

National Tree Seed Centre

Annual Report

2014



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Natural Resources Canada
Canadian Forest Service
Atlantic Forestry Centre
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NATIONAL TREE SEED CENTRE ANNUAL REPORT 2014

EXECUTIVE SUMMARY

The number of seedlots in storage increased to 13,942. Of this number, almost 6,900 seedlots are stored under Seed Bank and are available for research, and over 4,900 seedlots are stored for genetic conservation.

Five collections were made by National Tree Seed Centre staff. In addition, 6 seedlots were donated and purchased.

A total of 38 requests for seed resulted in 291 seedlots provided for research. The majority of the requests were from Canada (33 requests; 248 seedlots) but seed was also sent to France (1 request; 4 seedlots), Japan (1 request; 24 seedlots), and United States (3 requests; 15 seedlots).

Seed testing consisted of 442 germination tests, 205 moisture content tests, and 132 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. As well, ash seed collected in 2013 was germination tested.

Results from an experiment to determine optimal treatment durations to maximize germination of choke cherry (*Prunus virginiana* var. *virginia*) seed demonstrated that 2 weeks of moist incubation followed by 20 weeks of moist chilling were sufficient.

The CFS Senior Management Committee had the opportunity to visit the Seed Centre and to learn its role in fulfilling Canada's international obligations and national commitments.

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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 2014. Similar reports were prepared from 1998–2013. 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 179 to 13,942 in 2014. The numbers in brackets in Table 1 represent the numbers reported in the 2013 Annual Report.

Table 1. Seed stored at the NTSC as of December 31, 2014.

Seed Bank		Genetic Conservation		Reserved		Tree Breeding	
No. species	No. seedlots	No. species	No. seedlots	No. species	No. seedlots	No. species	No. seedlots
148	6,893	50	4,950	37	1,709	10	390
(148)	(6,800)	(50)	(4,847)	(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 6,893 (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 2014, 5 seedlots were discarded and 15 seedlots were depleted.

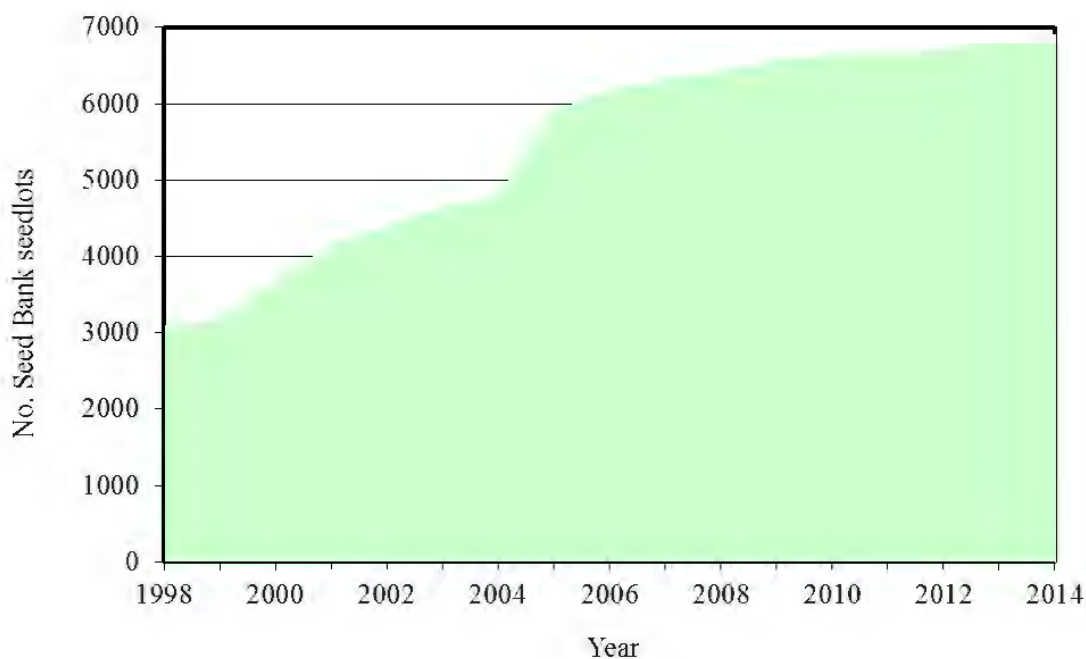


Figure 1. Increase in number of Seed Bank seedlots stored at the NTSC since 1998.

