National Tree Seed Centre

Annual Report

2010

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Canadian Forest Service - Atlantic
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NATIONAL TREE SEED CENTRE ANNUAL REPORT 2010

EXECUTIVE SUMMARY

Seed production was meagre in the Maritimes in 2010. Thirty-seven collections were made by National Tree Seed Centre staff with 29 of these being poplar from Quebec as part of a genomics project. Two seedlots of black cottonwood (*Populus trichocarpa*) were purchased.

A total of 59 requests for seed resulted in 822 seedlots provided for research. The majority of the requests were from Canada (47 requests; 510 seedlots) but seed was also sent to Finland (1 request; 1 seedlot), Great Britain (1 request; 105 seedlots), and United States (10 requests; 206 seedlots).

Seed testing consisted of 702 germination tests, 582 moisture content tests, and 182 thousand-seed weight tests. A significant proportion of the germination testing is re-testing of seedlots tested 10 years ago which provides an up-to-date assessment of seed quality. The data are also used to evaluate long-term storage potential.

Other activities during the year included:

- A strategic plan was published which defines the Seed Centre's mission as safeguarding Canada's forest genetic resources in the face of climate change and other threats by acquiring, evaluating, preserving, and providing a national collection of forest genetic resources to assist in securing the forest biological diversity that underpins the sustainable development of Canada's forests.

- Donations of ash seed to the USDA National Centre for Genetic Resources Preservation and the Millennium Seed Bank in Great Britain for long-term storage as a back-up for seed stored at the Seed Centre.

- A list of species for which seed are stored was provided to Botanic Gardens Conservation International for their database which is in the public domain. This will provide the Seed Centre with international profile as a place where seeds are stored and conserved.

- An article about the Seed Centre was published in a Canadian university science text book. This will raise awareness about the Seed Centre in the public education system.

- A comparison between germination and viability tests of black ash (*Fraxinus nigra*) seed indicated comparable results but only when numbers of germinated seed were combined with numbers of seed that were fresh (alive but not germinated).

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INTRODUCTION

In the 1960s, tree genetics and breeding research was expanding across Canada. There was increasing demand for small quantities of seed of known origin and quality for provenance testing. In response to this need, the Canadian Forest Service established the National Tree Seed Centre (NTSC) in 1967 at the Petawawa Research Forest (formerly Petawawa Forest Experiment Station) in Ontario. At that time, reforestation programs across Canada were being initiated or were expanding and there was a need for large quantities of seed as well as knowledge on how to collect, process, test, and store tree seed. Germination testing protocols existed for the major conifer reforestation species, but in some cases, fine tuning was required. As well, the Seed Centre played an active role in acquiring and disseminating seed of native and exotic species to researchers to establish provenance trials and other genetic tests. A significant accomplishment of the Seed Centre was the development of the Petawawa Germination Box. This was in response to the need for a container of appropriate size to permit maximum use of germinator space, allow for full development of germinants, and maintain uniform moisture levels in the germination medium.

Following a review of the research program within the Canadian Forest Service the NTSC was transferred to the Atlantic Forestry Centre in Fredericton, N.B. in 1996. The mission of the NTSC is to safeguard Canada's forest genetic resources in the face of climate change and other threats by acquiring, evaluating, preserving, and providing a national collection of forest genetic resources to assist in securing the forest biological diversity that underpins the sustainable development of Canada's forests.

This report covers the activities of the NTSC for 2010. Similar reports were prepared from 1998–2009. The report also captures the results of tests and experiments that were conducted during the year in order to ensure that this information is synthesized and reported.

STATUS OF INVENTORY

Seed is stored in four categories: Seed Bank, Genetic Conservation, Reserved, and Tree Breeding (Table 1). The total number of seedlots increased by 281 to 13 294 in 2010. The numbers in brackets in Table 1 represent the numbers reported in the 2009 Annual Report.

Table 1. Seed stored at the NTSC as of December 31, 2010.

Seed Bank		Genetic Conser vation		Reserved		Tree Breeding	
No. species	No. seedlots	No. species	No. seedlots	No. species	No. seedlots	No. species	No. seedlots
156 (159)	6,623 (6,546)	48 (45)	4,370 (4,214)	37 (33)	1,911 (1,863)	10 (10)	390 (390)

Seed Bank seedlots are the active collection that are available for distribution. Since 1998, the number of seedlots in the Seed Bank collection has increased from 3,079 to 6,623 (Figure 1). The increase represents the net gain after discarding seedlots due to low germination and the depletion of seedlots as they are provided to clients. In 2010, nine seedlots were depleted.

