

National Tree Seed Centre

Annual Report

2013



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NATIONAL TREE SEED CENTRE ANNUAL REPORT 2013

EXECUTIVE SUMMARY

The number of seedlots in storage increased to 13,763. Of this number, almost 6,800 seedlots are stored under Seed Bank and are available for research, and over 4,800 seedlots are stored for genetic conservation.

Three collections were made by National Tree Seed Centre staff. In addition, 218 seedlots were donated by various agencies.

A total of 50 requests for seed resulted in 223 seedlots provided for research. The majority of the requests were from Canada (45 requests; 191 seedlots) but seed was also sent to Spain (1 request; 7 seedlots), and United States (4 requests; 25 seedlots).

Seed testing consisted of 359 germination tests, 188 moisture content tests, and 127 thousand-seed weight tests. A significant proportion of the germination testing was 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.

Results from an experiment to determine optimal pre-treatment durations to maximize germination of *Prunus* seed demonstrated that 4 weeks of moist incubation followed by 20 weeks of moist chilling were sufficient for *P. pennsylvanica*, *P. serotina*, and *P. virginiana* var. *virginia*.

The Seed Centre's program of storing ash seed in response to emerald ash borer was featured by both print and television media.

Students from the English and French campuses of the Maritime School of Forest Technology visited the Seed Centre to learn about seed collection, handling, processing, testing, and storage.

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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 (CFS) established the National Tree Seed Centre (NTSC) in 1967 at the Petawawa Research Forest (formerly Petawawa Forest Experiment Station), Chalk River, 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 NTSC played an active role in acquiring and disseminating seed of native and non-native species to researchers to establish provenance trials and other genetic tests. A significant accomplishment of the NTSC 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.

Canada was the first industrialized country to ratify the Convention on Biological Diversity (CBD) in 1992. This national commitment is high-lighted in Article 9: “Establish and maintain facilities for ex-situ conservation of and research on plants, animals and micro- organisms, preferably in the country of origin of genetic resources”. As a signatory to the CBD, Canada was obligated to develop a national biodiversity strategy. Accordingly, a Federal-Provincial-Territorial Biodiversity Working Group was established to develop the Canadian Biodiversity Strategy that was released by the Biodiversity Convention Office of Environment Canada in 1995. Under the Forested Areas section of this Strategy, Strategic Direction 1.74 is to “Establish and maintain forest seed and clonal gene banks to conserve genetic diversity of tree species”. In response to the Canadian Biodiversity Strategy, in 1997 the CFS published a 3-year Action Plan that stated that CFS will “Maintain a national forest seed bank to conserve genetic diversity, while continuing to develop protocols for ex situ conservation of forest genetic resources”.

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 2013. Similar reports were prepared from 1998–2012. 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.

INVENTORY STATUS

Seed is stored in four categories: Seed Bank, Genetic Conservation, Reserved, and Tree Breeding (Table 1). The total number of seedlots increased by 170 to 13,763 in 2013. The numbers in brackets in Table 1 represent the numbers reported in the 2012 Annual Report.

Table 1. Seed stored at the NTSC as of December 31, 2013.

Seed Bank		Genetic Conservation		Reserved		Tree Breeding	
No. species	No. seedlots	No. species	No. seedlots	No. species	No. seedlots	No. species	No. seedlots
148	6,800	50	4,847	37	1,726	10	390
(148)	(6,689)	(50)	(4,788)	(37)	(1,726)	(10)	(390)

The Seed Bank category is the active portion of the collection and represents seedlots that are available for distribution for research. Since 1998, the number of seedlots in the Seed Bank collection has increased from 3,079 to 6,800 (Figure 1). This number includes seedlots from native and non-native species. 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 2013, 16 seedlots were discarded and 20 seedlots were depleted.

