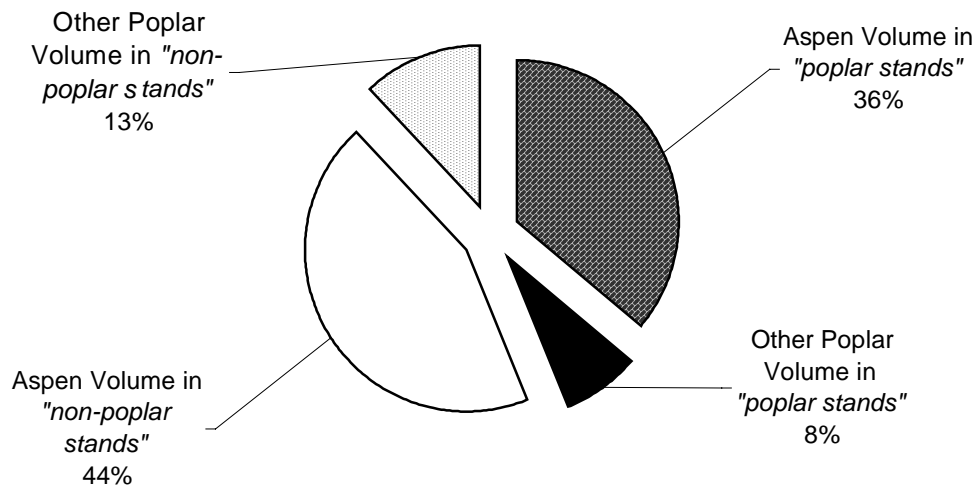
The 17.8 million hectares account for approximately **1.6 billion m³** or 44% of the total *Populus* volume. The balance of **2.1 billion m³** (56%) of *Populus* volume can be found in stands where species **other than *Populus*** form the majority of the stands ("*non-poplar stands*") and brings the total inventory to **3.7 billion m³ of *Populus*** (see also **Figure 1**).

Figure 1.

Distribution of total poplar volume among species and stand types.

Total Volume **3.7 billion m³**

Source: Canada's National Forest Inventory (CanF 191, V.94)



- PRODUCTION OF AND PROVINCIAL REVENUES FROM ASPEN AND POPLAR

Production of Aspen and Poplar

In relation to production, the National Forestry Database (NFDP) only recognizes softwoods and hardwoods, thus production data for aspen and poplar are not available on a national or provincial basis.

Since Manitoba Natural Resources (Forest Resources Management) was unable to produce data in time for this report, only summarized results of the available provincial surveys are reported in **Table 2**. Ontario production volumes are exclusive of chip volumes from private land; these were reported as 241, 272 and 173 m³ ('000') for the three reported years respectively.

Table 2

Production of Aspen and Poplar from Crown and Private Lands in '000' m³

Year	1996	1996-1997	1997	1997-1998	1998	1998-1999	1999	1999-00
Quebec		2848		3477		4005		
Ontario ^{*)}	4685		4958		5026			
Saskatchewan ^{**)}		526		542		495		^{***)} 143
Alberta				7512		7836		^{***)} 5052
British Columbia	990		1210		1190		1325	

Source: Personal Communication with provincial resource ministries (February – April, 2000)

^{*)} All Crown wood recorded as roundwood; private land chip volume not included

^{**)} Crown lands only

^{***)} Incomplete data for the year

It should be noted that reported production of aspen and poplar volumes are less than the Annual Allowable Cut (AAC) levels. For Crown land Ontario reported an AAC level for 1999 of 7.7 million m³. The AAC is determined on an area basis for a five-year term and is balanced over this period. The Crown land AAC for 1999 is considerably higher than the annual production levels on Crown and private land reported for the period 1996 to 1998. In Alberta aspen and poplar make up 81.3% and 15.1% of the deciduous inventory respectively. In 1995 the net AAC for deciduous species in Alberta was 9.3 million m³. Based on the aspen and poplar proportion of the inventory, the AAC for these species on Crown land is estimated to be around 8.9 million m³, which is in excess of the combined Crown and Private production level of 7.8 million m³ in 1998-1999.

Provincial Revenues from Aspen and Poplar

Provincial revenues from the sale of aspen and poplar are modest (**Table 3**). All reporting Provinces charge a stumpage fee (and various other minor charges) on wood produced from Crown lands; Quebec also charges a fee on wood produced from Private lands ⁽¹⁾.

- **Quebec** average charges from 1996 to 1999 for aspen and poplar from Crown lands have been \$ 1.26 per m³ and \$ 6.22 per m³ from Private land ⁽¹⁾. For 1999-2000 the stumpage charges increased to \$ 5.98 and \$ 7.00 per m³ for Crown and Private land respectively ⁽¹⁾.
- **Ontario** average charges for 1996 and 1997 for aspen and poplar from Crown lands were \$ 4.15 and \$ 4.69 per m³ respectively. For 1998 the charges increased to \$ 6.97 per m³. These charges include a “Renewal” portion, which is directed to the Forest Renewal Trust Fund and the Forestry Futures Trust Fund (funds that can only be used for forest renewal and improvement purposes).
- **Saskatchewan** average stumpage charges from 1996 to 1999 for aspen and poplar from Crown lands were \$ 0.72 per m³.
- **Alberta** average charges during the period 1996-1999 for aspen and poplar from Crown lands are estimated at \$ 1.43 per m³.
- **British Columbia** average charges for aspen and poplar from its Crown lands have averaged \$ 0.71 per m³ over the four-year period.

Table 3

Provincial Revenue from Aspen and Poplar from Crown and Private Lands in \$ ('000')

Year	'96	'96-97	'97	'97-98	'98	'98-99	'99
Quebec ^{*) (1)}		\$ 9,000		\$ 10,888		\$ 14,671	
Ontario		\$ 18,250		\$ 19,540		\$ 32,306	
Saskatchewan		\$ 178		\$ 502		\$ 451	
Alberta	\$ 3,857		\$ 2,933		\$ 7,638		\$ 12,408
British Columbia ^{**)}	\$ 749		\$ 952		\$ 742		\$ 912

Source: Personal Communication with provincial resource ministries (February – April, 2000)

^{*)} Quebec is the only province charging fees on Private Lands

^{**)} British Columbia revenue is pro-rated for aspen and poplar

⁽¹⁾ **Revision 27 July 2001:**
The figures for Quebec as stated are incorrect. They represent the average value per m³ of standing wood. Quebec does not charge a stumpage on private wood, but does on public wood.

TECHNICAL DATA

- IDENTIFICATION, REGISTRATION AND CONTROL OF CLONAL VARIETIES

There are no regulations in Canada for the identification and registration of poplar (and willow) clonal varieties. Several years ago the Poplar Council of Canada attempted to introduce a voluntary Certification Service under which commercial nurseries could register certified clonal varieties. Certification would cover clonal identity, quality, type and sanitary condition of the stock. Nurseries would be charged a certification fee by the Certification Service and would be able to recover their costs through a slight increase in stock prices. When potential nurseries were contacted, there was a general lack of enthusiasm in having to pay for this service and the proposal was subsequently abandoned. In British Columbia, for example, most sales of planting stock of any consequence were to corporate clients, who generally were well informed about the clonal varieties and were unprepared to absorb higher stock prices.

The Forest Practices Code of British Columbia requires that all seed and vegetative material be registered with the Ministry of Forests. These rules apply to reforestation of Crown lands only. The producer must maintain records of individual varieties at the nursery. Individual varieties do not need to be registered, but should be deployed in accordance with Ministry recommendations to ensure their stability. Hybrid poplars are exempt from the genetic diversity standards and may be deployed as clonal mixes or clonal blocks. The Ministry does maintain a list of some of the acceptable poplar clones for outplanting on Crown lands.

There is one federal and one provincial government organization in Canada involved in disseminating useful information on poplar varieties and poplar management:

- A federal tree nursery located at Indian Head in Saskatchewan, the Shelterbelt Centre of the Prairie Farm Rehabilitation Administration (PFRA) of Agriculture and Agri-Food Canada, promotes “*economic security, rural development and agricultural sustainability by producing hardy trees and shrubs for prairie farmers and other eligible clients*”. The Shelterbelt Centre is involved in tree improvement (including poplar), planting technology, weed control, pest control and agro-forestry. The Centre provides poplar trees (as well as other tree and shrub seedlings) and technical services free of charge to eligible clients in Alberta, Manitoba, Saskatchewan and the Peace River area in British Columbia. An eligible client must be a “*bona fide farmer owning at least 40 acres (16 ha) of land*”.

Forest companies interested in growing and managing poplar, do not meet the eligibility criteria for clients, but they will have access to material resulting from expanded selection and breeding efforts undertaken at the Centre. For more information, please refer to: <http://www.agr.ca/pfra/pfintroe.htm>.

- Provincial nurseries in Quebec have increased production of poplar in response to an increased customer demand (see **Table 4**). There is also one private nursery, owned by Norampac (Cabano, Quebec), growing stock for its own use.

Table 4.

Poplar Stock Production in Quebec

Year	1997	1998	1999	2000	2001
Nurseries					
Provincial	19200	76200	229500	177700	535000
Private (Norampac)	15000	50000	50000	50000	n/a
Total	34200	126200	279500	227700	535000

Source: Pierre Périnet – Ministère des Ressources naturelles, Québec

The “Ministère des Ressources naturelles” (MRN), in cooperation with other Quebec-based institutions, has plans to compile and report the results of previous research and trial activities in poplar culture to develop the basis for technology transfer. There is a need to ensure a successful transition from increased availability of poplar stock to successful poplar establishment and management. The MRN has been active in poplar selection and breeding for years and appears in a good position to successfully deliver this needed technology transfer.

- CULTIVATION OF POPLAR

Planting Stock Types

Poplar stock is produced in several different types, which are mostly a function of ease of propagation, desired end product and cost.

- Unrooted dormant cuttings are produced in a stoolbed and are cut from one-year-old material, varying in length from 15 cm to a maximum of about 1.00 m long. The density of the stools in the beds depends to a large degree on the product required by the customer, but is typically 0.3 x 0.3 m, or slightly less than 0.1 m² per stool.
- Unrooted dormant sets or whips are also produced in a stoolbed and are cut from one- or two-year-old dormant material. One-year-old material has superior root development. They vary in length from 1.50 m to as much as 5.00 or 6.00 m in some cases.