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, 2014, the NTSC Seed Bank had 6,567 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 (326 seedlots) are also stored. Seed is also stored from non-native species growing in Canada, but most of the 326 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	13	51	0.8
British Columbia	32	353	5.3
Manitoba	7	65	1.0
New Brunswick	64	1,497	22.8
Newfoundland and Labrador	17	169	2.6
Nova Scotia	40	552	8.4
Ontario	48	2,411	36.7
Prince Edward Island	34	253	3.8
Quebec	22	1,043	15.9
Saskatchewan	8	123	1.9
Yukon Territory	3	50	0.8
Total	105	6,567	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. 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 nine 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 103 to 4,950 seedlots primarily due to two important donations made in 2013. The Ontario Gene Conservation Association, Ontario

Ministry of Natural Resources and Forestry Tree Seed Plant, and Trees Ontario collaborated to collect and donate 100 collections of *Fraxinus americana*, *F. nigra*, *F. pennsylvanica* and *F. quadrangulata* because these species are threatened by emerald ash borer (*Agrilus planipennis*). The second donation was 3 seedlots of *F. quadrangulata* from Point Pelee National Park. Staff at Parks Canada Agency in Radium, BC requested seed from seven *Pinus albicaulis* seedlots for a trial to evaluate resistance to white pine blister rust (*Cronartium ribicola*). The request resulted in one seedlot being exhausted. 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).

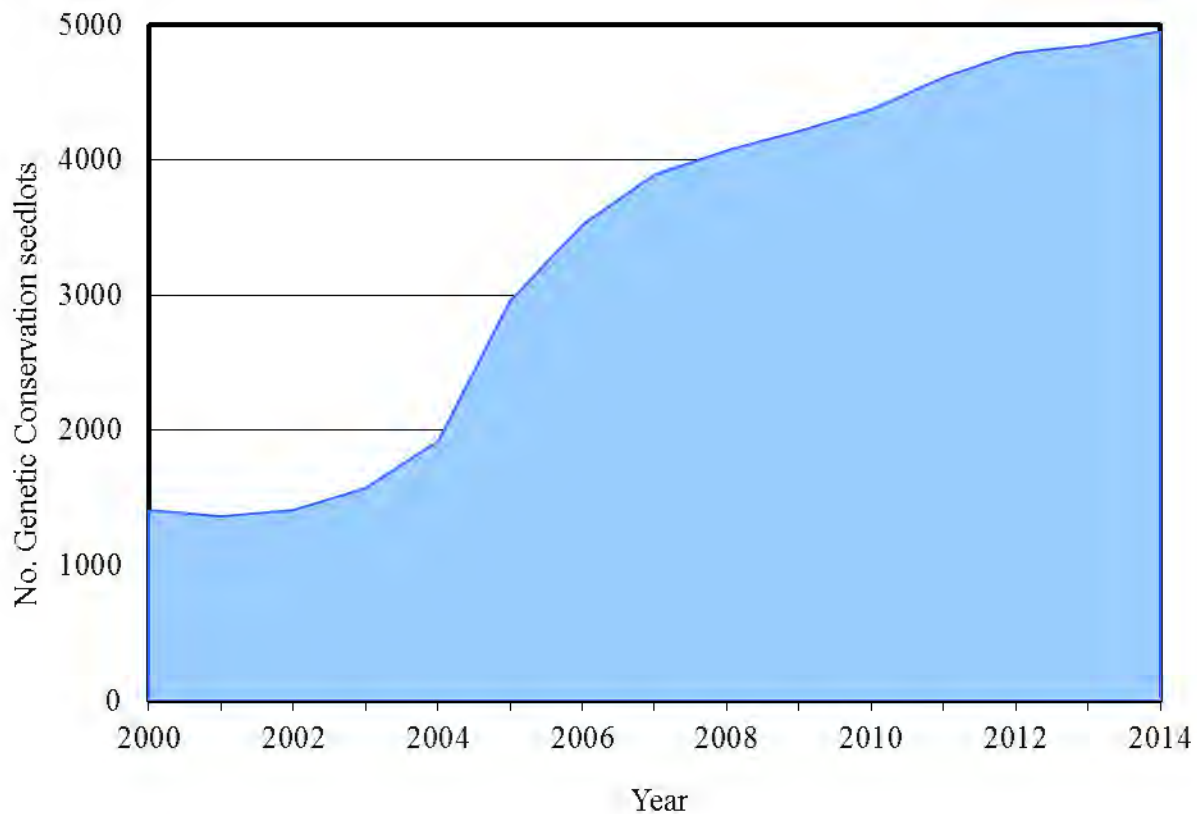


Figure 2. Increase in the number of Genetic Conservation seedlots stored at the NTSC since 2000.