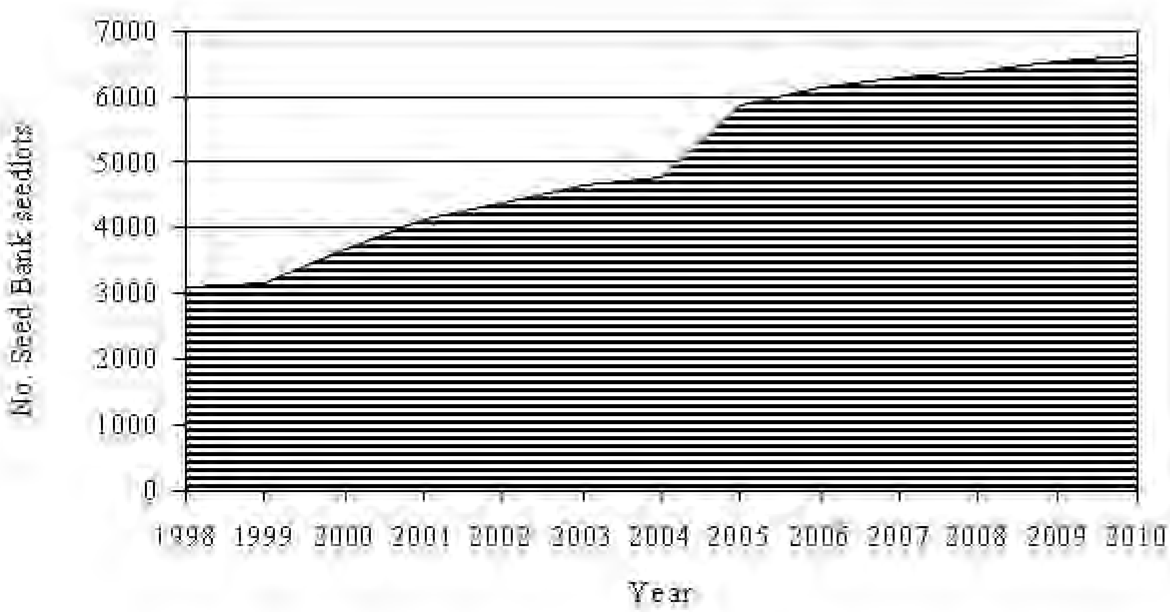

Figure 1. Increase in number of Seed Bank seedlots stored at the NTSC since 1998.

One of the objectives of the NTSC is to obtain seed samples of Canadian tree and shrub species from across their natural ranges. As of December 31, 2010, the NTSC Seed Bank had 6,338 seedlots from 117 Canadian species in storage (Table 2). Seed from 39 exotic species (285 seedlots) are also stored. Exotic species are defined as those that are non-native which may or may not be present in Canada. The proportion of seed from exotic species will continue to decrease as seedlots become exhausted due to client requests and no effort will be made to replace them. Clients can be directed to seed centres in other countries that have seed from species they need.

Table 2. Number of native species, number of seedlots, and percentages by province of seedlots stored in the Seed Bank category.

Province	No. species	No. seedlots	Percent
Alberta	12	45	0.7
British Columbia	32	278	4.4
Manitoba	7	66	1.0
New Brunswick	68	1458	23.0
Newfoundland and Labrador	17	169	2.7
Nova Scotia	39	549	8.7
Ontario	49	2359	37.2
Prince Edward Island	32	254	4.0
Quebec	26	1001	15.8
Saskatchewan	10	113	1.8
Yukon Territory	3	46	0.7
Total	117	6338	100

Since the Seed Centre moved to Fredericton, staff have concentrated their efforts acquiring collections from New Brunswick (N.B.), Nova Scotia (N.S.), and Prince Edward Island (P.E.I.). Travel beyond the Maritime provinces is difficult due to limited resources (staff and budget). There is an ongoing effort to acquire seed from other provinces and Seed Centres when the opportunity arises. The NTSC needs to continue its effort of acquiring seedlots from outside the Maritime provinces. Since collections by NTSC staff are unlikely due to distance and costs, these seedlots are purchased or obtained through donation.

The Genetic Conservation category was initiated in 2000 using seed already in storage. Its purpose is to ensure that genetic material obtained from rare, endangered, and/or unique populations, as well as samples from throughout a species' range is preserved. Over the past five years, the driving force for seed collections has been genetic conservation. Any surplus seed from these collections is placed in Seed Bank. The collection increased by 156 to 4,370 seedlots.

Figure 2 shows the increase in the number of seedlots in this category since 2000. There is seed from 48 species in Genetic Conservation with the number of seedlots ranging from 1 to 1,641 (Table 3).

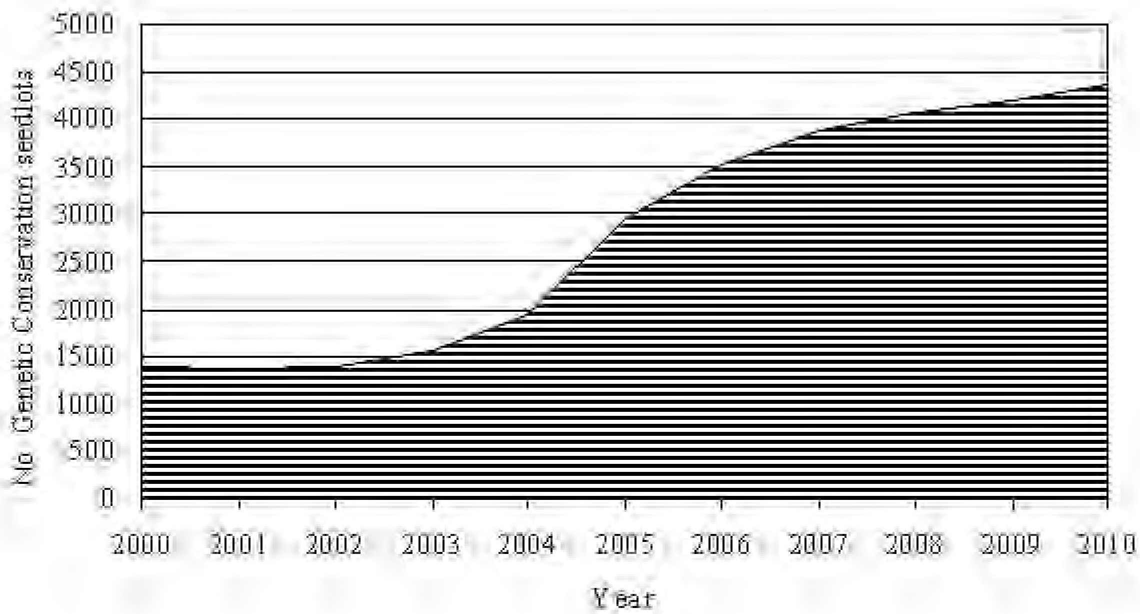

Figure 2. Increase in the number of Genetic Conservation seedlots stored at the NTSC since 2000.

The Reserved category contains seedlots that have been reserved by researchers. Many of these seedlots were collected for special projects. Forty-eight seedlots were exhausted in 2010.