- Bareroot dormant plants are usually produced from unrooted dormant cuttings and sets or whips that are out-planted in a nursery to grow a viable root system. If the root systems are very large, they are trimmed down to a manageable size at the nursery.

Competition from weeds is a serious threat. In the nursery preparation phase grasses and broadleaved weeds can be effectively controlled with a mix of glyphosate and 2,4-Dimethylamine. Glyphosate may have to be applied several times when dealing with perennial grasses, to prevent spread through rhizomes. After planting of the stock in the nursery bed, a pre-emergent or pre-bud-break herbicide application is advisable. There are not many herbicides available in Canada. Dichlobenil (Casoron) is registered for use on poplar and has been used successfully in British Columbia when applied immediately following planting in the nursery bed. Agriculture and Agri-Food Canada is currently reviewing an application for the registration of oxyfluorfen (Goal). This has proven a very valuable tool in weed control in nurseries and trial sites.

- Container plants are produced from seed, small single-bud hardwood or greenwood cuttings and root cuttings (aspens). These plants are usually dormant at time of planting, but can also be “hot planted” during the growing season.

For the hard-to-propagate species of aspen (*P. tremuloides* and its hybrids), dormant root cuttings are placed in containers in a greenhouse. The aim is to produce fully rooted plants with soil for out-planting in the field. The container crop is initiated in the late winter under greenhouse conditions and grows during the spring and summer into large plants with well-developed root systems. The last part of the growing cycle takes place outdoors. At the end of the season, in the following winter, the dormant seedlings are extracted from the containers, packaged and stored in a cooler or freezer pending out-planting the following spring.

Single-bud greenwood cuttings are collected from actively growing young, succulent green shoots and planted (with leaves) into a container. Usually rooting of greenwood cuttings is promoted by using rooting hormones and mist beds. This method is expensive and labour intensive, but can be used to obtain substantial numbers of plants from a single mother plant. There is potential to quickly multiply a single plant, during the growing season, into thousands of identical plants for experimental purposes, or to produce a lot of new material for out-planting in a new nursery bed.

Plantations

- Plantation Activity with Hybrid Poplars (Intensively Managed Plantations)

In Canada the total area of intensively managed poplar plantations pales in comparison to the natural aspen stands (primarily *Populus tremuloides*). An estimate of the total planted area of intensively managed hybrid poplar, established by several corporations and one provincial government organization, is provided in **Table 5**. The information provided in **Table 5** is not available by age class and does not include smaller private growers.

Table 5

Approximate Area of Hybrid Poplar Plantations in Canada

	Approximate Area - ha	Age Range (Years)	Comments
Domtar Inc. - Quebec	140	1 to 3	Trial Plantations
Louisiana-Pacific Canada Ltd. (Panneaux Chambord) - Quebec	158	1 to 3	Trial Plantations
Norampac Inc. - Quebec	57	1 to 3	Trial Plantations
Direction de la recherche forestière (MRN). - Quebec	392	1 to 29	Trial Plantations
Domtar Inc. - Ontario	2200	1 to 15	Operational Plantations
University of Toronto (U of T) - Ontario	Not Available	Not Available	Trial Plantations
Alberta Pacific Forest Industries Inc. (Alpac) - Alberta	70	1 to 5	Trial Plantations
Ainsworth Lumber Co. Ltd. -British Columbia	<1	1	Trial Plantation
Pacifica Papers Inc. - British Columbia ^{*)}	1619	2 to 12	Operational Plantations
Scott Paper Ltd. - British Columbia	2300	1 to 42	Operational Plantations
Total	6937	1 to 42	

Source: Personal Communication with companies, Quebec direction de la recherche forestière and University of Toronto (February – April, 2000)

^{*)} Does not include 1983 hectares of poplar plantations in N.W. Washington State.

- **Domtar (Quebec)** is currently analysing the results of the plantation trials before making a decision on future expansion.
-
- **Louisiana-Pacific Canada Ltd. (Quebec - Panneaux Chambord)** started trials in 1996 and planted its first trial plantation with hybrid poplar in 1997. The company aims to plant up to 400,000 poplars by 2001.

- **Norampac (Quebec)** also started in 1996 and planted its first trial plantation in 1997. The plan is to plant 40 hectares in 2000.
- The **direction de la recherche forestière (Quebec)** has established 392 hectares of various trial plantations since 1970. These include poplar collections, conservation plantations, clonal tests, progeny tests, demonstration plantations etc.
- **Domtar (Ontario)** plans to maintain a plantation program of about 100 hectares per year. An ice storm in January 1998 caused severe wood damage and Domtar accelerated its harvesting program to salvage this wood.
- The **University of Toronto**, in cooperation with Domtar Inc., the Ontario Ministry of Natural Resources and the Canadian Forest Service – ENFOR project, also established trial plantations in various parts of **Ontario**, but plantation data could not be accessed in time for this report.
- **Alberta Pacific Forest Industries Inc. (Alpac)** has been establishing trial plantations and plans to expand its hybrid poplar plantation efforts to an operational level of 220 hectares in 2000. The long-range plans are to produce 400,000 m³ of poplar per year.
- **Ainsworth Lumber Co. Ltd. (British Columbia)** established a small clonal trial near Kamloops (BC) and plans to expand this to a seven hectares drip-fertigated (fertilized and irrigated) trial in 2000.
- **Pacifica Papers Inc. (British Columbia, ex-MacMillan Bloedel Ltd paper mills)** started trial plantations in 1988 and formed an operational Poplar Division in 1994. The company suspended expansion of its poplar farms in 1998, but still plans to maintain the plantations. Pacifica also owns and leases approximately 2,000 hectares of poplar plantations in NW Washington State.
- **Scott Paper Ltd. (British Columbia)** has the longest record in Canada of poplar management. The company started a plantation program in the early 1960's and planted Euramerican hybrids at peeler plantation spacing. In the mid 1980's the company became involved in short rotation, intensively managed poplar.

There have been a few interesting innovations in site preparation and cultivation, most notably at Pacifica Papers Inc. This company established its plantations in the usual systematic pattern of tree rows that were 3.0 m apart to facilitate easy cultivation. The company marked the tree rows by a continuous mounding of soil in which dormant unrooted cuttings would later be planted. During the mounding process, in the preceding fall, a concentrated band of fertilizer (usually phosphate based) was deposited at the bottom of the mound. This process had several advantages: it was easy for the planters to know where to plant and planting productivity increased dramatically; the mounds enabled quick root development as a result of warming of the soil in the spring; and the fertilizer provided a lifetime supply of P and a bit of N for a head start.

- Plantation Activity with Aspen and Hybrid Aspen

Since the early 1980's there has been a dramatic increase in demand for aspen fibre in Canada for use in panel board (especially Oriented Strand Board or OSB) and pulp. Concerns about a potential shortage of aspen fibre in the long term have led to several forest products companies founding the Western Boreal Aspen Co-operative (WBAC) in 1994 with the following objectives:

- *“To develop genetically improved trembling aspen and hybrid clones that will yield fast growing, disease resistant trees with good form and fibre qualities”*
- *“To research and develop propagation and silvicultural techniques to establish and grow trembling and hybrid aspen plantations.”*
- *“To successfully transfer aspen management technology to the field”*

Planting of aspen (and balsam poplar) has primarily been aimed at reforesting portions of Crown land that are not sufficiently regenerated several years after harvesting, including rehabilitated roads, skid trails and landings. These plantings are not considered plantations, but merely fill-in of non-regenerated areas in naturally regenerated deciduous stands or sometimes conifer plantations. To date the planted aspen has originated from open-pollinated, wild seed collections.

Any planting of improved or hybrid aspen is on private land and to date only in trial plantations.

The Western Boreal Aspen Co-operative recognized the need to develop silviculture systems for the management of aspen (and other poplar) plantations. A substantial effort has been made to establish test plots to optimize aspen planting stock type and timing of planting for best performance, with some interesting preliminary results. Another major challenge is the development of a regime for effective weed control. Some of the site preparation methods being investigated are based on successful methods used in hybrid poplar management elsewhere. With the explosion of aspen harvesting activity, it has become very important and urgent to develop plantation technology for aspen, not only for intensively managed, short rotation plantations, but also for traditional reforestation purposes. It appears that reliance on natural regeneration alone may not be sufficient and to date results of aspen reforestation have been inconsistent.

Weyerhaeuser Canada Ltd. has planted between 25,000 and 50,000 open-pollinated aspen on test sites located on private land to develop and evaluate silvicultural systems. The company's Aspen Silviculture Program started in 1996 and the first plantings were in 1997. The strategy behind this program is to establish fast growing, short rotation deciduous crops. One 1997 trial, evaluating survival and growth response of out-planted

aspen under various silvicultural treatments, involves a co-operative effort with Daishowa-Marubeni International Ltd. and Millar Western Forest Products Ltd.. A brief report on breeding and selection will follow in the section on Selection and Breeding.

- Plantation Density

Hybrid poplar plantations in Canada have primarily been established to provide fibre for the pulp and paper industry and plantation densities generally reflect this. In most cases plantations have been established and are owned by integrated forest companies. Fibre plantations typically range in density from 1000 to as high as 1600 trees per hectare, with a planned rotation length of 10 to 15 years. Scott Paper is the exception: they established plantations at 770 trees per hectare, with rotation lengths of 15 to approximately 20 years. They are now considering establishing plantations at even lower densities, because of the susceptibility to wind damage in high-density plantations.

Although plantation density data are scarce, the general consensus is that 700 to 800 trees per hectare provide an optimum mix of saw logs, veneer logs and pulpwood, without a significant loss of mean annual increment of merchantable volume.

In Quebec, farmers are encouraged to establish plantations at 3.0 m by 3.0 m plantation spacing (1111 trees per ha), and to prune select stems for the sawmill and veneer industry. Industrial owners, such as OSB plants, reportedly aim more for fibre yield; they do not seem too concerned about tree size.

Scott Paper in New Westminster, B.C. established demonstration plots with plantation densities ranging from 425 to 770 stems per hectare at their nursery site. After 12 years they confirm that lower density plots carry less volume, but have significantly larger diameter trees.

- Yields

Yield data for hybrid poplar are not readily available in North America. Most information is proprietary. A summary of average growth rates in Canada can be found in **Table 6**. These rates are considered conservative and represent anticipated growth for stands on average sites and managed under average conditions. Deployment of the right hybrid varieties on the right sites will result in an increase in average growth rates. Increasing the intensity and improving the quality of crop management will lead to further increases and can be expected to closely match the best growth rates.