The Reserved category contains seedlots that have been reserved by researchers. Many of these seedlots were collected for special projects. There was a reduction of 17 seedlots 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>	263	<i>Prunus pensylvanica</i>	61
<i>Fraxinus nigra</i>	216	<i>Prunus virginiana</i> var. <i>virginiana</i>	337
<i>Fraxinus pennsylvanica</i>	300	<i>Salix lantana</i> spp. <i>richardsonii</i>	1
<i>Fraxinus profunda</i>	1	<i>Thuja occidentalis</i>	89
<i>Fraxinus quadrangulata</i>	19	<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. Five collections were made (Table 4). Pin cherry (*Prunus pennsylvanica*) 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 *Cornus* species collections were opportunistic to provide a source of material to service seed requests.

Table 4. Seed collections made by Seed Centre staff in 2014.

Species	Total
<i>Prunus pennsylvanica</i>	1
<i>Cornus sericea</i> spp. <i>sericea</i>	3
<i>Cornus racemosa</i>	1

The NTSC also acquired seed via donation. Two seedlots of *Prunus pennsylvanica* were provided by a seed collector and Canadian Natural Resources Limited in Alberta. Two seedlots of *P. pennsylvanica* were purchased from Wild Rose Consulting, Inc., Alberta as well as one seedlot of choke cherry (*P. virginiana* var. *virginiana*) from Boreal Horticultural Services Ltd., Alberta. The *P. pennsylvanica* seed were used for an experiment to determine the duration of incubation and moist chilling treatments that maximizes germination. A seed collector in southern Ontario was contracted to make 20 individual-tree cone collections of white pine (*Pinus strobus*).

In 2012 a pan-Canadian survey was conducted under the auspices of CONFORGEN (a program for the Conservation of Forest Genetic Resources) to assess the conservation needs for tree species to identify species that conservation activities can be initiated to potentially avoid species become listed. The survey identified 30 hardwood and 5 softwood species some of which are listed. When possible these species will be targeted for seed collection.

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 2014.

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	221
2014	-	2	24	31
Total	3,162	2,569	337	6,068

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 2014, 38 requests representing 291 seedlots were processed. The majority of the requests were from Canada but seed was also sent to France, Japan, and United States (Table 6). Twelve fewer requests were received than in 2013 however 68 more 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 2014

Country	No. requests	No. seedlots
Canada	33	248
France	1	4
Japan	1	24
United States	3	15
Total	38	291

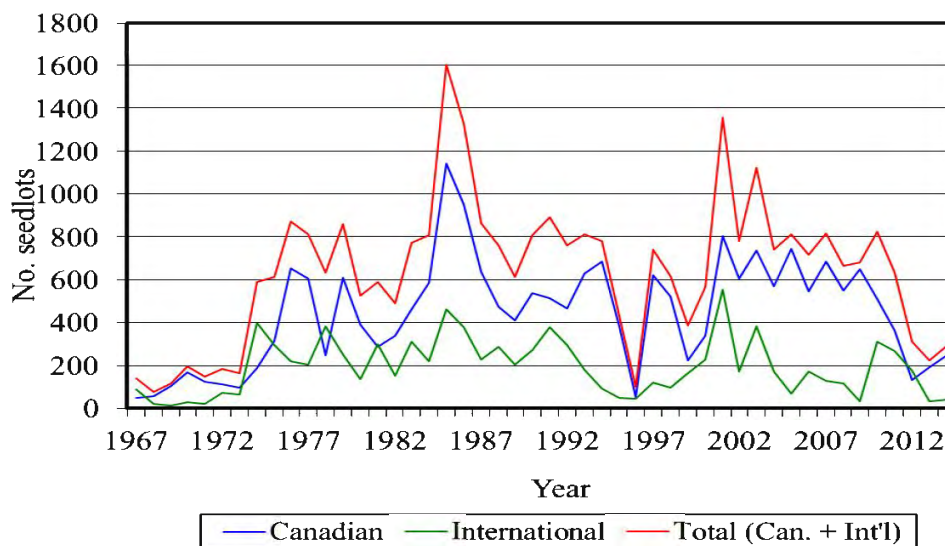


Figure 3. Number of seedlots sent to clients between 1967 and 2014.