The Tree Breeding category is composed of seedlots that originated from the genetics program at the Petawawa Research Forest and were transferred to the Seed Centre for storage. There was no change in this category.

Table 3. Species and number of seedlots stored in Genetic Conservation.

Species	No.	Species	No.
Abies balsamea	8	*Picea glauca*	1641
Acer negundo	15	*Picea glauca* spp. *albertiana*	9
Acer pensylvanicum	17	*Picea glauca* spp. *porsildii*	15
Acer rubrum	111	*Picea mariana*	413
Acer saccharum	23	*Picea rubens*	25
Acer spicatum	50	*Pinus banksiana*	95
Alnus incana spp. *rugosa*	3	*Pinus contorta* var. *latifolia*	2
Alnus incana spp. *tenuifolia*	1	*Pinus flexilis*	101
Alnus viridis spp. *crispa*	6	*Pinus pinceana*	181
Betula alleghaniensis	57	*Pinus ponderosa*	2
Betula cordifolia	5	*Pinus resinosa*	15
Betula minor	1	*Pinus rigida*	4
Betula papyrifera	10	*Pinus strobus*	32
Betula populifolia	20	*Pinus sylvestris*	12
Betula spp.	1	*Populus balsamifera*	20
Cephalanthus occidentalis	1	*Populus grandidentata*	13
Cornus florida	4	*Populus tremuloides*	16
Fraxinus americana	223	*Prunus pensylvanica*	61
Fraxinus nigra	159	*Prunus virginiana* var. *virginiana*	337
Fraxinus pennsylvanica	155	*Salix lantana* spp. *richardsonii*	1
Fraxinus profunda	1	*Thuja occidentalis*	49
Fraxinus quadrangulata	1	*Thuja plicata*	2
Larix laricina	267	*Tsuga canadensis*	183
Larix occidentalis	1	*Tsuga mertensiana*	1

SEED COLLECTIONS

Seed production was poor for most species in the Maritimes. In order to ensure good quality seed, seed is only collected during good seed years. Seed collected in good seed years is of better genetic quality because of ample pollen production and higher physiological quality due to trees allocating significantly more resources to the developing seed crop. Also, less time is required to collect sufficient seed when there is a good seed crop. A total of 37 seedlots from 6 species was collected by Seed Centre staff (Table 4).

Eight collections were made in New Brunswick and 29 in Quebec. The New Brunswick collections consisted of *Acer saccharinum* and *Quercus rubra*. The *Acer saccharinum* seed was collected by request from a researcher with Michigan State University for a provenance test. In June, Seed Centre staff assisted personnel from CFS-Laurentian, Quebec in collecting seed from several *Populus* species and hybrids. These collections were made as part of a multi-agency project titled "Monitoring of novel genome regions during the introgression process in poplars" which is being led by Dr. Nathalie Isabel of CFS-Laurentian.

Table 4. Seed collections made by Seed Centre staff in 2010.

Species	NB	QC	Total
Acer saccharinum	7		7
Populus balsamifera		4	4
Populus deltoides ssp. *deltoides*		14	14
Populus x *jackii*		6	6
Populus hybrids		5	5
Quercus rubra	1		1
Total	8	29	37

The NTSC also acquires seed via donation and purchase. Two seedlots of *Populus trichocarpa* were purchased from Quality Tree Seed Ltd., Kamloops, BC. Table 5 shows the number of seedlots acquired by the NTSC since 1996. About 57% of the seedlots were obtained through collection and a substantial number, 39%, were donated.

Table 5. Number of seedlots acquired by the NTSC through collection, donation, and purchase between 1996 and 2010.

Year	Number of Seedlots			
	Collection	Donation	Purchase	Total
1996	239	22	0	261
1997	75	245	0	320
1998	284	47	9	340
1999	139	80	0	219
2000	195	673	0	868
2001	137	122	45	304
2002	367	36	0	403
2003	69	142	0	211
2004	549	381	137	1067
2005	142	29	3	184
2006	329	42	30	401
2007	190	181	0	371
2008	160	3	0	163
2009	137	75	30	242
2010	37	0	2	39
Total	3049	2078	256	5383

SEED REQUESTS

The Seed Centre's policy is to provide seed, at no cost, for scientific research. Seed is also provided to universities and other educational institutions for educational purposes and to arboretums. A Seed Request Form must be completed by the client before a seed order is processed. The purpose of this form is to gather information on the type of research being carried out and to serve as a means for screening requests. Seed requests received from international clients are referred to the Canadian Food Inspection Agency to determine if an import permit is required and for the issue of Phytosanitary Certificates.

During 2010, 59 requests representing 822 seedlots were processed. The majority of the requests were from Canada but seed was also sent to Finland, Great Britain, and United States (Table 6). The number of seedlots provided by the NTSC since 1967 has ranged from a low of 99 in 1996 to a high of 1,603 in 1985 (Figure 3). Canadian researchers have received about 70% of the seed while international clients accounted for the remaining 30%.

Table 6. Number of requests and number of seedlots shipped by country in 2010.