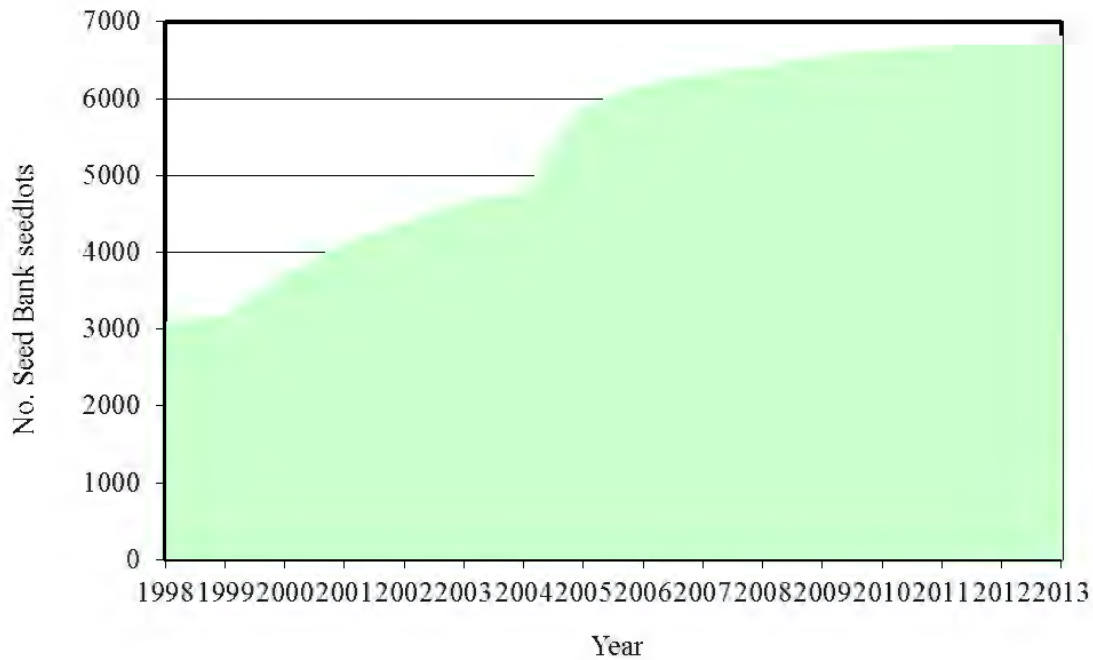


Figure 1. Increase in number of Seed Bank seedlots stored at the NTSC since 1998.

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, 2013, the NTSC Seed Bank had 6,481 seedlots of 105 species in storage from locations in Canada (Table 2). Seed from 55 non-native species as well as native species from the United States (319 seedlots) are also stored. Seed is also stored from non-native species growing in Canada, but most of the 319 seedlots are from species native to other countries. The proportion of seedlots from non-native species continues to decrease as seedlots are discarded due to low germination or are exhausted due to client requests. No effort is made to replace them.

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

Province	No. species	No. seedlots	Percent
Alberta	12	47	0.7
British Columbia	32	354	5.5
Manitoba	7	65	1.0
New Brunswick	63	1,497	23.1
Newfoundland and Labrador	17	169	2.6
Nova Scotia	39	552	8.5
Ontario	46	2,324	35.8
Prince Edward Island	34	253	4.0
Quebec	22	1,046	16.1
Saskatchewan	8	123	1.9
Yukon Territory	3	51	0.8
Total	105	6,481	100

Since the NTSC moved to Fredericton, staff have concentrated their efforts acquiring collections from New Brunswick, Nova Scotia, and Prince Edward Island. Travel beyond the Maritime provinces is challenging due to limited resources (staff and budget). There is an ongoing effort to acquire seed from other provinces and seed centres when opportunities arise. 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 conserve the genetic variation occurring in natural populations as well as to ensure that genetic material from rare, endangered, and/or unique populations is preserved. Over the past eight years, seed collecting has focused on expanding the genetic conservation collection. Any surplus seed from these collections is placed in Seed Bank. The collection increased by 59 to 4,847 seedlots primarily due to two important donations. The Quebec Ministry of Natural Resources donated 41 ash

collections of *Fraxinus nigra* and *F. pennsylvanica* because these species are threatened by emerald ash borer (*Agrilus planipennis*). The second donation was 15 seedlots of *Pinus albicaulis* from three National Parks located in Alberta and British Columbia. The Seed Centre is providing back-up storage of germplasm from this nationally listed endangered species. Figure 2 shows the increase in the number of seedlots in this category since 2000. There is seed from 50 species in Genetic Conservation with the number of seedlots ranging from 1 to 1,641 (Table 3).