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. **Four hundred and forty-two 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 (1970B82), 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.

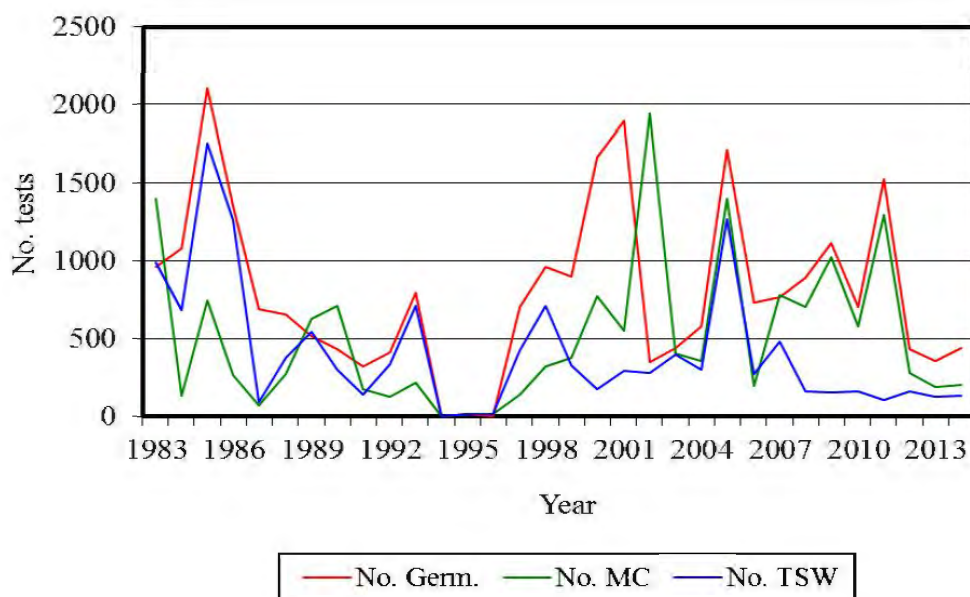


Figure 4. Number of germination tests (No. Germ.), moisture content tests (No. MC), and thousand-seed weight tests (No. TSW) carried out by the NTSC since 1983.

The target moisture content (MC) for orthodox seed is between 5 and 7%. Seed that are above this range are dried before being stored. **Two hundred and five moisture content** determinations were carried out. MC is often checked when seed are re-tested particularly those seedlots exceeding 7%. When MC exceeds 7% the seed are conditioned to lower their MC. Ninety-three 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 thirty-two 1000-seed weights** was done.

RESEARCH AND DEVELOPMENT

Treating Choke Cherry (*Prunus virginiana* var. *virginiana*) Seed to Maximize Germination¹

Oil sands companies operating in Alberta are required to reclaim mining sites after bitumen extraction has ceased. Tree and shrub species used for reclamation are purchased from forest nurseries. These nurseries produce excellent tree planting stock but some are having difficulty growing quality shrub planting stock. An informal survey conducted in 2013 of several Alberta forest nurseries producing native shrubs for reclamation identified choke cherry (*Prunus virginiana* var. *virginiana*) as problematic due to low and protracted germination.

The oil sands have become a high priority for the Government of Canada and concomitantly for the Canadian Forest Service. As a result a call for proposals was made and funding was received from the CFS Oil Sands Disturbance Mitigation and Reclamation Initiative Accelerated Science Funding for a project to improve the germination of choke cherry seed. Previous work on Maritime seedlots of choke cherry had been done by the National Tree Seed Centre (Simpson 2014) which provided a good starting point. For this trial, treatments were further refined and their effect assessed on four Alberta choke cherry seedlots. The results reported here are for the treatment that was most effective.