Country	No. requests	No. seedlots
Canada	47	510
Finland	1	1
Great Britain	1	105
United States	10	206
Total	59	822

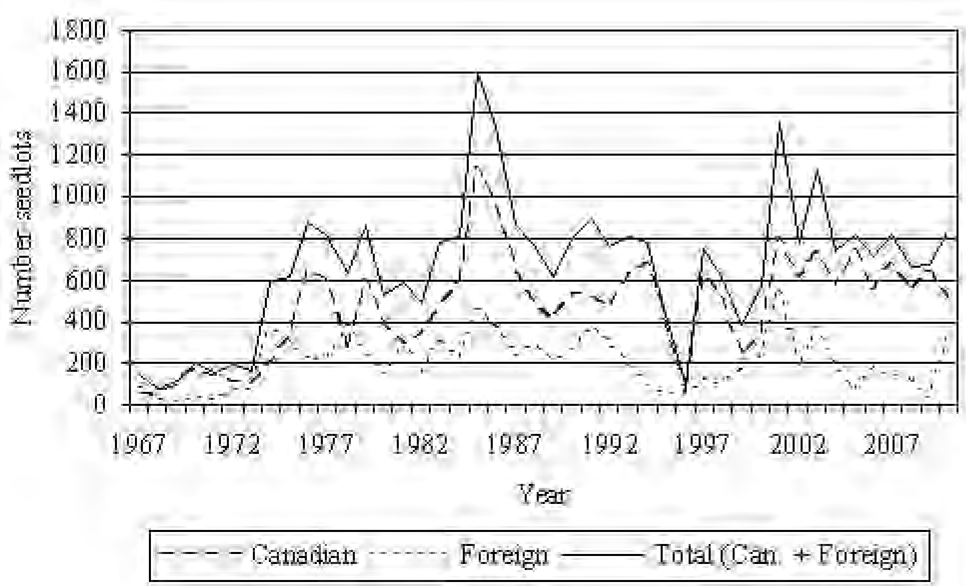

Figure 3. Number of seedlots sent to clients between 1967 and 2010.

SEED TESTING

Germination tests are performed on all seedlots prior to storage as well as seedlots in storage that have not been tested for several years. In most cases four replicates of 50 seeds each are placed on moistened Versa-Pak in Petawawa Germination Boxes. When larger seed are being tested, the number of seed is usually reduced. **Seven hundred and two germination tests** were carried out. Seedlots in storage are tested every 10 years. As testing of these seedlots is completed, the results are used to update the seed storage data.

Figure 4 shows the number of tests carried out by the NTSC since 1983. Some testing was carried out prior to 1983 (1970 – 82), however, the number of tests conducted was low and does not represent a fully operational lab. The reduction in the number of tests between 1994 and 1996 coincided with the transfer of the Seed Centre from Petawawa to Fredericton.

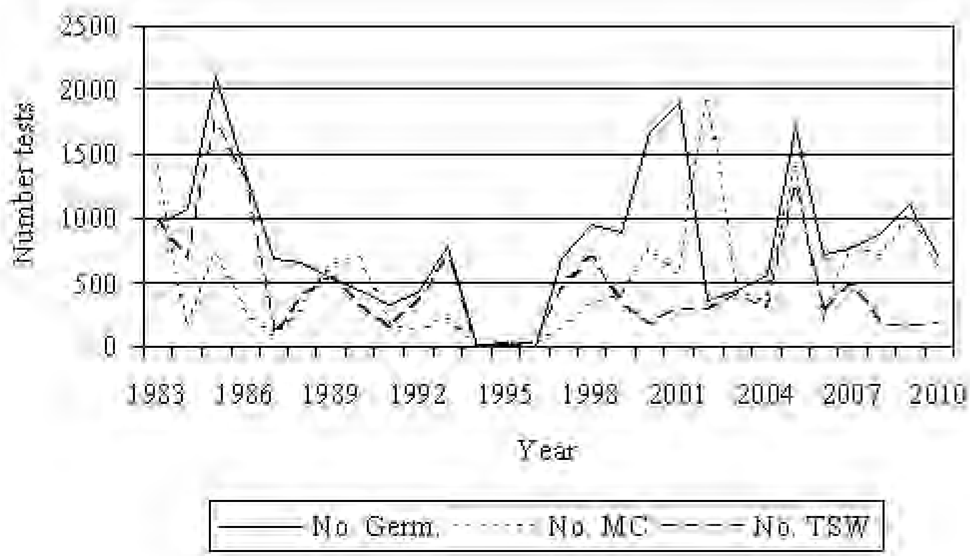

Figure 4. Number of germination tests (No. Germ.), moisture content tests (No. MC), and thousand-seed weight tests (No. TSW) carried out by the NTSC since 1983.

The target moisture content (MC) for orthodox seed is between 5 and 8%. Seed that are above this range are dried before being stored. **Five hundred and eighty-two moisture content** determinations were carried out. MC is checked when seed are re-tested. If MC exceeds 8% the seed are conditioned to lower their MC. **Thirty-four** seedlots were conditioned.

Once MC is within acceptable limits, the 1000-seed weight is determined. This is carried out by counting and weighing eight replicates of 100 seeds. When dealing with small seed (birches, poplars, willows) fewer replicates are performed. When the collected sample is small (less than 800 seeds), the total number of seed is counted, the total weight of the sample is determined, and the 1000-seed weight calculated. A total of **one hundred and eighty-two 1000-seed weights** was done.

SEED CENTRE STRATEGIC PLAN

A strategic plan was developed for the Seed Centre in order to emphasize the importance and utility of *ex situ* conservation. The Canadian Forest Service is well situated to take the lead in Canada for *ex situ* conservation as the Seed Centre has been storing seed for over 40 years and has amassed considerable data useful, among other things, for evaluating the long-term storage potential of many tree species. There is also the opportunity to work and collaborate with the provinces and territories through CON**FOR**GEN (Canadian program for the Conservation of Forest Genetic Resources) on various aspects of *ex situ* conservation. Conservation initiatives also mesh with activities of international organizations such as the Millennium Seed Bank and international agreements such as the Global Strategy for Plant Conservation of the Convention on Biological Diversity.

The mission of the Seed Centre is to safeguard Canada's forest genetic resources in the face of climate change and other threats by acquiring, evaluating, preserving, and providing a national collection of forest genetic resources to assist in securing the forest biological diversity that underpins the sustainable development of Canada's forests.