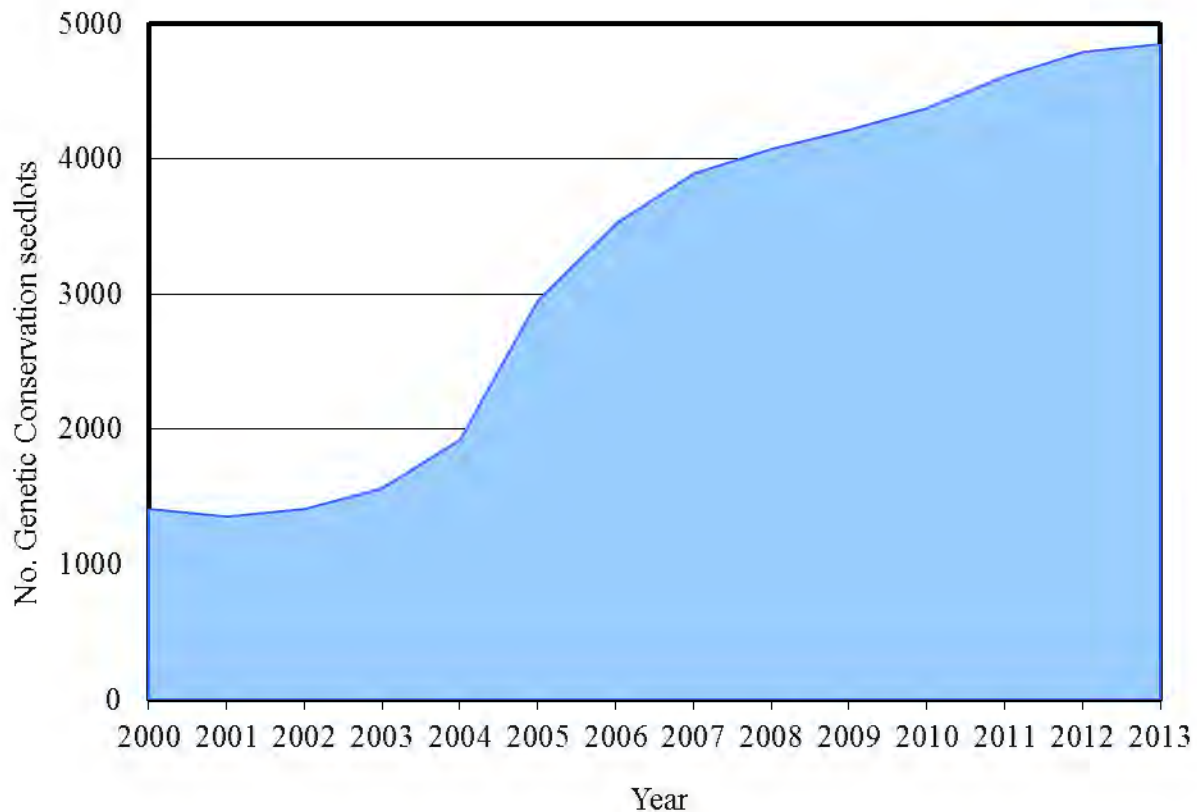


Figure 2. Increase in the number of Genetic Conservation seedlots stored at the NTSC since 2000.

The Reserved category contains seedlots that have been reserved by researchers. Many of these seedlots were collected for special projects. There was no change in this category.

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

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

Species	No. seedlots	Species	No. seedlots
<i>Abies balsamea</i>	8	<i>Picea glauca</i>	1,641
<i>Acer negundo</i>	15	<i>Picea glauca</i> var. <i>albertiana</i>	9
<i>Acer pensylvanicum</i>	17	<i>Picea glauca</i> ssp. <i>porsildii</i>	15
<i>Acer rubrum</i>	111	<i>Picea mariana</i>	433
<i>Acer saccharum</i>	23	<i>Picea rubens</i>	222
<i>Acer spicatum</i>	49	<i>Pinus albicaulis</i>	37
<i>Alnus incana</i> spp. <i>rugosa</i>	3	<i>Pinus banksiana</i>	95
<i>Alnus incana</i> spp. <i>tenuifolia</i>	1	<i>Pinus contorta</i> var. <i>latifolia</i>	4
<i>Alnus serrulata</i>	2	<i>Pinus flexilis</i>	101
<i>Alnus viridis</i> spp. <i>crispa</i>	9	<i>Pinus pinceana</i>	181
<i>Betula alleghaniensis</i>	57	<i>Pinus ponderosa</i>	2
<i>Betula cordifolia</i>	5	<i>Pinus resinosa</i>	15
<i>Betula minor</i>	1	<i>Pinus rigida</i>	4
<i>Betula papyrifera</i>	10	<i>Pinus strobus</i>	52
<i>Betula populifolia</i>	20	<i>Pinus sylvestris</i>	12
<i>Betula</i> spp.	1	<i>Populus balsamifera</i>	20
<i>Cephalanthus occidentalis</i>	1	<i>Populus grandidentata</i>	13
<i>Cornus florida</i>	4	<i>Populus tremuloides</i>	16
<i>Fraxinus americana</i>	247	<i>Prunus pensylvanica</i>	61
<i>Fraxinus nigra</i>	200	<i>Prunus virginiana</i> var. <i>virginiana</i>	337
<i>Fraxinus pennsylvanica</i>	247	<i>Salix lantana</i> spp. <i>richardsonii</i>	1
<i>Fraxinus profunda</i>	1	<i>Thuja occidentalis</i>	89
<i>Fraxinus quadrangulata</i>	1	<i>Thuja plicata</i>	2
<i>Larix laricina</i>	267	<i>Tsuga canadensis</i>	183
<i>Larix occidentalis</i>	1	<i>Tsuga mertensiana</i>	1

SEED COLLECTIONS

Seed production was average and variable 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. Three collections were made (Table 4). *Prunus virginiana* var. *virginiana* fruit were collected for comparison with Alberta sources for a germination experiment to determine the duration of incubation and moist chilling treatments that maximizes germination. The *Quercus rubra* acorns were collected to provide a source of material to service seed requests.

Table 4. Seed collections made by Seed Centre staff in 2013.

Species	Total
<i>Prunus virginiana</i> var. <i>virginiana</i>	1
<i>Quercus rubra</i>	2

The NTSC also acquired seed via donation. Fifty-two seedlots from five species were provided by Canfor Corporation through the BC Forest Tree Seed Centre. The seed was no longer required and the donation consisted of: 2 *Pinus monticola*, 3 *P. ponderosa*, 3 *Pseudotsuga menziesii* var. *glauca*, 6 *Larix occidentalis*, and 38 *Picea glauca* x *engelmannii*. The province of Alberta donated four seedlots of *Picea glauca*. The province of Saskatchewan donated two seedlots of *Pinus contorta* var. *latifolia* from Cypress Hill Provincial Park where the species occurs as the most eastern population well outside its contiguous range.

There was a good seed crop on ash, particularly in Ontario and Quebec. This resulted in donations in order to conserve ash germplasm due to the threat to the resource posed by emerald ash borer. The Quebec Ministry of Natural Resources sent 16 *Fraxinus nigra* and 25 *F. pennsylvanica*. In Ontario, Trees Ontario, the Forest Gene Conservation Association, and the Tree Seed Plant cooperated to contract collections by certified collectors and to cover the shipping costs. This effort resulted in: 16 *F. americana*, 16 *F. nigra*, 53 *F. pennsylvanica*, and 15 *F. quadrangulata* collections. In addition Point Pelee National Park donated three *F. quadrangulata* collections. The Nova Scotia Department of Natural Resources donated one collection of *F. nigra*. Cooperation from agencies and other seed centres by donating seed to the Seed Centre is greatly appreciated.