Methods

After processing, seed were imbibed in water for 72 h, mixed with moist peat in Ziploc[®] bags, and placed in various treatments. A combination of nine treatments that included incubation in the dark (21°C) (2, 4, 6 weeks) and chilling in the dark (4°C) (16, 20, 24 weeks). Following treatments, seed were transferred to germination boxes and placed in a germination cabinet (25°C for 12 h with light, 20°C for 12 h in dark, 85% relative humidity). Germination was recorded every 7 days for 21 days.

Results and Discussion

The 2-week incubation + 20-week chilling treatment was most effective in maximizing germination. After 21 days in a germination cabinet, total germination ranged from 19–85% (Figure 5). Variation in germination was a reflection of seedlot quality. After being placed in the germination cabinet 99% of the seed that germinated did so within seven days. This was a marked improvement over the long duration reported by several Alberta nurseries. About 2% of the seed germinated with abnormal radicles. Seed that failed to germinate were either dead or still viable. Germination during chilling (Figure 5) indicated that some seed required a shorter treatment duration to alleviate dormancy.

¹ A manuscript for publication in a journal is being prepared for this trial. Therefore only selected results are presented.

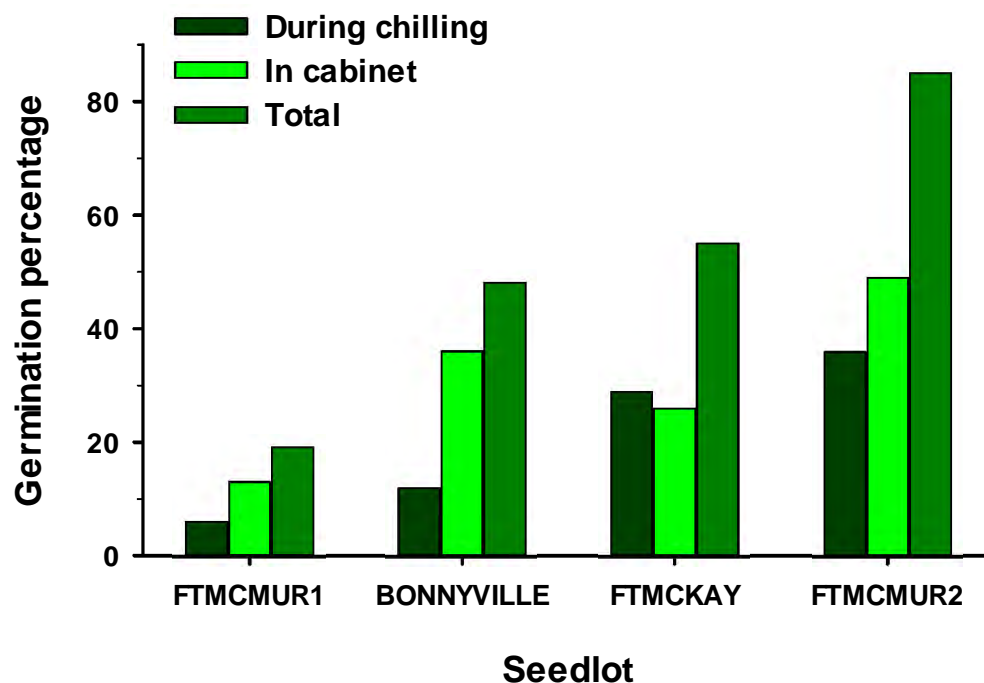


Figure 5. Percentage of choke cherry seed, from four Alberta seedlots, that germinated normally after incubation at 21°C for 2 weeks followed by chilling at 4°C for 20 weeks. (Seedlot abbreviations: FTMCMUR1 = Fort McMurray 1, FTMCKAY = Fort MacKay, FTMCMUR2 = Fort McMurray 2)

Literature Cited

Simpson, J.D. 2014. National Tree Seed Centre Annual Report 2013. Nat. Res. Can., Can. For. Serv.-Atl. 20 p.

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 25 years (Figure 6) due to less demand from European importers. A total of 245 kg of certified seed was exported in 2014. Grand fir (*Abies grandis*) and subalpine fir (*A. lasiocarpa*) accounted for 52 kg and 55 kg respectively, while 77 kg and 70 kg of Douglas-fir (*Pseudotsuga menziesii* var. *glauca* and *P. menziesii* var. *menziesii*) respectively, were exported.

