National Tree Seed Centre

Annual Report

2016

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NATIONAL TREE SEED CENTRE ANNUAL REPORT 2016

EXECUTIVE SUMMARY

The number of seedlots in storage increased to 14,629. Of this number, over 7,100 seedlots are stored under Seed Bank and are available for research. Additionally, over 5,400 accessions are stored for gene conservation, including seven species listed by the Species at Risk Act.

Eighteen collections were made by Seed Centre staff. In addition, 35 seedlots were donated from a number of sources: Melissa Spearing (private collector), Point Pelee National Park, Thousand Islands National Park, The University of Guelph Arboretum, and Yukon Department of Energy, Mines and Resources.

A total of 58 requests for seed resulted in 505 seedlots provided for research. The majority of the requests were from Canada (49 requests; 443 seedlots) but seed was also sent to France, Germany, Great Britain, Netherlands, Spain, and United States. Over the last five years, 53% of the clients were from universities and 29% from the Canadian Forest Service. Seed for 25% of the requests was used for mine site reclamation studies and 15% for climate change projects.

Seed testing consisted of 307 germination tests,157 moisture content tests, and 116 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. About 220 seedlots were conditioned to lower seed moisture content.

Results from an experiment to promote germination of highbush cranberry (*Viburnum opulus* var. *americanum*) seed demonstrated that practically all seed that germinated did so during a second chilling treatment. The longer durations of this treatment resulted in an increase in the proportion of damaged germinants.

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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 high quality 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 for establishing 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 CFS, 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 2016. Similar reports were prepared from 1998−2015. 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, Gene Conservation, Reserved, and Tree Breeding (Table 1). The total number of seedlots increased by 558 to 14,629 in 2016. The numbers in brackets in Table 1 represent the numbers reported in the 2015 Annual Report.

Table 1. Seed stored at the NTSC as of December 31, 2016.

Seed Bank		Gene Conservation		Reserved		Tree Breeding	
No. species	No. seedlots	No. species	No. seedlots	No. species	No. seedlots	No. species	No. seedlots
157 (156)	7,121 (6,891)	63 (52)	5,416 (5,081)	34 (37)	1,704 (1,709)	9 (10)	388 (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 7,121 (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 2016, 12 seedlots were discarded and 17 seedlots were depleted.

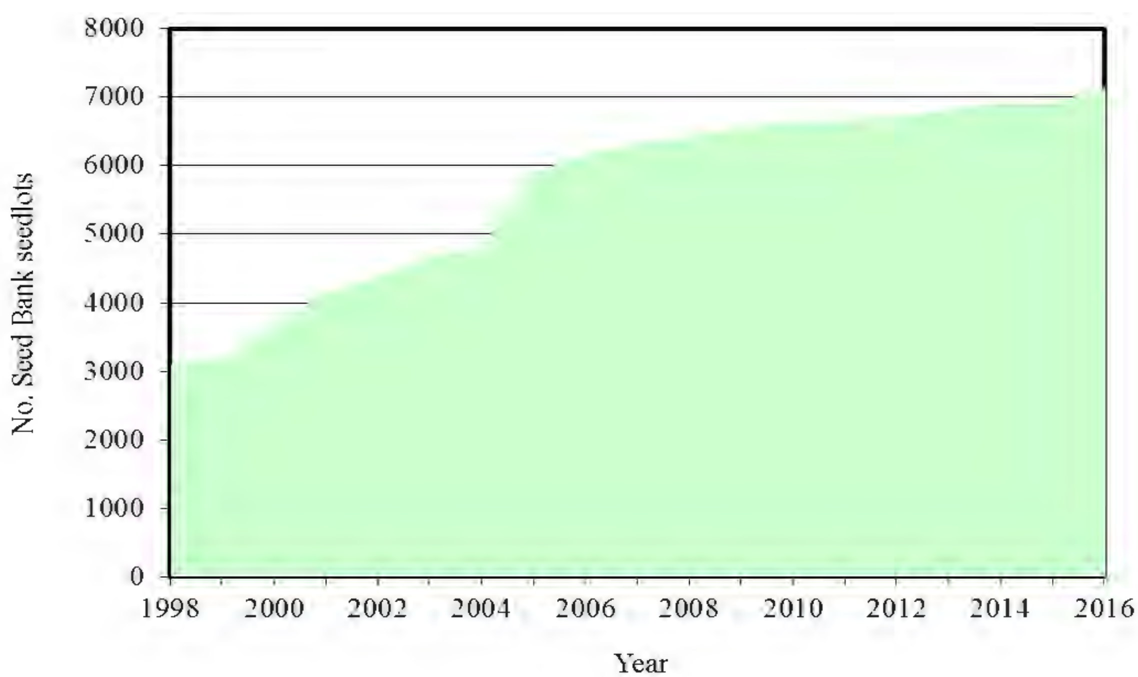

Figure 1. Increase in number of Seed Bank seedlots stored at the NTSC since 1998.