Table 5 shows the number of seedlots acquired by the NTSC since 1996. About 52% of the seedlots were obtained through collection and a substantial number, 43%, were donated. The remaining 5% were purchased.

Table 5. Number of seedlots acquired by the NTSC through collection, donation, and purchase between 1996 and 2013.

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	1,067
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
2011	104	13	57	170
2012	1	258	0	259
2013	3	218	0	207
Total	3,157	2,567	313	6,037

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 arboreta and botanic gardens. 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 2013, 50 requests representing 223 seedlots were processed. The majority of the requests were from Canada but seed was also sent to Spain and United States (Table 6). Thirteen more requests were received than in 2012 however 90 fewer seedlots were requested. 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 clients 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 2013.

Country	No. requests	No. seedlots
Canada	45	191
Spain	1	7
United States	4	25
Total	50	223

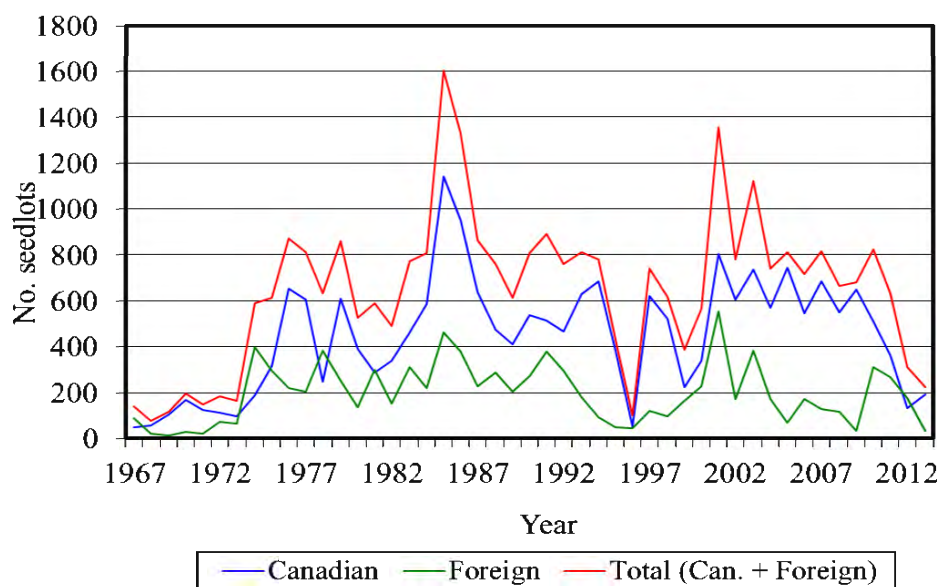


Figure 3. Number of seedlots sent to clients between 1967 and 2013.

SEED TESTING

Germination tests are performed on all seedlots prior to storage as well as seedlots in storage. 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. **Three hundred and fifty-nine germination tests** were carried out. Newly acquired seedlots are tested before being placed in storage. Seedlots in storage are tested every 10 years.

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. The reduction in the number of tests between 1994 and 1996 coincided with the transfer of the NTSC from Petawawa to Fredericton.

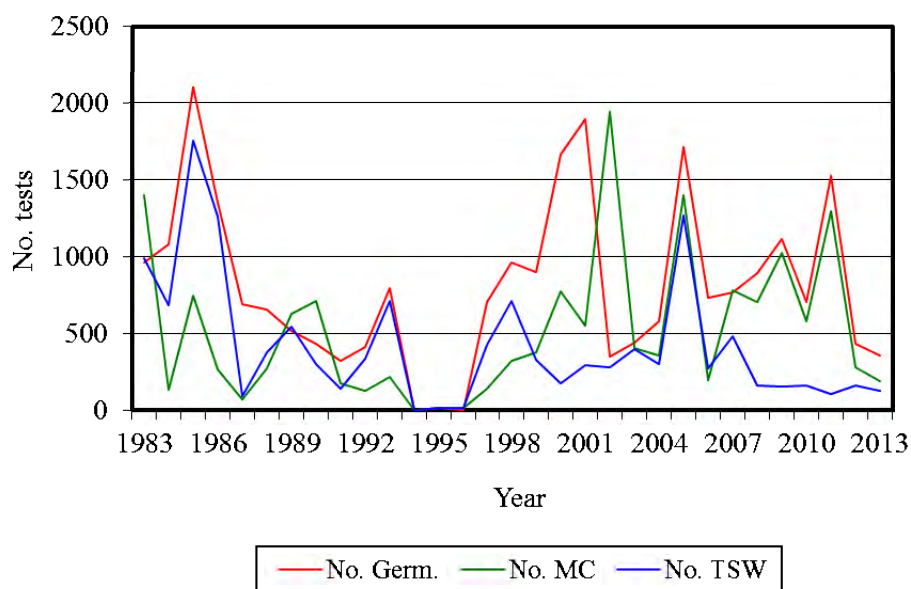


Figure 4. Number of germination tests (No. Germ.), moisture content tests (No. MC), and thousand-seed weight tests (No. TSW) carried out by the NTSC since 1983.

The target moisture content (MC) for orthodox seed is between 5 and 8%. Seed that are above this range are dried before being stored. **One hundred and eighty-eight moisture content** determinations were carried out. MC is often checked when seed are re-tested particularly those seedlots approaching 8%. When MC exceeds 8% the seed are conditioned to lower their MC. Forty-eight 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 (alders, 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 twenty-seven 1000-seed weights** was done.