Table 6**Current and Anticipated Hybrid Poplar Growth Rates (m³/ha/yr) for various regions of Canada (Best and Average)**

Region or Province	Current growth rate m ³ /ha/yr		Anticipated future growth rate m ³ /ha/yr	
	Best	Average	Best	Average
Southern Quebec	19	9	20	14
Quebec – Boreal Region	-	-	12	10
Southeast Ontario	15	> 12	18	14
Prairie Region & NE B.C.	N/A	12	19	16
B.C. Northern Interior	-	-	20	17
B.C. Southern Interior	30	-	*) 35	*) 25
B.C. Coast	**) 37	23	45	35

Source: Personal Communication with company and government sources Nov 1999 – Apr 2000

*) Author's estimate for the best sites.

**) Actually achieved on Vancouver Island; has not culminated yet.

One source estimates that mean annual increments for hybrid aspen could reach 16 m³/ha/yr. Under comparable climatic conditions, the Finns are reporting an **average** of 12m³/ha/yr for hybrid aspen, which is not based on their best selections. Therefore we can expect mean annual increments for highly selected hybrid aspen to be at least at the 12m³/ha/yr level.

Since highly selected hybrid poplar on the appropriate sites and with the right management will, in all likelihood, always be more productive than hybrid aspen, the anticipated hybrid poplar mean annual increments for the Prairie Provinces are therefore realistic, and may even be slightly conservative at an average of 16m³/ha/yr (**Table 6**).

Shelterbelt Plantings

The Shelterbelt Centre of the Prairie Farm Rehabilitation Administration (PFRA) in Saskatchewan plays an important role for farmers in the Prairie Region in western Canada. The demand for poplar plant material is approximately 300,000 annually. The Centre provided 241,000 poplars and 250,000 willows in 1998 alone. Poplars have been planted in farmstead shelterbelts because of their fast initial growth. They provide wind protection to homes, farm buildings, livestock and soil. The Centre first started to distribute plant material in 1909 and farmers have planted over 20 million poplars since.

There is an increased interest in Canada in hybrid poplar for agroforestry, phytoremediation, woody crops production and riparian restoration. This has led to an increased emphasis on research in poplar at the Centre, which includes determining which landscape areas have potential for the production of short rotation, intensively managed poplar plantations.

- SELECTION AND BREEDING

Challenges and Opportunities

For all southern regions, knowledge about the performance of hybrid poplar is fairly extensive. With the exception of coastal and the southern interior of British Columbia, pressing problems are **lack of cold hardiness and frost tolerance** of the many hybrid varieties tested. This is an area that needs to be addressed through well-designed testing and breeding programs. Genetic engineering, in conjunction with conventional breeding, may offer some solutions in the future through the manipulation of various genes affecting dormancy and leaf abscission. This is some of the work initiated at the University of Washington – Poplar Molecular Genetics Co-operative, in conjunction with Oregon State University, and which could benefit Canada. For more information, refer to <http://poplar2.cfr.washington.edu/toby> and <http://www.fsl.orst.edu/tgerc/index.htm>.

Several years of drought have hampered plantation efforts in some regions in Northern Alberta. Drought tolerance is therefore an important aspect of clonal selection. The Shelterbelt Centre of the PFRA has begun investigations into **drought adaptation** of the best clonal varieties and a PhD project is underway, focusing on water limitation to the growth of the variety “Walker”, a putative hybrid of *Populus deltoides*.

Another serious hurdle is the **disease** *Septoria musiva*. Currently this disease is not an issue in British Columbia and in the boreal region of Quebec, but it restricts the use of potentially very productive hybrid varieties in the eastern Ontario and southern Quebec regions. Its impact or presence in the Prairie region is unknown.

For the Prairie region a serious knowledge gap exists. No selection or breeding has taken place for the purpose of establishing plantations of hybrid poplar in this area and the only selections used to date are based on their performances as shelterbelt trees (see PFRA). The Shelterbelt Centre of the PFRA has embarked on a breeding program to fill this gap.

For hybridization purposes, *Populus balsamifera* and *P. trichocarpa* from the Fort Nelson region (N.E. British Columbia) may offer opportunity for selection and breeding. These sources are considered superior to the *P. balsamifera* anywhere else in the Prairie region, although no breeding has ever been done with them. There is extensive natural hybridization between *P. trichocarpa* and *P. balsamifera* in this area.

Breeding Programs

The **Ministère des Ressources naturelles du Québec** - direction de la recherche forestière (MRN) - has had a breeding program in place since 1971 that created more than 1000 families. The program tested more than 3,700 clonal varieties in 100 clonal tests and also evaluated, besides its own material, crosses obtained from abroad. The list of recommended material includes more than 60 clonal varieties for the various ecological areas of Quebec. In 1995 and 1998 breeders succeeded in making field crosses with *Populus deltoides* females and created 13 families (of *Populus deltoides* x *P. nigra*, *P. deltoides* x *P. maximowiczii* and x *P. trichocarpa*) and more than 50 families of *P. deltoides* x *P. deltoides* respectively. There was no breeding in 1999, but there are plans for breeding in 2000 or 2001.

Clonal varieties from the **University of Toronto** selection and breeding program, which was discontinued several years ago, continue to be of interest and are being tested by several forest companies in Alberta. Experimental crosses were carried out in 1978 to evaluate crossing relationships between the Aigeiros (*Populus deltoides*, *P. nigra*) and Tacamahaca (*P. balsamifera* and *P. maximowiczii*) Sections. There are crossing incompatibilities, hindering the creation of some interspecific crosses. The information will be of value to organizations starting a breeding program.

The **Shelterbelt Centre** of the PFRA is actively involved in the selection of drought tolerant and cold hardy clonal varieties that show good pest resistance and have acceptable wood quality. To date four clones have been released for use in the Prairie region. Over 200 different clonal varieties are under test in Saskatchewan. The Centre plans to carry out controlled crosses in 2000.

Several companies in **Alberta** are formulating strategic plans involving poplar genetic improvement. These companies are also testing existing clonal varieties originating from the University of Toronto, the Ministère des Ressources naturelles du Québec and the Shelterbelt Centre of the PFRA. Alberta Pacific Forest Industries Inc. (Alpac) is also testing material from the University of Washington – Poplar Molecular Genetics Co-operative, of which it is a full member.

In British Columbia, **Pacifica Papers Inc.** has numerous clonal tests in place that have been evaluated over the period 1988 to 1997. These tests include material from the Poplar Molecular Genetics Co-operative. In 1996 Pacifica undertook a pilot breeding program, creating 27 families of interspecific, intraspecific, backcrosses and several F2 crosses, for a total of 2724 clonal varieties. Of these, 35 were selected for further testing and were recovered from the nursery site when Pacifica suspended further poplar technology development. The 35 clonal varieties are now being held, grown and maintained by Washington State University in Puyallup.

Scott Paper Limited continues to test and select hybrid poplar from the University of Washington – Poplar Molecular Genetics Co-operative - breeding program (Scott Paper is also a member).

In the Prairie region, one of the Western Boreal Aspen Co-operative's (WBAC) objectives is to “develop genetically improved trembling aspen and hybrid clones.” Exploratory breeding work started in 1998, but encountered unexpected technical and biological problems, which were resolved in 1999. WBAC initiated a new round of breeding in the spring of 2000 to test breeding protocols. Besides breeding at the Weyerhaeuser Tree Improvement Centre (located in the Drayton Valley, Alberta – Weyerhaeuser is a WBAC member), the co-operative also invited several other greenhouse operations to join in developing breeding protocols. Early results are very encouraging and the co-operative looks set to produce its first controlled crosses in 2000.

Protection

For the 1996-1999 period, there is only one significant development in the disease field to report. During 1991 a new rust species (*Melampsora medusae*) appeared on the scene in the Pacific North West of the US. It quickly spread to South Western British Columbia. Poplar plantation managers were able to select for clonal resistance to this rust. In 1996 a putative hybrid rust, *Melampsora x columbiana* (thought to be a cross between *M. occidentalis*, which is native to the area, and *M. medusae*), developed, which seriously affected clonal poplar varieties that were resistant to the *M. medusae*. This hybrid rust produces new strains that have been identified and described by researchers from Washington State University. It is noteworthy that these strains seem to vary in presence from region to region in the PNW. The strategy is to eventually select new clonal varieties that do not rely on single-gene, but on multi-gene (partial) resistance and to create new varieties in crosses with *P. maximowiczii*, which is resistant.

Willow

The Montreal Botanical Garden - Institut de recherche en biologie végétale – has been active in research of willow (*Salix*) species in short rotation coppice management. Most of this work involved developing cultural techniques to increase yields, while trying to keep costs low. In 1995 the Institute established a 10 hectares willow plantation south of Montreal, an initiative that is supported by the Canadian Forest Service – ENFOR project, Hydro Québec and various provincial organizations. The objective is to test and grow willow at various levels of management intensity; this includes use of organic fertilizers (biosolids) to improve yield. The researchers hope to determine the impact on yield on sites with various degrees of drainage. They also want to verify what effect repeated coppicing cycles (2, 3 and 4 years) have on yield. The Institute has entered into a co-operative relationship with the State University of New York (SUNY), which also carries out an active willow research project.

A similar project at the University of Toronto was halted several years ago when project funding ran out.

- HARVEST AND UTILIZATION

Harvest

There are no significant developments in harvest technology to report in Canada for the period 1996-1999.

Pulp and Paper

The value of aspen in pulp and paper manufacturing is well recognized in North America. Great potential exists to improve the utilization of hybrid aspen and hybrid poplar for the manufacture of specialty grades of mechanical pulps and of higher value paper grades for the magazine and advertising market. The high inherent brightness of both aspen and hybrid poplar make these species very suitable for this use.

Composite and Engineered Wood

New opportunities in utilizing the vast aspen resources in Canada have led to a significant increase in the capacity to produce Oriented Strand Board (OSB). OSB has largely replaced plywood as a building product used in sheathing in North American construction. Over the last several years there has been a consolidation of the OSB manufacturing base and many small and independent producers have been bought out or have merged with large forest products companies. Aspen is also used for the manufacture of parallel strand lumber for the door and window frame market.