For safeguarding Canada's forest genetic resources, the Seed Centre will:
1. Adopt and implement a comprehensive strategy in collaboration with the jurisdictions (e.g., through CON**FOR**GEN) to collect and conserve seed for supporting conservation and recovery of natural populations, habitats, and ecosystems.
2. Develop effective deployment and rejuvenation strategies for *ex situ* collections.
3. Conduct research concomitant with collections and banking activities to ensure for effective *ex situ* conservation measures.

Activities to be conducted in 5-year intervals were identified in order to address the following objectives:
1. Undertake and maintain collections.
2. Provide germplasm for research purposes.
3. Research.
4. Strengthen partnerships.
5. Synthesize and integrate national-level information.
6. Develop a national *ex situ* network.

RESEARCH AND DEVELOPMENT

Comparison of Black Ash Excised Embryo Tests vs. Germination Tests

Black ash (*Fraxinus nigra*) seed has been collected since 2004 to conserve germplasm due to the threat to the resource posed by emerald ash borer (*Agrilis planipennis*). Black ash seed pose a challenge to germination because, when shed in the autumn, they are immature and dormant. This necessitates treatments to mature the embryo and alleviate dormancy. Several years ago, a lengthy trial was conducted to determine the duration of treatments to promote maximum germination (Daigle and Simpson 2007). Results demonstrated that seed need to be treated for up to 12 months in order to maximize germination. Due to this long time period, seed quality had been routinely evaluated by viability testing by excising the embryos and incubating them which provided results in less than 21 days. With the collection of 23 seedlots in 2009 it was decided to compare viability testing with germination testing. Fifteen older seedlots were also used.

Methods

To conduct viability tests the seed was removed from the pericarp and placed in water at 3°C for 120 hours. The purpose of this treatment is to soften the seed coat and allow the seed to imbibe moisture making it easier to process. After soaking, an incision was made along the longitudinal axis of the seed and the embryo was removed and placed on Versa-Pak™ in a Petawawa Germination Box. Three replications of up to 25 seed each were prepared. The germination boxes were placed in a Conviron G30 germination cabinet set at 25°C with a daily light duration of 8 hours and a constant relative humidity of 85%. After 14 days the embryos were assessed. An embryo was viable if it remained at the same color (creamy-white) as it was when excised or one or both cotyledons turned green, and/or the radicle started to develop. Embryos showing signs of decay were classified as non-viable.

At the time the viability tests were set up, samples of 100 black ash samaras were placed in plastic bags with about 100 ml of moist peat (moisture content ~ 75%) and subjected to the following treatment combination prior to germination testing: moist chilling for 60 days, warm treatment for 120 days, and moist chilling for 180 days. The cold treatments were carried out in a walk-in cooler (3 C) and the warm treatment was at ambient laboratory temperature (22 C). Upon completion of the treatments, four replicates of 25 seed were placed on moistened Versa-Pak™ in Petawawa Germination Boxes and transferred to a Conviron G30 germination cabinet for 28 days using germination conditions of 8 h light at 30 C followed by 16 h darkness at 20 C with a constant relative humidity of 85%. Germination was assessed every 7 days and successful germination was achieved once radicle emergence had occurred. On day 28, seed that failed to germinate were cut and examined to determine if they were empty, dead, or fresh (filled seed which may be capable of germinating).

Results and Discussion

Overall, germination was substantially less than viability (38% vs. 58%) (Table 7). The likely explanation for this is that many of the ungerminated seed were still dormant. The cut test, following the completion of the germination test, revealed that, on average, 20% of the embryos were fresh as evidenced by being fully elongated, firm, and creamy-white in color. It seems that the seed did not receive a sufficient second duration of moist chilling to alleviate dormancy even though 180 days of moist chilling was ample in the previously reported trial (Daigle and Simpson 2007). When average germination and fresh seed are added, the summed value is the same as mean viability (58%). There were five seedlots (9130029, 20041633, 20091062, 20091072, 20091079) that exhibited germination close to the viability which supports the hypothesis that viability is a good predictor of potential germination.

Literature Cited

Daigle, B.I.; Simpson, J.D. 2007. Black ash germination experiment. Pages 17–30. *In* National Tree Seed Centre Annual Report 2006. Nat. Res. Can., Can. For. Serv-Atlantic, 49 p.

Table 7. Percentage of seed of 38 *Fraxinus nigra* seedlots that germinated or were fresh compared to those that were viable as determined from an excised embryo test.

Seedlot No.	Germ. (%)	Fresh (%)	Germ. + Fresh (%)	Viable (%)
8830125	34	36	70	81
9130028	32	49	81	81
9130029	66	13	79	69
20041619	43	30	73	71
20041620	62	8	70	72
20041621	31	36	67	56
20041622	34	26	60	63
20040625	25	17	42	40
20041627	33	14	47	45
20041630	61	27	88	72
20041631	38	20	58	55
20041632	3	53	56	43
20041633	48	12	60	53
20041634	54	24	78	81
20041635	23	19	42	39
20091062	69	5	74	68
20091063	67	6	73	79
20091064	43	31	74	73
20091065	23	23	46	56
20091066	16	52	68	79
20091067	55	24	79	81
20091068	51	14	65	68
20091069	16	7	23	31
20091070	14	5	19	20
20091071	33	12	45	52
20091072	13	2	15	16
20091073	34	19	53	60
20091074	61	11	72	73
20091075	34	1	35	53
20091076	41	20	61	73
20091077	16	49	65	57
20091078	22	16	38	36
20091079	54	11	65	51
20091080	44	15	59	60
20091081	40	7	47	56
20091082	57	10	67	72
20091083	33	18	51	48
20091084	10	23	33	37
Mean	38	20	58	58

INTERNATIONAL COLLABORATION

In response to the threat to ash species in Canada posed by the emerald ash borer the Seed Centre initiated a seed collection program in 2004 to store seed thereby conserving genetic variation within the ranges of five native ash species. Almost 540 seedlots have been placed in storage (see Table 3). Seed has been collected by Seed Centre staff, donated by cooperators, and purchased from collectors. Figure 5 shows the distribution of collections. Substantially more collections must be made in Quebec, Ontario, and Manitoba. The province of Quebec, through the Ministère des Ressources naturelles et de la faune, has agreed to assist in this effort.