RESEARCH AND DEVELOPMENT

***Prunus* Germination Experiment**

This experiment is a follow-up to a germination trial that was reported in the 2009 NTSC Annual Report where a single seedlot from three native *Prunus* species: pin cherry (*P. pennsylvanica*), black cherry (*P. serotina*), and choke cherry (*P. virginiana* var. *virginiana*) was tested to examine germination protocols. The treatments used in 2009 involved combinations of moist chilling pre-treatment (0 and 12 weeks at 3°C); moist incubation (0, 6, and 12 weeks at 20°C); and moist chilling (12, 24, and 36 weeks at 3°C) (Daigle and Simpson 2010).

Germination of seeds can be delayed by various forms of dormancy which may include impermeable membranes, hard seed coats, immature embryos, and chemical inhibitors. Seed will not germinate until dormancy is overcome. Treatments required to alleviate dormancy can include moist chilling, moist incubation, and scarification (mechanical, chemical) of the seed. A combination of dormancy factors is often present in species that are difficult to germinate. Although the endocarp of *Prunus* seed is hard and somewhat impermeable to water, the seed coat that surrounds the embryo is permeable to water and does not appear to impede germination. Grisez et al. (2008) reported that treatments designed to crack, remove, or soften the endocarp such as freezing, mechanical scarification, boiling water, sulfuric acid, citric acid, lye, or hydrogen peroxide did not improve germination and were, in many cases, detrimental.

Germination results for the trial conducted in 2009 varied among species and treatments. Best germination obtained was 40% for pin cherry (6 weeks moist incubation (20°C), 28 weeks moist chilling); 92% for black cherry (6 weeks moist incubation, 36 weeks moist chilling), and 69% for choke cherry (6 weeks moist incubation, 28 and 36 weeks moist chilling). The duration of some of the treatments was too long as many seeds germinated during that time. This follow-up experiment was designed to fine tune the seed treatment protocols for these three *Prunus* species that are considered by some to be difficult to germinate.

Methods

The results from the 2009 germination experiment were taken into account when deciding on the treatments for this follow-up trial. Four single-tree seedlots for each species were selected — two each from two provenances. All seedlots had been in frozen storage (-20°C) for several years. One hundred seeds for each of the treatments were placed in 250 ml of moistened peat (moisture content ~ 78%) and put into plastic zip-loc bags and subjected to the various treatments. The bags were opened for 24 hours every 4 weeks to allow for air exchange. Following treatments, four replicates of 25 seeds each were placed on moistened VersaPak™ in Petawawa Germination Boxes and placed in a Conviron germination cabinet set on a 24-hour cycle of 30°C for 8 hours with light followed by 16 hours at 20°C without light and at a constant relative humidity of 85%.

Results and Discussion

Pin cherry (*Prunus pensylvanica*)

Two seedlots collected at Dunbar, New Brunswick (46.13334° N; 66.70000° W) in 2004 and two seedlots collected in 2005 from Island Lake, New Brunswick (47.63334° N; 66.40000° W) were used for this trial.

Grisez et al. (2008) recommended 60 days of warm stratification followed by 90 days cold stratification. Kock (2008) recommended a 30 to 60 day warm stratification period followed by 120 to 150 days cold stratification. AOSA (2002) recommended excising the embryo and using tetrazolium stain for all *Prunus* species and ISTA (2010) did not include *P. pensylvanica* on its species list.

The four seedlots were subjected to the following treatments: moist incubation durations of 0, 4, 6, and 8 weeks at 20°C followed by moist chilling durations of 16, 24, and 32 weeks at 3°C. A control, where no treatments were applied, was also tested.

Mean germination of the two seedlots from Dunbar was consistently better than the two seedlots collected at Island Lake (Table 7). As was the case with the first experiment, many of the seed germinated during moist chilling (Table 7 – shaded area). This suggests that the moist chilling durations exceeded the requirements of the seeds and appear to have damaged the seed as best germination (39%) was observed with a moist incubation of 4 weeks followed by 16 weeks of moist chilling. Future testing should include a moist chilling duration of 20 weeks in order to evaluate if this duration is sufficient to alleviate dormancy and to reduce germination during chilling.

Table 7. Mean germination (%) of *Prunus pensylvanica* seed from two provenances following 0, 4, 6 and 8 weeks of moist incubation and 16, 24 and 32 weeks of moist chilling. Shaded area indicates seed germination during moist chilling.

Provenance	Moist Chilling (weeks)	Moist Incubation (weeks)			
		0	4	6	8
Dunbar	16	15.0	39.0	31.5	14.0
Island Lake	16	0.0	3.5	1.5	1.5
Dunbar	24	11.0	28.0	15.0	33.5
Island Lake	24	0.0	4.0	2.0	2.0
Dunbar	32	24.5	34.5	34.0	22.5
Island Lake	32	1.0	4.5	2.0	0.0

Black cherry (*Prunus serotina*)

Two single-tree seedlots collected at Kennetcook, Nova Scotia (45.13334° N; 63.78333° W) and two from New Canaan, New Brunswick (46.08333° N; 65.31667° W), both collected in 2002, were used for this trial.