Several companies have tested hybrid poplar for possible use in OSB and other engineered wood products. The results were very good, but because of the proprietary nature of the test results, no details can be released. Another good use for aspen and poplar is in the manufacture of plywood. Hybrid poplar is an excellent base stock for sheets covered with expensive veneers.

Solid Wood

Still largely overlooked in Canada is the potential for the establishment of intensively managed hybrid poplar and aspen plantations for the production of valuable saw or veneer logs. Most poplar saw logs end up in the manufacture of low-value products (e.g. pallets, packaging), but higher end use is definitely a possibility.

During 1997-1998 Forest Renewal British Columbia (FRBC), a Crown Corporation of British Columbia, awarded funding for a research project on

“Solid Wood Product Opportunities from Short Rotation Hybrid Poplar Trees”.

Researchers at the B.C. Ministry of Forests – Kalamalka Forestry Centre initiated this project and contracted the Western Division of Forintek Canada Corporation in Vancouver to analyze the wood properties for solid wood opportunities. The project used nine-year-old hybrid poplars (*Populus trichocarpa* x *P. deltoides*) with an average DBH of 25 cm and average height of 20 m for the analysis. A local sawmill cut the wood into boards. Forintek took delivery of samples for kiln-drying and wood property testing. The remaining wood was used to manufacture various products, ranging from tongue & groove wall paneling, window and wall mouldings, to furniture and decorative boxes.

One interesting fact was that the hybrid poplar “far exceeded the performance of black cottonwood (*P. trichocarpa*) in all the machining tests.” The conclusions were that hybrid poplar could be used successfully for a variety of solid wood products. Lumber recovery seemed low, but the authors state that a longer rotation, resulting in an increased diameter for these trees, would result in an increase in lumber recovery to 60-70%. Hybrid poplar machined moderately well and its strength was about average compared to other wood species. The wood finished well; “it takes paint, stain/lacquer and wax coatings well and had a pleasant appearance.”

GENERAL INFORMATION

- GENETIC ENGINEERING OF POPLAR

There has been considerable interest in the potential for genetic engineering of poplar. In the woody plant world, poplar is one of the best model species available. It is generally easy to propagate through vegetative means and it grows rapidly. It also has a relatively small genome, making it a logical target for researchers. Scientists at laboratories of the Canadian Forest Service, the University of British Columbia, the University of Alberta and Université Laval have been involved in genetic engineering research of poplar.

Several companies in the western provinces have been members of two genetic research co-operatives operating at the University of Washington (Poplar Molecular Genetics Co-operative or PMGC) and Oregon State University (Tree Genetic Engineering Research Co-operative or TGERC).

During 1998 the Poplar Council of Canada conducted a survey for the Canadian Forest Service to gauge support for a similar biotechnology co-operative in Canada and companies did express an interest in the technology.

As was described earlier in this report, Canada has several serious hurdles to overcome. Probably the most serious one is the disease *Septoria musiva* – stem canker - in Eastern Canada. Solving this important and crippling problem could immediately become the most important objective of a co-operative.

Prepared by: Jim Richardson, Technical Director, PCC.

Administration and Operation of the National Poplar Commission

The Poplar Council of Canada (PCC) functions as the National Poplar Commission of Canada. PCC is recognized by the Government of Canada as representing the country nationally and internationally in all matters dealing with growth, production and utilization of poplars and willows.

PCC is an incorporated organization, with individual and corporate members. It was established in 1978. In 1999, the PCC had 50 individual paid-up members and 17 corporate members.

- PCC Administration

PCC is run by an annually elected Executive Committee and Board of Directors. Its day-to-day affairs are managed by a part-time Executive Secretary, based in the Council's Secretariat. In 1995 the Secretariat was housed in offices of the Canadian Forest Service, Natural Resources Canada in Edmonton, Alberta. In 1996, the Secretariat moved to offices of the Canadian Forest Service in Prince Albert, Saskatchewan, and in 1999 moved back to the Canadian Forest Service in Edmonton. Since 1997, PCC has retained the services of Jim Richardson as a part-time Technical Director to the Council, providing technical and scientific support. Jim is based in Ottawa, Ontario.

PCC contact information is as follows:

Address:	Poplar Council of Canada 5320 - 122 nd Street Edmonton, Alberta Canada T6H 3S5
Phone:	+1 780 435-7282
Fax:	+1 780 435-7356
E-mail:	poplar@poplar.ca
Website:	http://www.poplar.ca

The following individuals were elected to the Executive Committee and Board of Directors at the Annual Business Meeting held in August 1999:

Executive Committee

Chair	J. Doornbos	Canadian Forest Service, Edmonton, Alberta
Past Chair	J. Richardson	Ottawa, Ontario
Vice-Chair West	M. Byl	Louisiana-Pacific Canada Ltd., Dawson Creek, B.C.
Vice-Chair East	E. Audy	Papiers Domtar/Domtar Papers, Windsor, Quebec
Secretary-Treasurer	D. Cheyne	Alberta Pacific Forest Industries Ltd, Boyle, Alberta
Executive Secretary	S. Williams (ex officio)	Edmonton, Alberta
Technical Director	J. Richardson (ex officio)	Ottawa, Ontario

Board of Directors

1. *Representatives*

Composition boards & veneers:	M. Angelini	Structural Board Association, Toronto, Ontario
Pulp & paper, chemicals:	B. Kokta	Université du Québec, Trois-Rivières, Québec
Ontario:	P. Nitschke	Ontario Ministry of Natural Resources
Alberta:	T. Szabo	Alberta Environmental Prot., Land & Forest Service
Manitoba:	J. Dojack	Manitoba Forestry Branch
Quebec:	P. Périnet	Ministère des Ressources naturelles du Québec
Saskatchewan:	J. Thompson	Saskatchewan Environmental Resource Management
British Columbia:	M. Byl	Louisiana-Pacific Canada Ltd., Dawson Creek, B.C.
Universities:	B. Dancik	University of Alberta, Edmonton, Alberta

2. *Committees*

Economics	J. Smyth	Canadian Forest Service, Ottawa, Ontario
Genetics	L. Zsuffa	University of Toronto, Toronto, Ontario
Planting & Silviculture	F. Niemi	Daishowa-Marubeni Intl., Peace River, Alberta
Protection	M. Hubbes	University of Toronto, Toronto, Ontario
Management	D. Cheyne	Alberta Pacific Forest Industries Ltd., Boyle, Alberta
Utilization	J. Balatinecz	University of Toronto, Toronto, Ontario
Research	C. van Oosten	SilviConsult Inc., Nanaimo, B.C.
Planting Stock Certif.	L. Zsuffa	University of Toronto, Toronto, Ontario
Nominating	J. Smyth	Canadian Forest Service, Ottawa, Ontario

▪ PCC Activities

The PCC holds annual meetings of its members. These meetings usually take the form of 1-2 days of technical sessions for presentation of papers and several days of field study tours. Efforts are made to hold the meetings in different parts of the country each year in order to maximize participation. When opportunities arise, joint meetings are held with other related organizations.

In September 1996, the 18th Annual Meeting was held in Riding Mountain National Park, Manitoba in conjunction with a meeting of the Regional Reforestation Technical Committee. The meeting included three days of field study tours.

In September-October 1997, the 19th Annual Meeting was held in Campbell River, British Columbia with the theme of 'Poplar Farming on the West Coast of British Columbia'. The meeting featured visits to hybrid poplar plantations of MB Paper Ltd., Poplar Farms Division on Vancouver Island and Scott Paper Canada Ltd. along the lower Fraser River.

In September 1998, the 20th Annual Meeting was held at Université Laval, Sainte-Foy, Québec with the theme of 'Getting Ready for the 3rd Millenium'. The meeting had a strong focus on recent progress in poplar genetics and tree biotechnology and was followed by 2½ days of field study tour of poplar plantations in southern Quebec and eastern Ontario.

In August 1999, the 21st Annual Meeting was held in Edmonton, Alberta with the theme of 'Poplar and Aspen in the Western Boreal Forest: Global Issues, Local Research and the Role of Co-operatives'. The meeting discussed carbon budgets and credits, current western Canadian programs and local research, and poplar and aspen-related co-operatives. There were 1½ days of technical sessions and 2½ days of field study tours.

In addition to annual meetings and field study tours, PCC undertakes a variety of communication-related activities. A newsletter is published twice a year for members, with articles of current interest related to poplar and willow, including information from PCC field study tours. Proceedings of the Council's annual meetings are normally published and distributed to members and others. An Internet website has been established and is actively maintained. The site has general information about the Council and its activities, news of upcoming and recent events, contents of back issues of the PCC Newsletter and the most recent annual meeting proceedings, as well as links to other sites of interest, including IPC. In a part of the website accessible only to members, contact information for all individual and corporate members is made available.

In 1997-98, through a contract with the Canadian Forest Service, PCC undertook a survey of Canadian poplar-using industries to determine their interest in a potential Canadian poplar biotechnology co-operative. The survey revealed considerable interest and support for the establishment of such a co-operative, although companies were equally if not more interested in collaboration for support of more conventional breeding and planting programs. The results of the survey were published and are available on the PCC website.

- Difficulties encountered and lessons learned

PCC faces the type of problems encountered by most volunteer, non-profit organizations with minimal staff. It is a constant struggle to deliver a level of services sufficient to maintain membership interest and participation. These difficulties are exaggerated by the

enormous geographical size and variety of the country, which makes for regional biases in participation in meetings and workshops.

However, PCC has found that the Internet provides an inexpensive and accessible means to improving communication and distribution of information. Holding meetings and field study tours in different regions of the country also helps promote the exchange of information and experience.