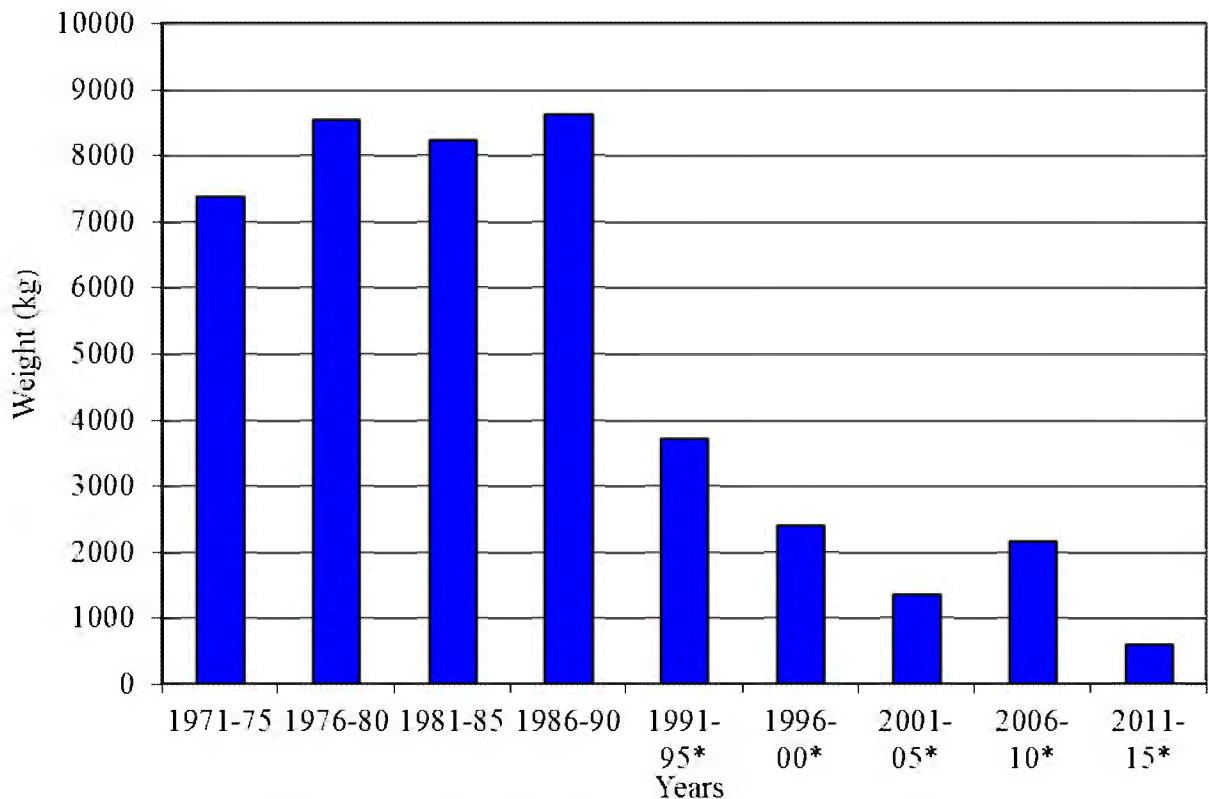


Figure 6. Weight of seed OECD certified or exported* by 5-year periods.

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 27 countries (primarily European with five from Africa plus 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, 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 affords producers the ability to obtain appropriate monetary value for seed orchard seed.

The Tested category, which was approved in 2012, completed 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.

Kenya and Uganda joined the Scheme in 2013. Discussions are ongoing with Australia, New Zealand, Indonesia, and Brazil.

Other issues and topics that are being discussed and developed include: impact of climate change on adaptation of seed and the application of the Scheme; finalized a comprehensive list of Latin names for all species that are marketed by the Scheme; development of guidelines to increase the commercial competitiveness of forest seed.

PUBLICATIONS AND PRESENTATIONS

Simpson, D. 2014. National Tree Seed Centre: Preserving Canada's forest genetic resources and Improving germination of choke cherry seed. Presented at In-situ Oil Sands Reclamation and Restoration Practices Fall COSIA Tour at Imperial's Cold Lake Operations, 9 September 2014, Cold Lake, AB.

SEED CENTRE PROMOTION

Throughout the year opportunities arose to promote the Seed Centre. This was accomplished primarily via tours and visits. Some of the more notable events of 2014 are included below.