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, 2016, the NTSC Seed Bank had 6,795 seedlots of 113 species in storage from locations in Canada (Table 2). Seed from 44 non-native species as well as native species from the United States (326 seedlots) are also stored. The proportion of seedlots from non-native species is decreasing 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	14	99	1.5
British Columbia	33	385	5.7
Manitoba	8	95	1.4
New Brunswick	63	1,509	22.2
Newfoundland and Labrador	17	169	2.5
Nova Scotia	40	550	8.1
Ontario	50	2,440	35.9
Prince Edward Island	34	253	3.7
Quebec	22	1,064	15.6
Saskatchewan	19	169	2.5
Yukon Territory	4	62	0.9
Total	113	6,795	100

Since the NTSC moved to Fredericton, effort has concentrated on 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 Gene 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, or threatened species as well as unique populations is preserved. Over the past 15 years, seed collecting has focused on expanding the Gene Conservation collection. Any surplus seed from these collections as well as samples from donated or purchased seed is placed in Gene Conservation. The collection increased by 335 to 5,416. Accessions were added from 11 new species. Of significance were seed from *Crataegus rotundifolia*, *Rosa acicularis*, *R. woodsii*, and *Symphoricarpos occidentalis*, amounting to 134 seedlots, which were donated in 2015 from

Agriculture and Agri-Food Canada. An additional 96 accessions of *Juglans cinerea* in the form of embryoic axes were placed in cryogenic storage. Other species added include *Abies lasiocarpa*, *Betula lenta*, *Gymnocladus dioicus*, *Hypericum kalmainum*, *Nyssa sylvatica*, *Ptelea trifoliata*, and *Salix discolor*. There is now germplasm in storage from seven species listed by the Species at Risk Act: *Betula lenta*, *Cornus florida*, *Juglans cinerea*, and *Pinus albicaulis* (Endangered); *Gymnocladus dioicus* and *Ptelea trifoliata* (Threatened); and *Fraxinus quadrangulata* (Special Concern). Figure 2 shows the increase in the number of seedlots in this category since 2000. There are seed and embryos from 63 species in Gene Conservation with the number of accessions per species ranging from 1 to 1,647 (Table 3).

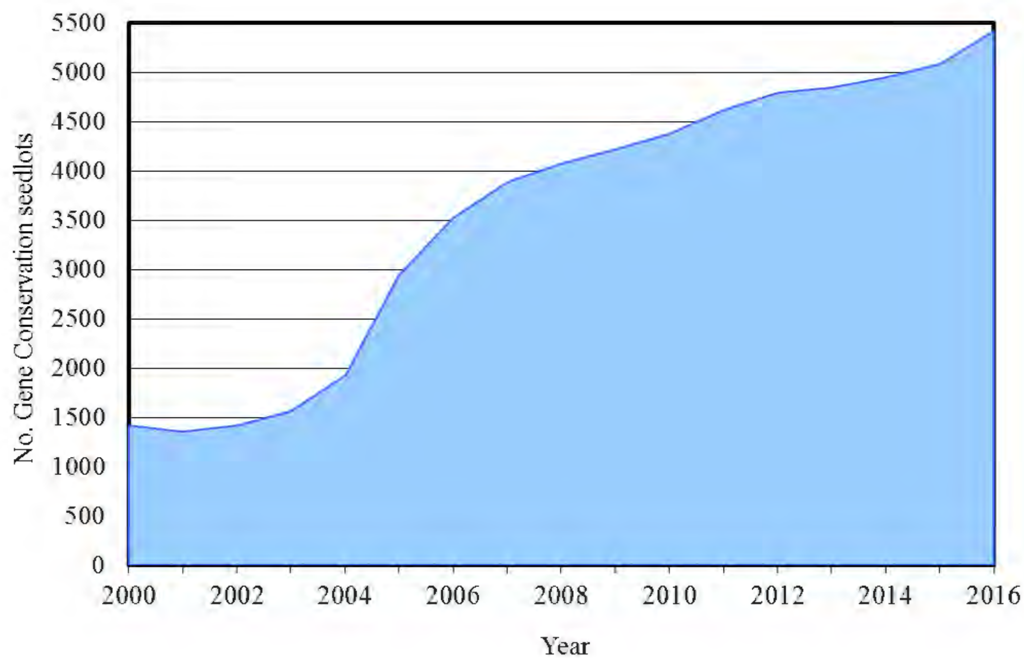

Figure 2. Increase in the number of Gene Conservation accessions stored at the NTSC since 2000.

The Reserved category contains seedlots that have been reserved by researchers. Many of these seedlots were collected for special projects. Four seedlots of three species were discarded due to not being required for research.

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. Two seedlots from one species were discarded.

Table 3. Species and number of accessions stored in Gene Conservation.