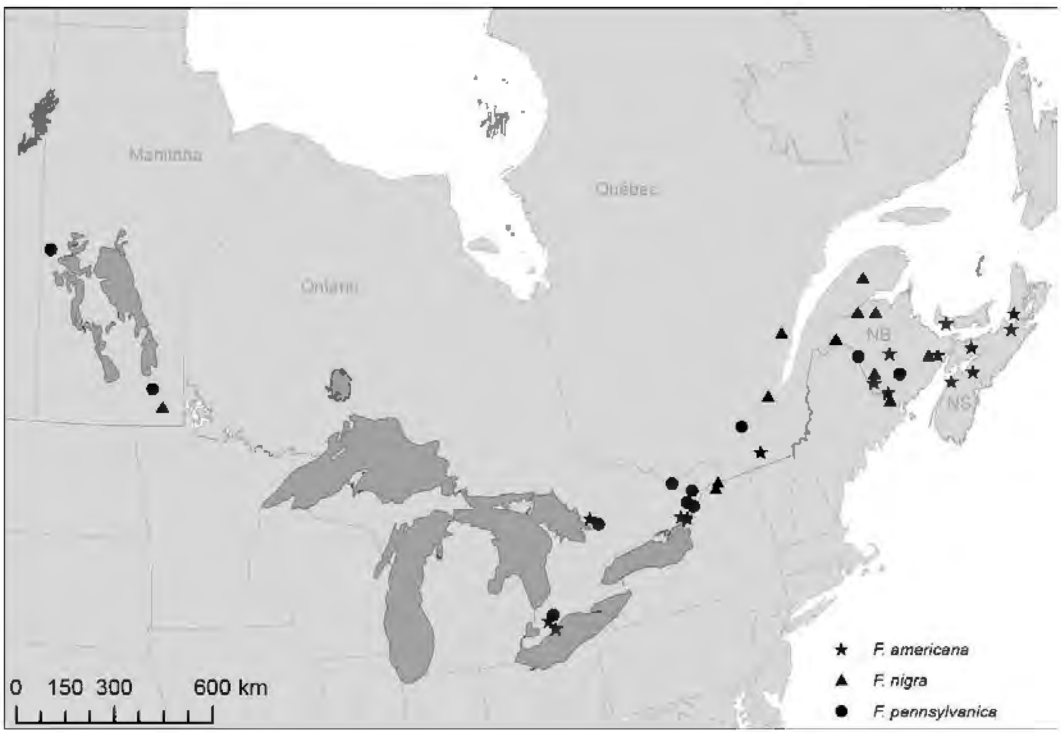

Figure 5. Locations of ash seed collected for genetic conservation.

A similar program was initiated in the United States in 2005. This led to the creation of a reciprocal storage agreement with the US Department of Agriculture, National Centre for Genetic Resources Preservation, Fort Collins, Colorado. This allows for backup storage of each others ash germplasm. Each agency retains ownership and distribution rights for its germplasm. Samples from a total of 105 seedlots comprised of 41 *Fraxinus americana*, 38 *F. nigra*, and 26 *F. pennsylvanica* were sent to the National Centre for Genetic Resources Preservation.

The Seed Centre had the opportunity to host Dr. Michael Way of the Millennium Seed Bank (MSB), Great Britain. The Seed Bank has a goal to store seed from 25% of the world's plants by 2020. Dr. Way was in Canada collecting seed in Alberta and stopped in Fredericton on his return to Britain. He gave a presentation on the MSB's program after which a donation of ash seed was made. The donation was comprised of the same seedlots contributed to the USDA Centre. Again, this provides a means for additional backup storage of this valuable germplasm. In September, Dale Simpson had an opportunity to spend two days at the MSB. This served the purposes of viewing their facilities, meeting some of the staff, and fostering long term cooperation and dialogue.

The Seed Centre was approached by the Arnold Arboretum of Harvard University, Boston, USA to contribute information about its seed inventory. Botanic Gardens Conservation International (BGCI) U.S. partnered with the United States Botanic Garden and the Arnold Arboretum to supplement BGCI's PlantSearch database with taxa-level information on plants maintained at botanical institutions in North America. This is in support of Target 8 of the Global Strategy for Plant Conservation that has a revised goal of ensuring 75% of threatened plant species are in accessible *ex situ* collections, preferably in the country of origin, and 20% of them are included in recovery and restoration programs by 2020. A list of 107 indigenous species for which seed is stored at the Seed Centre was uploaded to BGCI's PlantSearch database. When searched, this database provides a list of occurrences where germplasm is known to occur.

SEED CENTRE PROFILE

Students across Canada can look forward to learning about CFS' valuable contribution to preserving the genetic variation of Canada's forests - the National Tree Seed Centre.

The Seed Centre is featured in a university biology textbook, Biological Science, Canadian Edition, published by Pearson Canada Inc. The article titled "Canada's National Tree Seed Centre" outlines why the Seed Centre collects seed, the proper conditions for seed storage and how seed quality is evaluated (Figure 6). Pearson is working on another biology textbook for grade 11 students and has again chosen to include a brief article about the Seed Centre's role in preserving the genetic variation of Canada's forests.

Canada's National Tree Seed Centre

Trees are one of Canada's most important natural resources. Almost half of Canada's land area is forested: huge boreal forests of pine, spruce, fir, and larch stretch from the Atlantic to the Pacific. Canada's National Tree Seed Centre (NTSC) was founded to support the conservation and study of this key economic and environmental resource.