On March 22, Trudy Samuel, Director of Planning, Operations and Information Branch, CFS Ottawa visited the Seed Centre and was provided with an overview of the operation and priorities.

On July 25, Dan Galarneau, Director of Operations, CFS Great Lakes Forestry Centre visited the Seed Centre and was provided with an overview of the operation and priorities.

On September 8, members of the CFS Senior Management Committee (Director Generals from five CFS research centres, four other Directors, and the Assistant Deputy Minister) were provided the opportunity to visit the Seed Centre where they learned the role that the Seed Centre plays in fulfilling Canada's international obligations and national commitments, and the work that is conducted. The purpose of this visit was to renew CFS's commitment to continue supporting the Seed Centre which they agreed to.

SEED CENTRE STAFF

Dale Simpson, Manager, maintained essential functions such as scheduling/supervising various activities, filling seed orders, generating a list of seedlots for germination testing and prioritizing the tests, entering data into the database, and setting up/assessing germination tests for trials and experiments such as the choke cherry trial.

Peter Moreland continued to provide technical support for seed processing, conditioning, and germination testing. Mr. Moreland worked the equivalent of 22 weeks over the course of the year. Figure 7 summarizes the number of Aextra® work weeks provided to the Seed Centre. The chart assumes that there was a full-time seed technologist.

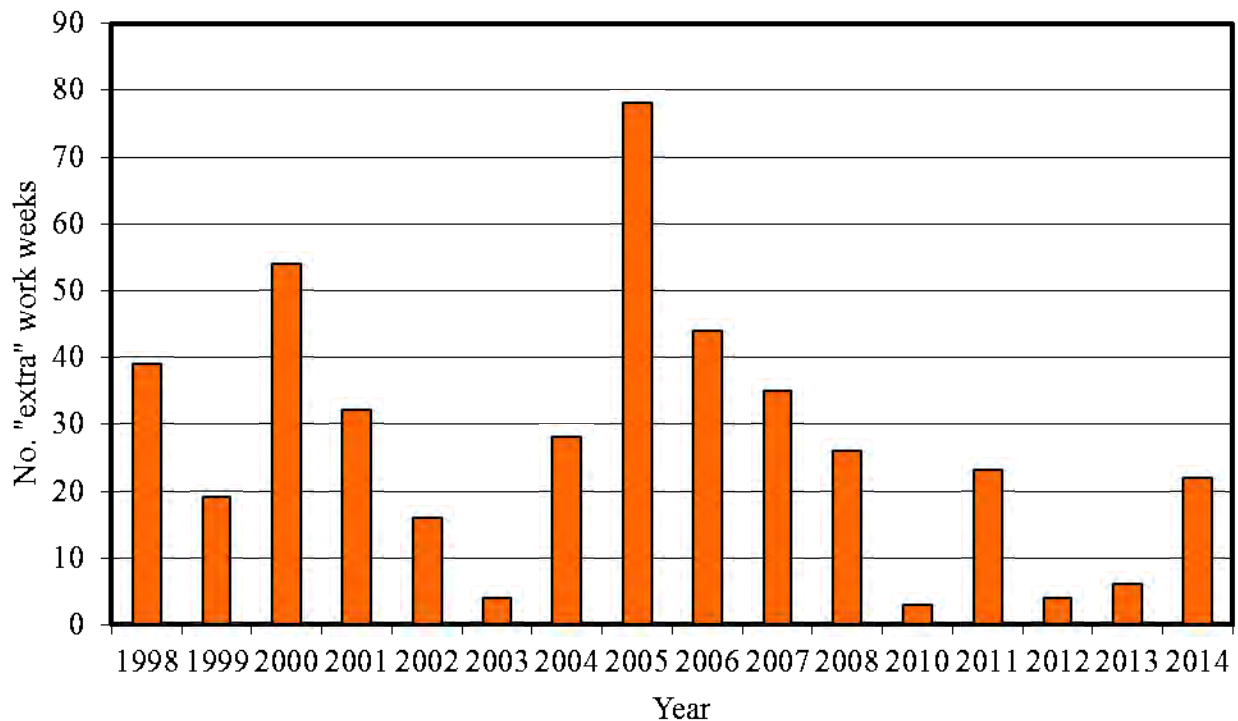


Figure 7. Number of Aextra® work weeks provided to the NTSC between 1998 and 2014.