ISTA (2010) recommended 3–4 months of moist chilling at 3–5°C, while Grisez et al. (2008) recommended 120 days and Kock (2008) recommended 120 to 150 days cold stratification. Seed may also benefit from moist incubation. Bettez (1997) recommended 2 weeks at 20°C followed by 6 weeks at 3°C followed by another week at 20°C and finally 7 to 11 weeks at 3°C. Daigle and Simpson (2010) found that germination increased from 39–90 % when seed that were moist chilled for 24 weeks were first given a moist incubation treatment of 6 weeks.

The four seedlots were subjected to the following treatments: moist incubation durations of 0, 4, 6, and 8 weeks at 20°C followed by moist chilling durations of 16, 20, and 24 weeks at 3°C. A control, where no treatments were applied, was also tested.

Best results (97% and 91.5%) were obtained for seed that were given a moist incubation treatment of 4 weeks followed by 24 weeks of moist chilling (Table 8). However, many of these seeds exhibited radicle elongation and, in some cases, germination during moist chilling which suggests that the moist chilling duration was too long (Table 8 – shaded area). It is interesting to note that germination did not occur during 20 weeks of moist chilling when these seeds were subjected to a 4 week moist incubation pre-treatment.

Table 8. Mean germination (%) of *Prunus serotina* seed from two provenances following 0, 4, 6 and 8 weeks of moist incubation and 16, 20 and 24 weeks of moist chilling. Shaded area indicates seed germination during moist chilling.

Provenance	Moist Chilling (weeks)	Moist Incubation (weeks)			
		0	4	6	8
Kennetcook	16	89.0	88.0	78.5	70.0
New Canaan	16	78.5	72.0	54.5	51.5
Kennetcook	20	86.5	95.5	90.5	88.0
New Canaan	20	78.0	86.0	73.5	63.0
Kennetcook	24	95.0	97.0	94.5	91.0
New Canaan	24	79.0	91.5	82.0	70.5

Choke cherry (*Prunus virginiana* var. *virginiana*)

Two single-tree seedlots collected at Canaan, New Brunswick (46.08333° N; 65.41666° W) in 2004 and two collected near Antigonish, Nova Scotia (45.60981° N; 62.27333° W) in 2006 were used for this trial.

Stratification of choke cherry seed requires a long period of moist chilling: Grisez et al. (2008) recommended 120 to 160 days; Kock (2008) recommended 120 to 150 days; Lockley (1980) recommended 16–24 weeks but found that approximately 50% of the seed stratified for 24 weeks germinated during stratification; and Rowley et al. (2007) recommended 16 weeks for choke cherry seed collected from high-elevation ecotypes of southeastern Idaho. Lockley (1980) also reported that germination improved for seed that were stratified for 16 weeks, germinated at 21–27°C, and then re-stratified for an additional 9 weeks. AOSA (2002) recommended excising the embryo and using tetrazolium stain for all *Prunus* species and ISTA (2010) did not include choke cherry on its species list. Daigle and Simpson (2010) found that a moist incubation pre-treatment improved germination of choke cherry seed and that at least 24 weeks of moist chilling was needed. They also found that seed subjected to the longer duration treatments germinated during moist chilling.

The four seedlots used in this trial were subjected to the following treatments: moist incubation durations of 0, 4, 6, and 8 weeks at 20°C followed by moist chilling durations of 16, 24, and 32 weeks at 3°C. A control, where no treatments were applied, was also tested.

All treatments that included a period of moist incubation produced higher germination (Table 9). Seed subjected to the longer treatment durations germinated while being moist chilled (Table 9 – shaded area). For example, 88.3% of the seed subjected to 4 weeks moist incubation followed by 24 weeks moist chilling germinated during moist chilling. Radicle length of these germinants ranged from 1–5 cm.

Table 9. Mean germination (%) of *Prunus virginiana* var. *virginiana* seed from two provenances following 0, 4, 6 and 8 weeks of moist incubation and 16, 24 and 32 weeks of moist chilling. Shaded area indicates seed germination during moist chilling.

Provenance	Moist Chilling (weeks)	Moist Incubation (weeks)			
		0	4	6	8
Canaan	16	26.0	46.5	46.0	43.5
Antigonish	16	26.5	69.0	62.0	73.0
Canaan	24	48.5	94.0	85.5	92.5
Antigonish	24	29.0	92.5	94.0	94.5
Canaan	32	41.5	92.5	82.0	85.5
Antigonish	32	11.5	88.0	96.0	99.0

Conclusions

The results of both germination experiments on choke cherry seed carried out by the NTSC in 2009 and 2012/2013 clearly demonstrate the advantage of moist incubation as part of the protocol to achieve high germination. Most of the literature does not include moist incubation as a recommended treatment for germinating choke cherry seed. The only exception that was found was a study by Lockley (1980) who observed that some non-germinated seed that were returned to chilling following an attempt at germination germinated after an additional 9 weeks of chilling.

Although the results indicate high seed germination, it could be challenging for a grower to manage in an operational situation. Growers prefer to work with seed that are intact. It appears that the experimental design did not determine the optimum stratification requirements as is evidenced by the high number of seed that germinated during treatment. Future testing should include a moist chilling duration of 20 weeks which would hopefully be sufficient to alleviate dormancy without initiating germination. Growers might consider sowing the seed before dormancy is completely alleviated and explore ways of satisfying the stratification requirements after the seeds are sown.

Another avenue that could be explored is germinating the seed at cooler temperatures. Most researchers reported that *Prunus* seed germinated during moist chilling. This suggests that warm temperatures, such as 20°C/30°C which is the general germination standard, may not be necessary for germination of *Prunus* seeds.