The National Tree Seed Centre, which is located in Fredericton, New Brunswick, collects and stores seed from all Canadian tree and shrub species. During "good seed years," when seeds are healthy and abundant, Seed Centre staff members gather seeds from a number of trees, collecting a representative genetic sample from natural tree populations across the full natural range of each species (**Figure A**). A typical seed lot weighs about 100 grams and contains 5000 to 50 000 seeds. Detailed information is collected about the source of each set of seeds, making the seeds very useful for university and government researchers from around the world. Seeds have been shipped free-of-charge to researchers in 50 countries, representing every continent except Antarctica.

Why is it important to collect and store seeds from Canadian trees and shrubs? Seeds are collected from a range of stands and from a range of trees within each stand. The goal is to obtain a diverse collection of genetic material, not to select "the best" trees or seeds from each stand. Some tree populations are uniquely adapted to specific environmental conditions. Other populations are endangered or threatened. The tree seed collection thus represents a priceless repository of genetic information. Conservation of genes from natural populations of commercial tree seasons is timely. As natural stands of commercially important tree species are harvested, the cleared land is reforested with genetically improved seedlings grown from seeds collected from seed orchards. As the genetic variation of natural populations declines, the National Tree Seed Centre becomes increasingly vital in conserving the genetic diversity of Canada's trees.

Figure A *Collecting seeds for the National Tree Seed Centre.*

Temperature and moisture are the most critical factors affecting the viability and health of stored seeds. Conifers and some deciduous trees with small seeds are hardy and tolerant to

continued

drying and low temperatures. Their seeds are cleaned, dried, and stored in airtight glass jars kept in large −20°C freezers. Other deciduous trees are less hardy. For example, oak and silver maple seeds are stored at +4°C, with circulating air. Such seeds must be collected often to guarantee a healthy supply of viable seeds.

The viability and health of stored seeds are monitored carefully. A subset of seeds from each collection is tested for germination success before and during storage. **Figure B** shows a germination test, in which seeds are planted in germination boxes in cabinets with light, temperature, and humidity at optimal levels. Seeds of many species can survive for decades when held at low moisture at subzero temperatures. For example, black spruce seeds had a germination success rate of 80 percent after 40 years of storage.

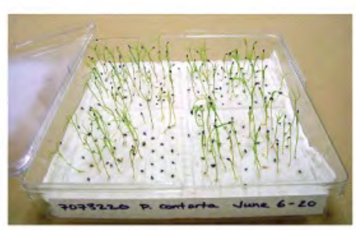

Figure B *Seed viability is assessed by germination tests carried out before and during storage.*

Figure 6. Article about the Seed Centre in Biological Science textbook.

SEED CERTIFICATION

Since 1970, Canada has been applying the OECD (Organization for Economic Cooperation and Development) tree seed certification scheme to seed collected for export. The CFS was nominated by the Government of Canada as the Designated Authority to implement the Scheme. All seed certification has been conducted by the Pacific Forestry Centre in response to demand, primarily by European seed dealers, for seed from west coast tree species. Practically all seed is certified in the Source-identified category.

Demand for certified seed, which was high in the 1970s and 1980s, has declined the past 20 years however the last 5 years were better than the previous 5 years (Figure 7). A total of 245 kg of certified seed was exported in 2010. Ninety-seven kg of coastal Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) seed were exported followed by 75 kg of subalpine fir (*Abies lasiocarpa*) and 59 kg of grand fir (*A. grandis*). Lesser quantities of interior Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) and lodgepole pine (*Pinus contorta* var. *latifolia*) were also exported. The European Union (EU) implemented a revised certification Directive on January 1, 2003. There had been concern about equivalence between this directive and the OECD Scheme. Fortunately, the EU has granted equivalence to Canada for *Abies grandis*, *Picea sitchensis*, *Pinus contorta*, and *Pseudotsuga menziesii* seed to be imported as Source-identified.