APPENDIX I

Total Volume of *Populus* by Stand Type

Volume in **'000' m³** by Province & Territory of stocked, productive land

	Stands where Predominant Genus is <i>Populus</i>				Stands ^{*)} where Predominant Genus is NOT <i>Populus</i>		
	ha (000)	Total Volume (000) m ³			Total Volume (000) m ³		
		<i>Populus tremuloides</i>	Other <i>Populus</i>	Total <i>Populus</i>	<i>Populus tremuloides</i>	Other <i>Populus</i>	Total <i>Populus</i>
Newfoundland and Labrador	4	98		98	4525	42	4567
Nova Scotia	0			0	6978		6978
Prince Edward Isl.	37	612	6	618	962	5	967
New Brunswick	4	55	3	58	42128	1785	43913
Quebec	2123	121509	13257	134766	168671	26671	195342
Ontario	4081	220285	163862	384147	103131	204722	307853
Manitoba	9	148	57	205	234768	42790	277558
Saskatchewan	3234	292868	30151	323019	61165	21485	82650
Alberta	3965	302725	39770	342495	675234	140441	815675
British Columbia	4204	359288	63540	422828	148589	17351	165940
Yukon T.	140	14325	1913	16238	36877	10116	46993
Northwest T.				0	130550	1269	131819
Total	17801	1311913	312559	1624472	1613578	466677	2080255

Source: Canada's National Forest Inventory (CanF191, V.94)

*) Hectares not available for this report

APPENDIX II

Total Area of Stands^{*)} of *Populus* by Age Class

Area in **'000' hectares** by Province & Territory of stocked, productive land

Age Class	Thousands of Hectares by Age Class								Total
	0-20	21-40	41-60	61-80	81-100	101-120	121+	Other ^{**)}	
Newfoundland and Labrador			1	2	1				4
Nova Scotia									0
Prince Edward Isl.								37	37
New Brunswick	2			1	1				4
Quebec	8	602	950	466	92	2	1	2	2123
Ontario	200	669	1497	1138	402	151	18	6	4081
Manitoba								9	9
Saskatchewan	140	544	623	459	391	96	42	939	3234
Alberta	24	240	1475	681	385	203	176	781	3965
British Columbia	71	543	841	862	840	682	365		4204
Yukon T.		10	20	31	48	19	12		140
Northwest T.									0
Total	445	2608	5407	3640	2160	1153	614	1774	17801

Source: Canada's National Forest Inventory (CanF191, V.94)

*) *Populus* is the **main component** of the forest stands included

**) Uneven-Aged and Undetermined Age Classes

APPENDIX III

Total Volume ^{*)} of *Populus tremuloides* (Trembling Aspen) by Age Class

Volume in **'000' m³** by Province & Territory of stocked, productive land

Thousands of m ³ by Age Class									
Age Class	0-20	21-40	41-60	61-80	81-100	101-120	121+	Other ^{***)}	Total
Newfoundland and Labrador	84	108	152	1399	625	13	38	2202	4621
Nova Scotia	16	347	4569	1664	211	6		165	6978
Prince Edward Isl.								1574	1574
New Brunswick	2992	4788	14805	11538	5642	1621	690	107	42138
Quebec	6802	44738	126452	80272	24120	3431	2285	2081	290181
Ontario	986	24545	96651	110390	49068	18943	4884	17948	323415
Manitoba								234917	234917
Saskatchewan	2370	43550	72472	67810	56407	17066	5303	90055	354033
Alberta	1087	26420	207448	196207	212147	144016	102330	88304	977959
British Columbia	174	13765	36382	84411	128782	148370	94334	1660	507878
Yukon T.	9	730	1456	5223	13893	8332	5237	16324	51204
Northwest T.								130550	130550
Total	14520	157991	560387	558914	490895	341798	215101	585887	2925493

Source: Canada's National Forest Inventory (CanF191, V.94)

*) **All stands** containing *Populus* species

**) Uneven-Aged and Undetermined Age Classes

APPENDIX IV

Total Volume^{*)} of *Populus balsamifera*, *P. deltoides*, *P. trichocarpa* & their naturally occurring interspecific hybrids by Age Class

Volume in **'000' m³** by Province & Territory of stocked, productive land

Age Class	Thousands of m ³ by Age Class								Total
	0-20	21-40	41-60	61-80	81-100	101-120	121+	Other ^{**)}	
Newfoundland and Labrador								42	42
Nova Scotia									0
Prince Edward Isl.								10	10
New Brunswick	1367	74	153	116	54	16	6	1	1787
Quebec	1661	4676	16427	11471	3621	356	224	1492	39928
Ontario	1921	29993	112753	120595	56709	21230	11759	13623	368583
Manitoba								42848	42848
Saskatchewan	356	4525	6950	8030	9950	2675	2245	16906	51637
Alberta	192	3951	30949	37054	43180	29193	21569	14121	180209
British Columbia	39	1641	3138	7725	16628	21662	29806	252	80891
Yukon T.		53	59	217	1156	3009	2021	5516	12031
Northwest T.								1269	1269
Total	5536	44913	170429	185208	131298	78141	67630	96080	779235

Source: Canada's National Forest Inventory (CanF191, V.94)

*) **All stands** containing *Populus* species

***) Uneven-Aged and Undetermined Age Classes

APPENDIX V

Total Area of Stands of *Populus* in Relation To Total Hardwoods and Conifers

Area in '**000**' hectares by Species ^{*)} of stocked, productive land

Thousands of Hectares by Age Class									
Age Class	0-20	21-40	41-60	61-80	81-100	101-120	121+	Other ^{**)}	Total
Total Conifer	4438	8879	15581	16522	14858	19138	34031	24859	<u>138306</u>
Poplar	444	2607	5406	3639	2161	1155	616	1774	<u>17801</u>
Birch	98	1347	2384	2503	1712	305	287	152	8787
Maple	59	420	1465	1421	1053	400	689	530	6037
Other Broadleaved	1548	1032	2114	1913	1396	487	1169	5	9663
Unspecified Broadleaved	834	1248	3858	2745	1503	852	415	65	11521
Total Hardwoods	2983	6653	15227	12221	7823	3199	3176	2526	53809
Missing ^{***)} Value	2113	598	357	162	19	5	7	23205	26465
Grand Total	9534	16130	31166	28904	22701	22342	37214	50590	218580

Source: Canada's National Forest Inventory (CanF191, V.94)

*) Indicated species is the **main component** of the forest stands included

***) Uneven-Aged and Undetermined Age Classes

****) Missing value: Stands of mixed Conifer and Deciduous, but not classified as either Conifer or Deciduous

APPENDIX VI

Literature and Reference List

The list includes relevant Canadian publications by both Canadian and foreign authors as well as foreign publications and papers by Canadian authors. It is not an comprehensive list since it has been compiled for the period 1996 to 1999.

Aravanopoulos, F.A.; Zsuffa, L.	1998	Heterozygosity and biomass production in <i>Salix eriocephala</i> .	Heredity. Volume 81, Issue 4, 1998.
Bulley, B.	1999	Aspen logging debris management techniques.	Technical note, Forest Engineering Research Institute of Canada, FERIC, 1999.
Callan, B.	1996	Aspen and poplar diseases.	FRDA Report, Canadian Forest Service, Oct. 1996.
Callan, B.E.	1998	Diseases of <i>Populus</i> in British Columbia: a diagnostic manual.	Victoria: Pacific Forestry Centre, 1998.
Carmean, W.H.; Li, J.	1998	Soil-site relations for trembling aspen in northwest Ontario.	Northern Journal of Applied Forestry. Volume 15, Issue 3, 1998.
Catling, P.M. et al.	1998	Site index, site quality and foliar nutrients of trembling aspen: relationships and predictions.	Canadian Journal of Forest Research. 1998.
Ceulemans, R. et al.	1996	First and second-year aboveground growth and productivity of two <i>Populus</i> hybrids grown at ambient and elevated CO ₂ .	Tree Physiology. Volume 16, Issue 1-2, 1996.
Chen, H.Y.H et al.	1998	Site index, site quality and foliar nutrients of trembling aspen: relationships and predictions.	Canadian Journal of Forest Research. Volume 28, Issue 12, 1998.
Chen, H.Y.H. et al.	1998	Height growth and site index models for trembling aspen (<i>Populus tremuloides</i> Michx.) in northern British Columbia.	Forest Ecology and Management. Volume 102, Issue 2/3, 1998.
Chen, H.Y.H. et al.	1998	Height growth and site index models for trembling aspen (<i>Populus tremuloides</i> Michx.) in northern British Columbia.	Forest Ecology Management. Volume 102. Issue 2/3, 1998.
Chen, S. et al.	1997	Genotypic variation in drought tolerance of poplar in relation to abscisic acid.	Tree Physiology. Volume 17, Issue 12, 1997.
Coleman, M.D. et al.	1996	Root growth and physiology of potted and field-grown trembling aspen exposed to tropospheric ozone.	Tree Physiology. Volume 16, Issue 1/2, 1996.
Corns, I.G.W.; Maynard, D.G.	1998	Effects of soil compaction and chipped aspen residue on aspen regeneration and soil nutrients.	Canadian Journal of Soil Science. Volume 78, Issue 1, 1998.
DeBell, D.S.; Harrington, C.A.	1997	Productivity of <i>Populus</i> in monoclonal and polyclonal blocks at three spacings.	Canadian Journal of Forest Research. Volume 27, Issue 7, 1997.
DeBell, D.S.; Harrington,	1997	Productivity of <i>Populus</i> in	Canadian Journal of Forest