Based on the results of this experiment the following treatments and durations are recommended:
pin cherry – 4 weeks moist incubation followed by 20 weeks moist chilling
black cherry – 4 weeks moist incubation followed by 20 weeks moist chilling
choke cherry – 4 weeks moist incubation followed by 20 weeks moist chilling.

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SEED CERTIFICATION

Canada has been applying the OECD (Organization for Economic Cooperation and Development) tree seed certification scheme since 1970 to seed collected for export to Europe. 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 has been certified in the Source-identified category.

Demand for certified seed, which was high in the 1970s and 1980s, has declined the past 20 years (Figure 6) due to less demand from European importers. A total of 202 kg of certified seed was exported in 2013. Grand fir (*Abies grandis*) accounted for 155 kg of the total weight of seed exported. Other species included subalpine fir (*Abies lasiocarpa*), lodgepole pine (*Pinus contorta* var. *latifolia*), and Douglas-fir (*Pseudotsuga menziesii* var. *glauca*).

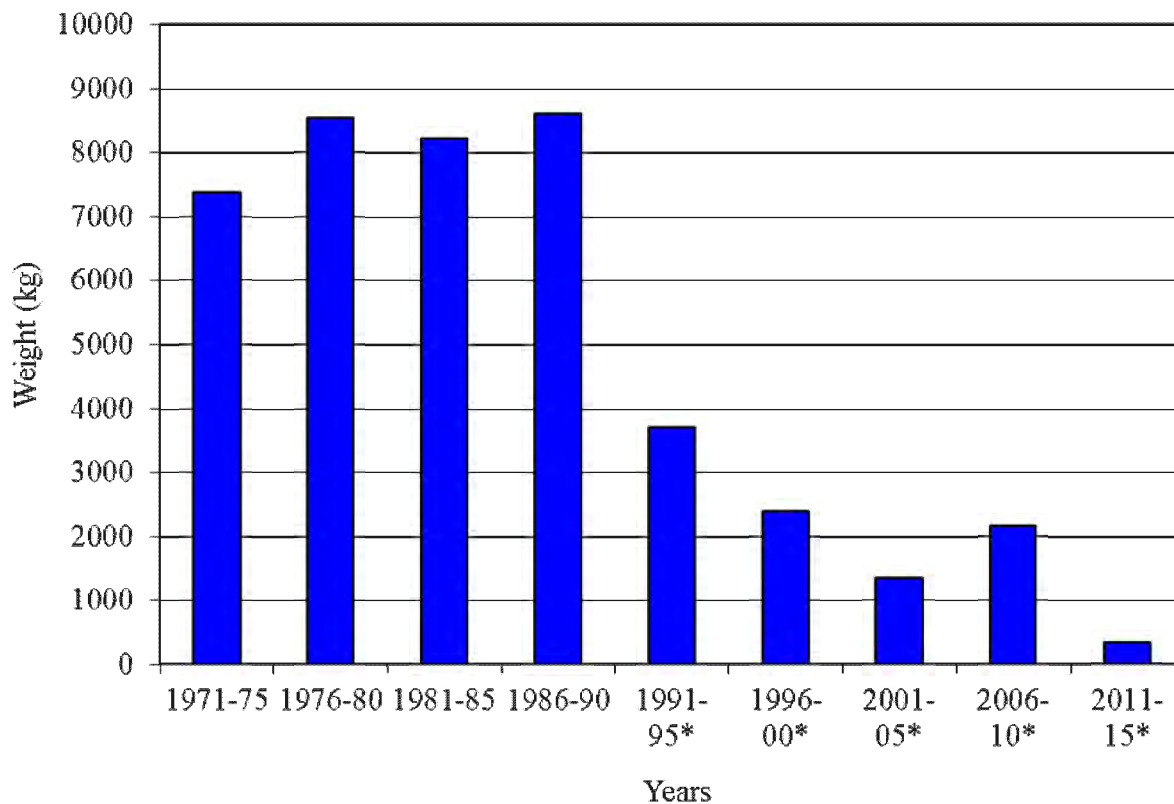


Figure 5. Weight of seed OECD certified or exported* by 5-year periods.

Officially established in 1967, the OECD Scheme for the Control of Forest Reproductive Material Moving in International Trade contained 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 (*Pseudotsuga menziesii*) 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. The Scheme's membership is comprised of 25 countries (primarily European with three from Africa and Canada and United States) 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 of marketing new types of reproductive material derived from forest tree breeding programs. A revised Scheme, adopted in 2007, is called the OECD Scheme for the Certification of Forest Reproductive Material Moving in International Trade only included the Source-identified and Selected categories. These categories benefit all stakeholders, including new applicant countries that are strengthening their domestic control systems for forest reproductive material. Inclusion of the Qualified category was approved in 2010. Having the Qualified category provided 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, which was approved in 2012, completes the Scheme. This category includes reproductive material from seed orchards as well as parents of families, clones, and clonal mixtures that have been tested thus demonstrating its genetic superiority. Now that the Scheme is once again complete it is hoped that it will be an incentive for more countries to join.

At the annual meeting held in September Kenya and Uganda's application to join the Scheme was accepted by member countries. Being members of the Scheme allows these countries to better market their seed to other African countries.