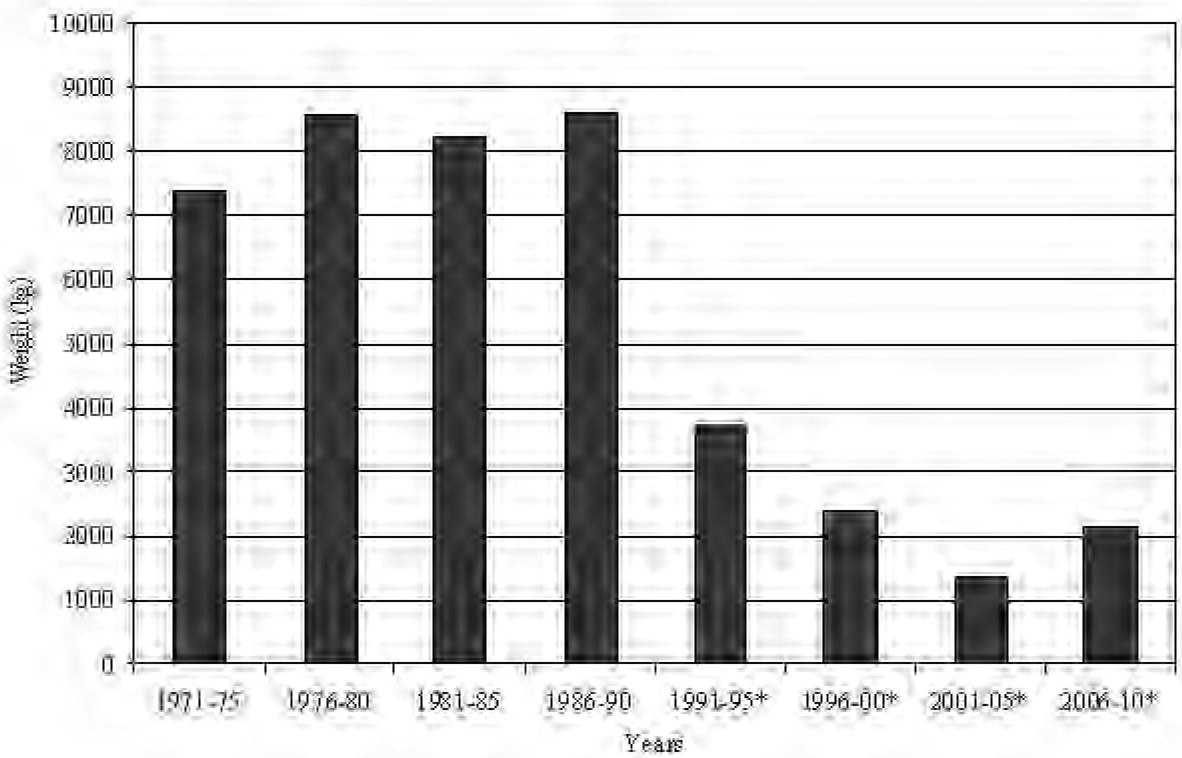

Figure 7. Weight of seed OECD certified or exported* by 5-year periods.

Officially established in 1967, the OECD Scheme for the Control of Forest Reproductive Material Moving in International Trade developed rules and procedures that were adopted in 1974. The Scheme allowed for the certification of seed under four categories: Source-identified (seed collected from a defined geographic area), Selected (seed collected from a stand that was selected for one or more attributes), Untested (seed from untested seed orchards or untested clonal material), and Tested (seed from tested seed orchards or tested clonal material). From its early implementation by a limited number of countries to enable the export of Douglas-fir seed from North America to Europe, the scope of the Scheme was progressively enlarged over time to attract new participants and to deal with many forest tree species. Three countries were granted approval to join the Scheme in 2008: Burkina Faso, Croatia, and Serbia. Several other countries have expressed an interest to join. The Scheme's membership is comprised of 25 countries working with more than 250 tree species.

During the late 1980s, it became apparent that the 1974 Scheme required revision because of changes in forest management (environmental and social aspects, biodiversity conservation, etc.) in addition to wood production and the growing importance on the market of new types of reproductive material derived from forest tree breeding programs. A revised Scheme was adopted on 20 June 2007. The Scheme includes only the Source-identified and Selected categories as these immediately benefit all stakeholders, including new applicant countries that are strengthening their domestic control systems for forest reproductive material. As a result of these updated categories it is hoped that the Scheme will be an incentive for other countries to join. A proposal was presented at the annual meeting in October 2009 for inclusion of the Qualified category which includes seed collected from seed orchards. The text underwent further modifications in 2010 and was approved at the annual meeting in September.

This is another important step forward to once again having a complete Scheme. Having the Qualified category will once again provide an opportunity for the marketing of seed orchard seed, the quantity of which is increasing annually. This will afford producers the ability to obtain appropriate monetary value for seed orchard seed. The Tested category will complete the Scheme and work has started on drafting text for this category.

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SEED CENTRE STAFF

Staff at the NTSC consist of one full-time seed technologist (Bernard Daigle) supervised by Dale Simpson. Mr. Daigle had a development opportunity in a communication/technology transfer position shared between the Canadian Wood Fibre Centre and Atlantic Forestry Centre. This resulted in him leaving the NTSC in mid May. Dale Simpson maintained the essential functions which were filling seed orders and assessing any germination tests that Mr. Daigle had set up.

In late November Chris Allaby was hired as a casual part-time with the Seed Centre. This enabled germination tests, scheduled for 2010, to be set up and assessed. Mr. Allaby worked the equivalent of 3 weeks. Figure 8 summarizes the number of "extra" work weeks provided to the Seed Centre.

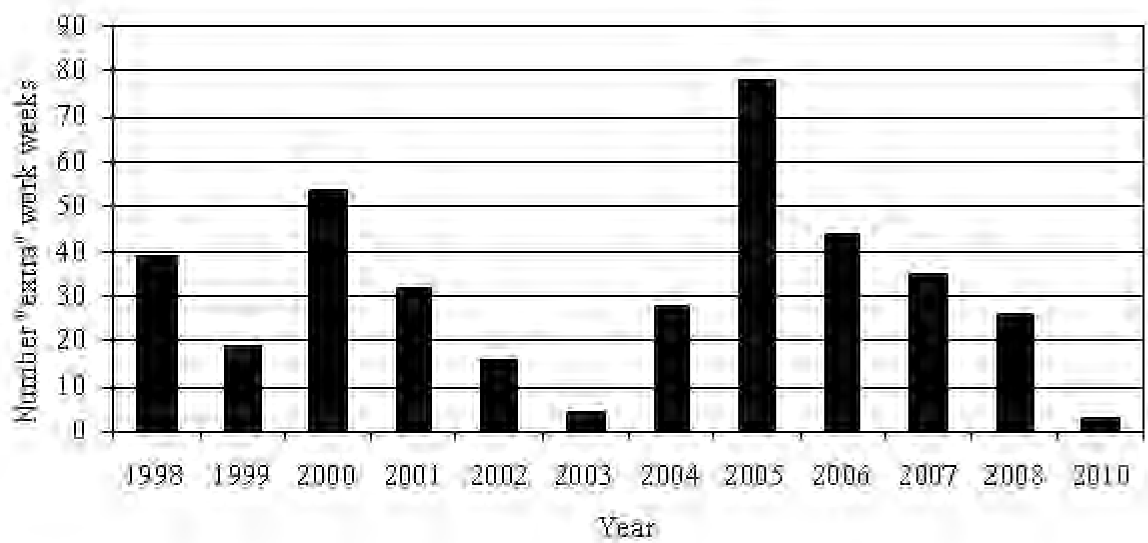

Figure 8. Number of "extra" work weeks provided to the NTSC between 1998 and 2010.