C.A.		monoclonal and polyclonal blocks at three spacings.	Research. Volume 27, Issue 7, 1997.
DeBell, J.D. et al.	1998	Fiber length in young hybrid Populus stems grown at extremely different rates.	Canadian Journal of Forest Research. Volume 28, Issue 4, 1998.
DeBell, J.D. et al.	1998	Fiber length in young hybrid Populus stems grown at extremely different rates.	Canadian Journal of Forest Research. Volume 18, Issue 4, 1998.
Dickson R.E. et al.	1998	Growth of five hybrid poplar genotypes exposed to interacting elevated CO ₂ and O ₃ .	Canadian Journal of Forest Research. Volume 28, Issue 11, 1998.
Dickson, R.E. et al.	1998	Growth of five hybrid poplar genotypes exposed to interacting elevated CO ₂ and O ₃ .	Canadian Journal of Forest Research. Volume 28, Issue 11, 1998.
Driessche, R van den	1999	First-year growth response of four Populus trichocarpa x Populus deltoides clones to fertilizer placement and level.	Canadian Journal of Forest Research. Volume 29, Issue 5, 1999.
Enebak, S.A. et al.	1996	Mortality of hybrid triploid aspen in Wisconsin and Upper Michigan.	Canadian Journal of Forest Research. Volume 26, Issue 7, 1996.
Gabre, G.M. et al.	1998	Clonal and seasonal differences in leaf osmotic potential and organic solutes of five hybrid poplar clones grown under field conditions.	Tree Physiology. Volume 18, Issue 10, 1998.
Gunthardt-Georg, M.S. et al.	1996	Leaf and stem structure of poplar (Populus x euramericana) as influenced by O ₃ , NO ₂ , their combination and different soil N supplies.	Canadian Journal of Forest Research. Volume 26, Issue 4, 1996.
Han, K.H. et al.	1997	High-frequency transformation of cottonwoods (genus Populus) by Agrobacterium rhizogenes.	Canadian Journal of Forest Research. Volume 27, Issue 4, 1997.
Harrington, C.A. et al.	1997	Leaf characteristics reflect growth rates of 2-year-old Populus trees.	Canadian Journal of Forest Research. Volume 27, Issue 8, 1997.
Harrington, C.A. et al.	1997	Leaf characteristics reflect growth rates of 2-year-old Populus trees.	Canadian Journal of Forest Research. Volume 27, Issue 8, 1997.
Harvey, H.P.; Driessche, R van den.	1997	Nutrition, xylem cavitation and drought resistance in hybrid poplar.	Tree physiology. Volume 17, Issue 10, 1997.
Hernandez, R.E. et al.	1998	Selected mechanical properties of fast-growing poplar hybrid clones.	Wood and Fiber Science. Volume 30, Issue 2, 1998.
Hernandez, R.E. et al.	1998	Selected mechanical properties of fast-growing poplar hybrid clones.	Wood Fiber Science. Volume 30, Issue 2, 1998.
Heuchelin, S.A. et al.	1997	Agrobacterium-mediated transformation of Populus x euramericana "Ogy" using the chimeric CaMV 35S-pin2 gene fusion.	Canadian Journal of Forest Research. Volume 27, Issue 7, 1997.

Hogg, E.H.	1999	Simulation of interannual responses of trembling aspen stands to climatic variation and insect defoliation in western Canada.	Ecological Modelling. Volume 114, Issues 2-3, 1999.
Hogg, E.H. et al.	1997	Sap flow in trembling aspen: implications for stomatal responses to vapor pressure deficit.	Tree Physiology. Volume 17, Issues 8-9, 1997.
Hogg, E.H.; Hurdle, P.A.	1997	Sap flow in trembling aspen: implications for stomatal responses to vapor pressure deficit.	Tree Physiology. Volume 17, Issue 8/9, 1997.
Ibrahim, L. et al.	1997	Main effects of nitrogen supply and drought stress upon whole-plant carbon allocation in poplar.	Canadian Journal of Forest Research. Volume 27, Issue 9, 1997.
Kalischuk, A.R. et al.	1997	Intersectional cottonwood hybrids are particularly susceptible to the poplar bud gall mite.	Canadian Journal of Botany. Volume 75, Issue 8, 1997.
Kang, H.D. et al.	1997	Transgenic Populus: in vitro screening for resistance to cottonwood leaf beetle (Coleoptera: Chrysomelidae).	Canadian Journal of Forest Research. Volume 27, Issue 6, 1997.
Karnosky, D.F. et al.	1996	Changes in growth, leaf abscission and biomass associated with seasonal tropospheric ozone exposure of Populus tremuloides clones and seedlings.	Canadian Journal of Forest Research. Volume 26, Issue 1, 1996.
Karau, J.	1996	Proceedings of the Canadian Energy Plantation Workshop, Gananoque, Ontario, 2-4 May, 1995.	Ottawa, Ont.: Natural Resources Canada, Canadian Forest Service, Science Branch, 1996.
Kleiner, K.W. et al.	1998	Effect of nitrogen availability on the growth and phytochemistry of hybrid poplar and the efficacy of the Bacillus thuringiensis cry1A(a) d-endotoxin on gypsy moth.	Canadian Journal of Forest Research. Volume 28, Issue 7, 1998.
Koubaa, A. et al.	1997	Nondestructive evaluation of physical, mechanical and anatomical properties of fast growing poplar hybrid clones.	Timber management toward wood quality and end-product value. Proceedings of the CTIA-IUFRO International Wood Quality Workshop, Quebec City, Canada. 1997.
Koubaa, A. et al.	1998	Interclonal, intraclonal and within- tree variation in fiber length of poplar hybrid clones.	Wood Fiber Science. Volume 30, Issue 1, 1998.
Kranjcec, Julie et al.	1998	The response of three riparian cottonwood species to water table decline.	Forest Ecology and Management, Volume 110, Issues 1-3, 1998

Kull, O. et al.	1996	Photosynthetic responses of aspen clones to simultaneous exposures of ozone and CO ₂ .	Canadian Journal of Forest Research. Volume 26, Issue 4, 1996.
Labrecque, M. et al.	1997	Biomass productivity and wood energy of Salix species after 2 years growth in SRIC fertilized with wastewater sludge.	Biomass and Bioenergy. Volume 12, Issue 6, 1997.
Labrecque, M. et al.	1998	Early performance and nutrition of two willow species in short-rotation intensive culture fertilized with wastewater sludge and impact on the soil characteristics.	Canadian Journal of Forest Research. Volume 28, Issue 11, 1998.
Labrecque, M.; Teodorescu, T.T.	1998	Les terres abandonnées at les cultures d'arbres sur courtes rotations: une conjoncture favorable pour l'énergie.	Proceedings of the Conference on Renewable Energy Technologies in Cold Climates. Montréal 1998
Larocque, G.R.	1999	Performance and morphological response of the hybrid poplar DN-74 (Populus deltoides x nigra) under different spacings on a 4-year rotation.	Annals of Forest Science. Volume 56, Issue 4, 1999.
Lester, D.T.	1995	The feasibility of plantation silviculture using poplar on agricultural lands of western and central Alberta.	Alberta environmental Protection, Land and Forest Service, 1995.
Lewis, K.J.	1996	Aspen decay and wood utilisation.	FRDA Report, Canadian Forest Service, Oct. 1996.
Li, B.; Wu, R.	1997	Heterosis and genotype x environment interactions of juvenile aspens in two contrasting sites.	Canadian Journal of Forest Research. Volume 27, Issue 10, 1997.
Li, B.L. et al.	1998	Developmental factors responsible for heterosis in aspen hybrids (Populus tremuloides x P. tremula).	Tree Physiology. Volume 18, Issue 1, 1998.
Li, B.L.; Wu, R.L.	1997	Heterosis and genotype x environment interactions of juvenile aspens in two contrasting sites.	Canadian Journal of Forest Research. Volume 27, Issue 10, 1997.
Li, H. et al.	1997	A genetic study on characteristics of crown light interception in Populus deltoides.	Canadian Journal of Forest Research. Volume 27, Issue 9, 1997.
Lieffers, V.J. et al.	1996	Semi-natural and intensive silvicultural systems for the boreal	Forest Chronicle. Volume 72, Issue 3, 1996.

Lindroth, A.; Cienciala, E.	1996	mixedwood forest. Water use efficiency of short-rotation <i>Salix viminalis</i> at leaf, tree and stand scales.	Tree Physiology. Volume 16, Issue 1/2, 1996.
Liu, S.H. et al.	1996	Absorption and translocation of glyphosate in aspen (<i>Populus tremuloides</i> Michx.) as influenced by droplet size, droplet number and herbicide concentration.	Weed science. Volume 44, Issue 3, 1996.
Marino, P.C.; Gross, K.L.	1998	Competitive effects of conspecific and herbaceous (weeds) plants on growth and branch architecture of <i>Populus x euramericana</i> cv. Eugenei.	Canadian Journal of Forest Research. Volume 28, Issue 3, 1998.
Maynard, D.G. et al.	1998	Soil nutrient and vegetation response to patch clear-cutting of an aspen forest near Meadow Lake, Saskatchewan.	Canadian Journal of Soil Science. Volume 78, Issue 1, 1998.
McLennan, D.S.	1996	The nature of nutrient limitation in black cottonwood stands in South Coastal British Columbia.	FRDA Report. Victoria, B.C.: Canadian Forest Service, Oct. 1996.
Navratil, S.	1996	Sustained aspen productivity on hardwood and mixedwood sites.	FRDA Report, Canadian Forest Service, Oct. 1996.
Newcombe, G.; van Oosten, C.	1997	Variation in resistance to <i>Venturia populina</i> , the cause of poplar leaf and shoot bight in the Pacific Northwest.	Canadian Journal of Forest Research. Volume 27, Issue 6, 1997.
Newcombe, G.; Bradshaw, H.D. Jr.	1996	Quantitative trait loci conferring resistance in hybrid poplar to <i>Septoria populicola</i> , the cause of leaf spot.	Canadian Journal of Forest Research. Volume 26, Issue 11, 1996.
Park, G.S.	1997	Effects of fertilization and clone on aboveground and soil carbon storages in a willow (<i>Salix</i> spp.) bioenergy plantation.	Journal of Korean Forestry Society. Volume 86, Issue 2, 1997.
Peterson, E.B. et al.	1996	Black cottonwood and balsam poplar managers' handbook for British Columbia.	FRDA Report, Canadian Forest Service, Sept. 1996.
Peterson, E.B.; Peterson, N.M.	1996	Ecology and silviculture of trembling aspen.	FRDA Report, Canadian Forest Service, Oct. 1996.
Poplar Council of Canada	1998	Proceedings of the 1998 Annual Meeting of the Poplar Council of Canada.	Edmonton, Poplar Council of Canada, 1998.