Other issues and topics that are being discussed and developed include: impact of climate change on adaptation of seed; marketing of forest reproductive materials in member countries; use of forest genetic resources in member countries; and applying the Scheme's rules to multifunctional forest trees, e.g., production of fruit, gums, honey, cork, etc.

PUBLICATIONS AND PRESENTATIONS

- Liu, J.; Bai, Y.; Lamb, E.G.; Simpson, D.; Liu, G.; Wei, Y.; Wang, D.; McKenny, D.W.; Papadopol, P. 2013. Patterns of cross-continental variation in tree seed mass in the Canadian boreal forest. PLoS One 8(4):e61060. doi:10.1371/journal.pone.0061060
- Simpson, D. 2013. Broadleaf reproductive biology. Presented at Tree Seed Working Group seed workshop, 22 July 2013, Surry, BC.
- Simpson, D. 2013. Broadleaf reproductive biology. Canadian Forest Genetics Association, Tree Seed Working Group, Newsbulletin 57:4.
- Simpson, D.; Daigle, D. 2013. Storage potential of spruce and pine seed. Canadian Forest Genetics Association, Tree Seed Working Group, Newsbulletin 56:19–22.

SEED CENTRE PROMOTION

Throughout the year opportunities arose to promote the Seed Centre. This was accomplished via print and television media, tours, and visits. Some of the more notable events of 2013 are mentioned below.

On July 22 Global News New Brunswick did a TV report on the Seed Centre's ash seed collection and storage program in response to the devastating impact that emerald ash borer is having on the resource.

On July 22 an article entitled "An Unlikely Ark in Fredericton" was published in the St. John Telegraph-Journal and Moncton Times & Transcript newspapers in regard to the Seed Centre's ash seed storage program.

On August 3 there was a Letter to the Editor in the Fredericton Daily Gleaner newspaper supporting the existence of the Seed Centre. See following text.



On November 13 students from the Maritime College of Forest Technology, Fredericton paid a visit to learn about seed biology, collection, storage, and testing

On November 18 Javier Gracia-Garza, Director General, Science Program Branch of the CFS, visited the Seed Centre and was provided with an overview of the operation and priorities.

On November 29 students from the Collège de technologie forestières des maritimes, Bathurst paid a visit to learn about seed biology, collection, storage, and testing.

SEED CENTRE STAFF

Bernard Daigle who had worked as a full-time Seed Technologist was successful in staffing the knowledge exchange position that is shared between the Canadian Wood Fibre Centre and Atlantic Forestry Centre. Before his departure he was able to set up and evaluate a seed pre-treatment germination trial for *Prunus pennsylvanica*, *P. serotina* and *P. virginiana* var. *virginiana*. Dale Simpson maintained essential functions such as filling seed orders and setting up/assessing germination tests.

Peter Moreland was assigned to provide technical support for germination testing and seed processing. Mr. Moreland started in late July working 1.5 days per week and this was extended to 4 days per week in late November. Figure 7 summarizes the number of “extra” work weeks provided to the Seed Centre. The chart assumes that there was a full-time seed technologist.

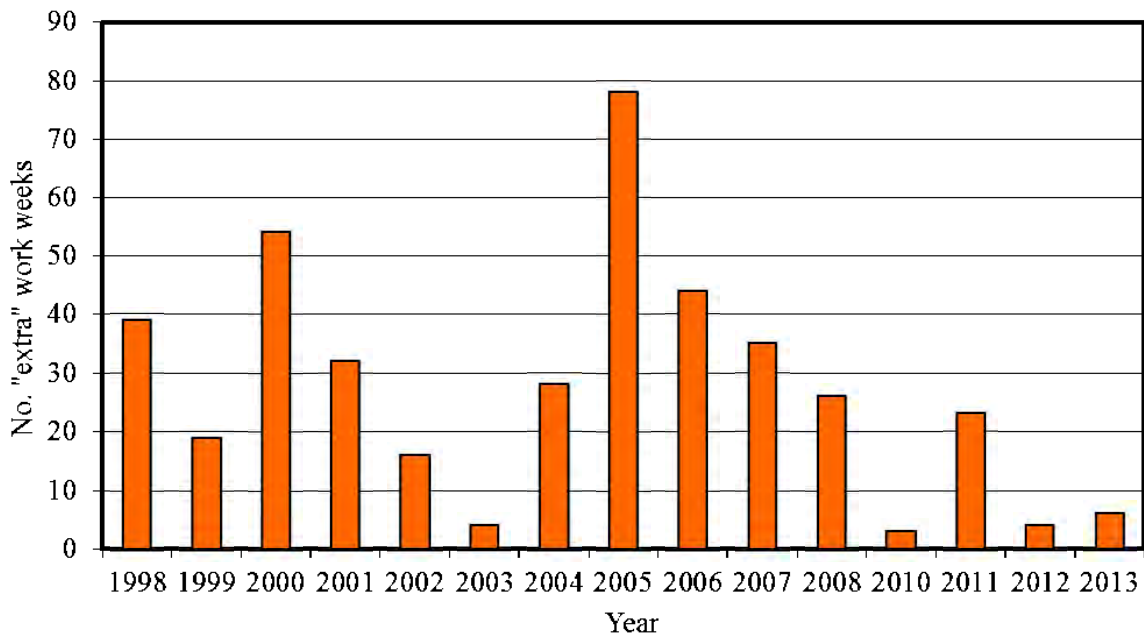


Figure 6. Number of “extra” work weeks provided to the NTSC between 1998 and 2013.