Prescott, C. E. et al.	1999	Effects of fertilization on decomposition rate of <i>Populus tremuloides</i> foliar litter in a boreal forest.	Canadian Journal of Forest Research. Volume 29, Issue 3, 1999.
Rood, S.B. et al.	1998	Initial cottonwood seedling recruitment following the flood of the century of the Oldman River, Alberta, Canada.	Special issue based on symposium on semiarid riparian ecosystems sponsored by the Rocky Mountain Chapter of the Society of Wetland Scientists at the 18th Annual Meeting of the Society, June 3-5 1997 in Bozeman, Montana, USA. Wetlands. Volume 18, Issue 4, 1998.
Russell, C. A. et al.	1998	Carbon dioxide efflux from the floor of a boreal aspen forest. II. Evaluation of methods--verification by infrared analysis of a dynamic closed chamber.	Canadian Journal of Soil Science. Volume 78, Issue 2, 1998.
Russell, C.A.; Voroney, R.P.	1998	Carbon dioxide efflux from the floor of a boreal aspen forest. I. Relationship to environmental variables and estimates of C respired.	Canadian Journal of Soil Science. Volume 78, Issue 2, 1998.
Scarascia-Mugnozza, G.E. et al.	1997	Production physiology and morphology of <i>Populus</i> species and their hybrids grown under short rotation. II. Biomass components and harvest index of hybrid and parental species clones.	Canadian Journal of Forest Research. Volume 27, Issue 3, 1997.
Schroeder, W.R.; Alspach, L.K.	1995	Herbicide program at the PFRA Shelterbelt Centre.	National Proceedings forest and conservation nursery associations, 1995
Schumaker, M.A. et al.	1997	Growth, leaf anatomy and physiology of <i>Populus</i> clones in response to solar ultraviolet-B radiation.	Tree Physiology. Volume 17, Issue 10, 1997.
Souch, C.A.; Stephens, W.	1998	Growth, productivity and water use in three hybrid poplar clones.	Tree physiology. Volume 18, Issue 12, 1998
Steele, S. J. et al.	1997	Root mass, net primary production and turnover in aspen, jack pine and black spruce forests in Saskatchewan and Manitoba, Canada.	Tree Physiology. Volume 17, Issue 8/9, 1997.
Stettler, R.F.	1996	Biology of <i>Populus</i> and its implications for management and conservation.	Ottawa: NRC Research Press, 1996.

Stone, D.M.; Elioff, J.D.	1998	Soil properties and aspen development five years after compaction and forest floor removal.	Canadian Journal of Soil Science. Volume 78, Issue 1, 1998.
Taylor, B.R. et al.	1996	Toxicity of aspen wood leachate to aquatic life: laboratory studies.	Environmental Toxicology and Chemistry, Volume 15, Issue 2, 1996.
Thomas, K.D.; Comeau, P.G.	1998	Vegetation management options for establishment of hybrid poplar plantations and their effect on nutrient cycling (MOF EP 1135.04).	Extension note British Columbia Ministry of Forests. 1998.
Tschaplinski, T.J. et al.	1998	Drought resistance of two hybrid Populus clones grown in a large-scale plantation	Tree Physiology, Volume 18, Issue 10, 1998
Valade, J.L. et al.	1997	Five short-rotation poplar clones grown in Quebec: wood and papermaking properties.	Timber management toward wood quality and end-product value. Proceedings of the CTIA-IUFRO International Wood Quality Workshop, Quebec City, Canada. Aug. 1997.
van Splunder, I. et al.	1996	Morphological responses of seedlings of four species of Salicaceae to drought.	Canadian Journal of Botany. Volume 74, Issue 12, 1996.
Visser, S. et al.	1998	Response of ecto- and arbuscular mycorrhizal fungi to clear-cutting and the application of chipped aspen wood in a mixedwood site in Alberta, Canada.	Applied Soil Ecology, Volume 7, Issue 3, 1998.
Wang, Y. et al.	1998	Relationships between tree slenderness coefficients and tree or stand characteristics for major species in boreal mixedwood forests.	Canadian Journal of Forest Research. Volume 28, Issue 8, 1998
Williams, D.; Morris, R	1998	Machining and related mechanical properties of 15 B.C. wood species.	Special Publication, Forintek Canada Corp. 1998.
Wisniewski, M. et al.	1997	Effects of near-lethal heat stress on bud break, heat-shock proteins and ubiquitin in dormant poplar (<i>Populus nigra</i> Charkowiensis x <i>P. nigra</i> incressata).	Tree Physiology. Volume 17, Issue 7, 1997.
Zsuffa, L.	1996	Some factors determining the productivity and sustainability of poplar and willow short rotation biomass plantations.	Biomass and Bioenergy. Volume 10, Issue 5/6, 1996.

Zsuffa, L.; Verwijst, T.	1999	Environmental and social issues in poplar and willow cultivation and utilisation. Selected papers from the 20th Session of the International Poplar Commission (IPC), Budapest, Hungary, October 1996.	Biomass and Bioenergy. Volume 16, Issue 4, 1999.
--------------------------	------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------

Personal Contacts

Audy, Émile	2000	Domtar Inc. – Windsor, Quebec	
Beuker, Egbert	1999	Finnish Forest Research Institute	
Campbell, Doug	2000	Saskatchewan Environment and Resource Management	
Carlson, Michael	1999	B.C. Forest Service, Kalamalka Research Station, Vernon, BC	
Castonguay, Mario	2000	Forêt Québec - Service de mise en valeur des forêts privées	
Cook, John	2000	B.C. Ministry of Forests, Revenue Branch	
Descombes, Denis	2000	Louisiana-Pacific Canada Ltd. - Division Québec	
Garon, Danielle	2000	Norampac - Québec	
Gray, Stephen	2000	Canadian Forest Service, Forest Inventory and Analysis	
Hopkins, Mark	2000	Ainsworth Lumber Co. Ltd. - British Columbia	
Kort, John	1999	Agriculture and Agri-Food Canada, PFRA Shelterbelt Centre, Indian Head, Saskatchewan	
Labrecque, Michel	2000	Institut de recherche en biologie végétale - Montreal Botanical Garden	
Mears, Robert	2000	Ontario Ministry of Natural Resources	
Niemi, Florance	2000	Daishowa-Marubeni International Ltd., Alberta	
Pearce, Alison	2000	British Columbia Assessment Authority	
Périnet, Pierre	1999 & 2000	Ministère des Ressources naturelles, Direction de la recherche forestière	
Plamondon, Claude	2000	Forêt Québec - Service de l'Aménagement Forestier	
Price, Daryl	2000	Alberta Forest Service	
Richardson, Jim	2000	Poplar Council of Canada	
Robertson, Allan	2000	Alberta Pacific Forest Industries Inc.	
Scarlett, Rod	2000	Woodlot Owners Association, Alberta	
Stener, Lars-Göran	1999	The Forestry Research Institute of Sweden	

Stenerson, Ken	2000	Scott Paper Limited
Thomas, Barbara	1999	University of Calgary
Ward, Brydon	1999	Alberta Pacific Forest Industries Inc.
Woods, Richard	2000	B.C. Ministry of Forests, Resources Inventory Branch
Young, Wayne	2000	Domtar Inc. - Cornwall, Ontario
Zsuffa, L.	2000	University of Toronto
Zulinski, Adam	2000	Domtar Inc. - Cornwall, Ontario

APPENDIX VII

**POPLAR AND WILLOW CULTURE:
MEETING THE NEEDS OF SOCIETY AND ENVIRONMENT**

**CANADIAN CONTRIBUTION TO THE THEME OF THE 21ST SESSION OF THE
INTERNATIONAL POPLAR COMMISSION
PERIOD 1996 - 1999**

INTRODUCTION

In this appendix aspen means Trembling Aspen (primarily *Populus tremuloides*; and some *P. grandidentata*); poplar refers to *Populus trichocarpa* (Black Cottonwood), *P. deltoides* (Eastern or Plains Cottonwood), *P. balsamifera* (Balsam poplar) and their various hybrids.

The only work with willow is done in Quebec, where the species is researched for its potential as a biofuel. There will be no further mention of willow in this appendix.

This appendix is based on interviews, reports, and literature assembled to produce the Canadian Report "Activities Related to Poplar and Willow Cultivation and Utilization in Canada" to the 21st Session of the International Poplar Commission for the Period 1996-1999, prepared for the Poplar Council of Canada (dated 31 March, 2000). Because of the need to keep this appendix as short as possible, the author made free use of abbreviated sentences.

1. EXTENT AND STATE OF ASPEN AND POPLAR STANDS AND PLANTATIONS

Natural Stands

- Area

Area data pertain to stands where genus *Populus* forms majority of these stands. Aspen makes up about 81% of total volume; poplar takes up remaining 19%.

Total Area of Stands of *Populus* by Age Class
Area in '000' hectares of stocked, productive land

Age Class	Thousands of Hectares by Age Class								Total
	0-20	21-40	41-60	61-80	81-100	101-120	121+	Other ^{*)}	
Total	445	2,608	5,407	3,640	2,160	1,153	614	1,774	17,801

^{*)} Uneven-Aged and Undetermined Age Classes

The 17.8 million hectares *Populus* include other species. *Populus* accounts for 33% of total hardwood area of stands where genus *Populus* is main component. Area of "unspecified broadleaved" species, when re-allocated proportionally to *Populus*, would increase total *Populus* to 22.7 million hectares, or 42% of area of all hardwoods when applied to total national picture.

- Trends

Emphasis on single species management changing to strategy of mixed wood management of aspen and spruce in boreal forest stands to ensure sustainable productivity.

Plantations

Approx. Area of Hybrid Poplar Plantations in Canada (excl. smaller private growers).

	Approximate Area - ha	Age Range (Years)	Comments
Total Hybrid Poplar Plantation Area	6,937	1 to 42	Operational and Trial Plantations

- Trends

Gradual increase in establishing intensively managed plantations for following reasons:

- ✓ Fibre requirements for pulp & paper and Oriented Strand Board (OSB) products - by and for forest products corporations.
- ✓ Solid wood production for saw log and veneer industry - by landowners not integrated with forest product manufacturing. Plantations established in conjunction with bioremediation projects (e.g. use of municipal effluent).
- ✓ Wood production for environmental reasons, with production of fibre or solid wood as secondary reason by local governments (e.g. municipalities and regional districts), farming community (manure and effluent disposal) and industry (directly or indirectly) to handle industrial biosolids and effluent and carbon-offset reasons.

2. PRIMARY USES OF POPLAR AND ASPEN

Industrial Uses

Large scale industrial use of aspen (and some poplar) for Kraft and CTMP pulps.

Growing use of aspen (and some poplar) for Oriented Strand Board (OSB).

Good quality poplar as plywood inner core (British Columbia).

Poplar and aspen are used in the manufacturing of pallets and packaging.

- Trends

Continued expansion in the manufacture of OSB.

Reported production of aspen and poplar volumes less than the Annual Allowable Cut (AAC) levels.

Research ongoing in use of hybrid poplar for OSB and higher end-use products (e.g. furniture, moulding).

Use of aspen resources in the boreal region results in the broadening of the economic bases of rural communities.

Non-Industrial Uses

Use of poplar in shelterbelts to prevent soil erosion and to influence climate around homesteads on the prairies.

Environmental Uses

Hybrid poplar in bio-remediation, e.g. use of municipal and industrial biosolids and effluents near metropolitan areas, use of excess animal wastes (manures and effluents) in agricultural areas. Important aspect for hybrid poplar and aspen in afforestation for carbon offsets (carbon credit). Important trend in Alberta: Coal and gas & oil industry offset growing carbon emissions by stimulating afforestation activities, often in co-operation with forest product corporations. Similar initiatives investigated by cement industry, which is significant producer of carbon.

Conservation

Boreal aspen forest management emphasized single-species management.

Mixed wood management of aspen and white spruce attractive silvicultural alternative, requiring careful co-ordination of conifer and aspen harvest where different licensees have rights to different species.

3. BIOTIC AND ABIOTIC CONCERNS

Native Insects

Forest tent caterpillar (*Malacosoma disstria & americana*) - boreal aspen and hybrid poplar.

Cottonwood leaf beetle (*Chrysomela scripta*) - hybrid poplar plantations and nurseries.

Poplar borer (*Saperda calcarata*) – hybrid poplar.

Poplar and willow borer (*Cryptorhynchus lapathi*) – hybrid poplar.

Tarnished plant bug (*Lygus lineolaris*) – hybrid poplar.

Introduced Insects

Gypsy moth (*Lymantria dispar*) – potential impact poplar and aspen; 1991 discovery of Asian race of gypsy moth British Columbia.

Asian long-horned beetle (*Anoplophora glabripennis*) – not (yet?) established in Canada, but potential threat.

Native Diseases

Stem Canker (*Septoria musiva*) – hybrid poplar in Eastern Canada

Sooty-bark Canker (*Encoelia pruinosa*) – aspen

Hypoxylon Canker (*Entoleuca mammata*) – aspen

Marssonina Leaf Blight (*Marssonina* spp.) – hybrid poplar, aspen

Various leaf rusts (*Melampsora* spp) – hybrid and native poplar (and aspen)

Septoria leaf blight (*Septoria populicola*) – native poplar and its hybrids in B.C.

Poplar leaf and shoot blight (*Venturia populina.*) – hybrid poplar (coastal B.C.).

Aspen leaf and shoot blight (*Venturia macularis.*) – aspen

New Disease

Hybrid leaf rust (*Melampsora x columbiana*) – hybrid poplar SW B.C.

Climate

January 1998 ice storm in Eastern Ontario and Western Quebec: severe damage to existing hybrid poplar (and other) plantations. Salvage operations in place to utilize damaged trees.

Persistent droughts in several regions in boreal aspen belt causing concerns about long term impact on aspen forests and feasibility of plantations with both hybrid aspen and poplar.

4. RESEARCH AND DEVELOPMENT

Silviculture Natural Stands

Daishowa - Marubeni International Limited, Canadian Forest Products Limited, Canadian Forest Service and Alberta Land and Forest Service launched EMEND, or Ecosystem Management by Emulating Natural Disturbance.

Objective: Determine which forest harvesting systems emulate effects of wildfire on structure and function of forest ecosystems. Different intensities of harvesting compared with burned and undisturbed areas to find which methods most closely simulate effects of wildfire, which is precursor to thriving aspen ecosystems.

Silviculture of Plantations

Innovations in site preparation and fertilization reported for hybrid poplar in B.C. Commercial plantation establishment using tree rows marked by continuous mounding of soil. Concentrated band of phosphate-based fertilizer placed at bottom of mound. Same company funded research in hybrid poplar fertilization at time of planting and at time of crown closure; successfully implemented research recommendations.

Western Boreal Aspen Co-operative (WBAC), applied similar techniques to trial plantations of aspen in Alberta. WBAC also researches ‘stock type’ and ‘time of planting’ trials with aspen, showing promising results.

Genetics and Physiology

Two B.C. companies established numerous hybrid poplar clonal tests. One company undertook pilot breeding program, creating 27 families of interspecific, intraspecific, backcrosses and several F2 crosses, for total of 2724 clonal varieties. Of these, 35 selected for further testing. Provincial government not involved in B.C.

Lack of cold hardiness and frost tolerance of hybrid varieties tested in Canada (except in SW and Interior B.C.) need solutions. Drought is issue in some regions in Northern Alberta. Shelterbelt Centre of Prairie Farm Rehabilitation Administration (PFRA) actively involved in selection for drought tolerance and cold hardiness of clonal varieties that show good pest resistance and have acceptable wood quality. To date four clones released for use in the Prairie region. Over 200 different clonal varieties under test in Saskatchewan. Centre plans to carry out controlled crosses in 2000. To date no selection or breeding for purpose of establishing plantations of hybrid poplar in this area; only selections used to date are based on performances as shelterbelt trees. Centre embarked on breeding program to fill gap. Several companies in Alberta planning hybrid poplar breeding programs. These companies also testing existing clonal varieties originating from University of Toronto, Ministère des Ressources naturelles du Québec and Shelterbelt Centre of the PFRA. One company testing clones created by University of Washington – Poplar Molecular Genetics Co-operative (PMGC).

Ministère des Ressources naturelles du Québec - direction de la recherche forestière (MRN) - has had breeding program since 1971; more than 1000 families. In 1995 and 1998 breeders succeeded making field crosses with *Populus deltoides* females and created 13 families (of *Populus deltoides* x *P. nigra*, *P. deltoides* x *P. maximowiczii* and x *P. trichocarpa*) and more than 50 families of *P. deltoides* x *P. deltoides* respectively. No breeding in 1999, but plans for breeding in 2000 or 2001.

Clonal varieties from University of Toronto selection and breeding program (discontinued several years ago) of interest and tested by forest companies in Alberta. Experimental crosses in 1978 evaluate crossing relationships between Aigeiros (*Populus deltoides*, *P. nigra*) and Tacamahaca (*P. balsamifera* and *P. maximowiczii*) Sections. There are crossing incompatibilities, hindering creation of some interspecific crosses. Information will be of value to organizations starting breeding program.

One of Western Boreal Aspen Co-operative's (WBAC) objectives is: “develop genetically improved trembling aspen and hybrid clones.” Exploratory breeding work in 1998. New round of breeding in spring 2000 to test breeding protocols. Early results encouraging; co-operative to produce first controlled crosses in 2000.

Three companies in Western Canada active members of University of Washington – Poplar Molecular Genetics Co-operative or PMGC. Two of these also members of Oregon State University -Tree Genetic Engineering Research Co-operative or TGERC.

Utilization

- Composite Products – Hybrid Poplar

Several companies tested hybrid poplar for use in OSB and other engineered wood products (e.g. parallel strand lumber, MDF board). Results very good; however, because of proprietary nature of test results, no details available. Forintek Canada Corporation (Western Division, Vancouver) reported major test planned in 2000 to manufacture OSB from hybrid poplar from across Canada.

- Solid Wood – Hybrid Poplar

During 1997-1998 Forest Renewal British Columbia (Crown Corporation of B.C.) funded research project on “Solid Wood Product Opportunities from Short Rotation Hybrid Poplar Trees”. Project used nine-year-old hybrid poplars (*Populus trichocarpa* x *P. deltoides*) with average DBH of 25 cm and average height of 20 m. Local sawmill cut wood into boards. Lumber recovery low; authors state that longer rotation, resulting in increased diameter, would result in increase in lumber recovery to 60-70%. Forintek Canada Corp. tested wood for kiln-drying and wood property testing. Remaining wood used to manufacture various products, ranging from tongue & groove wall paneling, window & wall mouldings, to furniture and

decorative boxes. One interesting fact: Hybrid poplar “*far exceeded performance of black cottonwood (P. trichocarpa) in all machining tests.*” Hybrid poplar machined moderately well; strength was average compared to other wood species. Wood finished well. Similar study in Oregon in 1999 verified BC findings.

Environment

Concerns about about changing climate and effects on aspen ecosystems in boreal region. Droughts are main concerns.

5. SUMMARY

Major issues

- Aspen

Sustainability of aspen management being addressed through research (EMEND project) and mixed wood management approaches. Climate changes may cause disruptions in boreal aspen ecosystems, impacting long term sustainability of aspen (and poplar) management.

- Poplar

Plantation programs and poplar technology development suffer from fluctuating interest by forest companies in poplar as source of fibre for pulp and paper. Small landowners are in risky position, unless they signed supply agreements or concentrated on growing for solid wood market.

In eastern Canada main issue remains susceptibility of hybrid poplar to *Septoria musiva* stem canker.

Challenges

- Aspen

Develop successful plantation establishment and silvicultural practices for aspen and hybrid aspen. This is critical to large scale, cost-effective plantation management.

Accelerate selection and breeding of hybrid aspen to deliver acceptable plantation varieties in next 15 to 20 years.

Build long term relationships with gas, oil and coal industry to form base for carbon offset plantations on farmland.

- Poplar

Solve *Septoria musiva* problem in eastern Canada.

Encourage private landowners in various regions to build critical mass of poplar supply to develop markets for higher value logs.

Determine market potential for bio-remediation and carbon offset as a source of cashflow for plantation establishment and maintenance.

Successes

Research and technology development proved potential of hybrid poplar and aspen plantation management. Recent utilization and marketing studies show potential for hybrid poplar as substitute species for several established conifer and deciduous species for non-structural use (e.g. decorative uses).

Aspen has become species of choice for pulp and paper and OSB manufacturing, rather than weed species to be ignored.

Aspen has come of age and poplar is soon to follow!

6. SOURCES OF INFORMATION

For books and publications, please refer to **INRODUCTION** for information and source.

Websites:

<http://nfdp.ccfm.org>, for access to Canada’s national forest database.

<http://www.agr.ca/pfra/pfintroe.htm>, for the Shelterbelt Centre of the Prairie Farm Rehabilitation Administration (PFRA) in Saskatchewan.

<http://poplar2.cfr.washington.edu/toby>, University of Washington – Poplar Molecular Genetics Co-operative (PMGC).
<http://www.fsl.orst.edu/tgerc/index.htm>, Oregon State University -Tree Genetic Engineering Research Co-operative (TGERC).
<http://www.nrcan.gc.ca/>, Natural Resources Canada, for general information on insects and diseases.

Poplar Council of Canada:

Address: Poplar Council of Canada
5320 - 122nd Street
Edmonton, Alberta
Canada T6H 3S5
Phone: +1 780 435-7282
Fax: +1 780 435-7356
E-mail: poplar@poplar.ca
Website: <http://www.poplar.ca>