Species	No. seedlots	Species	No. seedlots
Abies balsamea	8	*Picea glauca*	1,647
Abies lasiocarpa	1	*Picea glauca* ssp. *porsildii*	15
Acer negundo	15	*Picea glauca* var. *albertiana*	9
Acer pensylvanicum	17	*Picea mariana*	435
Acer rubrum	111	*Picea rubens*	222
Acer saccharum	23	*Pinus albicaulis*	48
Acer spicatum	49	*Pinus banksiana*	95
Alnus incana spp. *rugosa*	3	*Pinus contorta* var. *latifolia*	8
Alnus incana spp. *tenuifolia*	1	*Pinus flexilis*	101
Alnus serrulata	2	*Pinus pinceana*	181
Alnus viridis spp. *crispa*	9	*Pinus ponderosa*	2
Betula alleghaniensis	57	*Pinus resinosa*	15
Betula cordifolia	5	*Pinus rigida*	4
Betula lenta	5	*Pinus strobus*	72
Betula minor	1	*Pinus sylvestris*	12
Betula papyrifera	10	*Populus balsamifera*	20
Betula populifolia	20	*Populus grandidentata*	13
Betula spp.	1	*Populus tremuloides*	16
Cephalanthus occidentalis	1	*Prunus pensylvanica*	61
Cornus florida	4	*Prunus virginiana* var. *virginiana*	356
Crataegus rotundifolia	36	*Ptelea trifoliata*	1
Fraxinus americana	272	*Rosa acicularis*	10
Fraxinus nigra	216	*Rosa woodsii*	66
Fraxinus pennsylvanica	338	*Salix discolor*	16
Fraxinus profunda	1	*Salix lantana* spp. *richardsonii*	1
Fraxinus quadrangulata	20	*Symphoricarpos occidentalis*	22
Gymnocladus dioicus	1	*Thuja occidentalis*	89
Hypericum kalmainum	1	*Thuja plicata*	2
Juglans cinerea	185	*Tsuga canadensis*	183
Larix laricina	267	*Tsuga mertensiana*	1
Larix occidentalis	1	*Ulmus rubra*	10
Nyssa sylvatica	2		

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. Eighteen collections were made (Table 4). The *Salix* collections were made to increase the inventory of this species and to donate samples to the Millennium Seed Bank, Great Britain. *Diervilla* seed had not been collected previously so this was an opportunity to learn when to collect, and how to process and test the seed.

Table 4. Seed collections made by Seed Centre staff in 2016.

Species	Total
Diervilla lonicera	1
Quercus macrocarpa	1
Salix discolor	16

The NTSC also acquired 35 seedlots via donation. Melissa Spearing, Bethany, Ontario collected and donated the following: *Rhus copallinum* (2), *Lindera benzoin* (3), *Nyssa sylvatica* (2), and *Fraxinus pennsylvanica* (3). Parks Canada Agency at Point Pelee National Park, Ontario donated one *Fraxinus quadrangulata* and Thousand Islands National Park sent one seedlot each of *Fraxinus americana* and *Fraxinus pennsylvanica*. The University of Guelph Arboretum donated the following: *Betula lenta* (4), *Fraxinus quadrangulata* (1), *Gymnocladus dioicus* (1), *Hypericum kalmianum* (1), and *Ptelea trifoliata* (3). Twelve seedlots were received from Yukon Department of Energy, Mines and Resources comprised of: *Abies lasiocarpa* (1), *Picea glauca* (6), *P. mariana* (1), and *Pinus contorta* var. *latifolia* (4). All these donations are appreciated in order to augment the Seed Centre's inventory and to receive seed from species not previously stored.

In 2012 a pan-Canadian survey was conducted under the auspices of CON**FOR**GEN (a pan-Canadian program for the Conservation of Forest Genetic Resources) to assess the conservation needs for tree species in order to identify those that require conservation activities to potentially avoid these species becoming listed under the Species at Risk Act. The survey identified 30 hardwood and 5 softwood species, eleven of which are listed. When possible these species are targeted for seed collection.

Table 5 shows the number of seedlots acquired by the NTSC since 1996. About 50% of the seedlots were obtained through collection while 45% were donated. The remaining 5% were purchased.

Table 5. Number of seedlots acquired by the NTSC through collection, donation, and purchase between 1996 and 2016.

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	5	2	24	31
2015	44	332	16	382
2016	18	35	0	53
Total	3,224	2,936	353	6,513

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.

This was a relatively busy year for seed requests with 58 requests received for 505 seedlots. The majority of the requests were from Canada but seed was also sent to France, Germany, Great Britain, Netherlands, Spain, and United States (Table 6). Seed was provided from 89 species. The number of seedlots provided annually since 1967 has ranged from a low of 99 in 1996 to a high of 1,603 in 1985 (Figure 3). Over 31,300 seedlots have been distributed to clients during the 49 year history of the Seed Centre. On average, Canadian clients have accounted for 77% of the requests while international clients accounted for the remaining 23%.

Table 6. Number of requests and number of seedlots shipped by country in 2016.

Country	No. requests	No. seedlots
Canada	49	443
France	2	10
Germany	1	3
Great Britain	1	16
Netherlands	1	21
Spain	1	6
United States	3	6
Total	58	505

An analysis of the seed requests received over that past five years showed that 53% of the clients were from universities; 29% from the Canadian Forest Service; and 18% were from other organizations such a provincial governments, other Government of Canada departments, and research organizations. Seed for 45% of the requests was used for molecular genetics research, germination studies, or growing seedlings for trials; 25% for mine site reclamation studies; 15% for climate change projects; and 15% for education, arboreta, and botanic gardens.

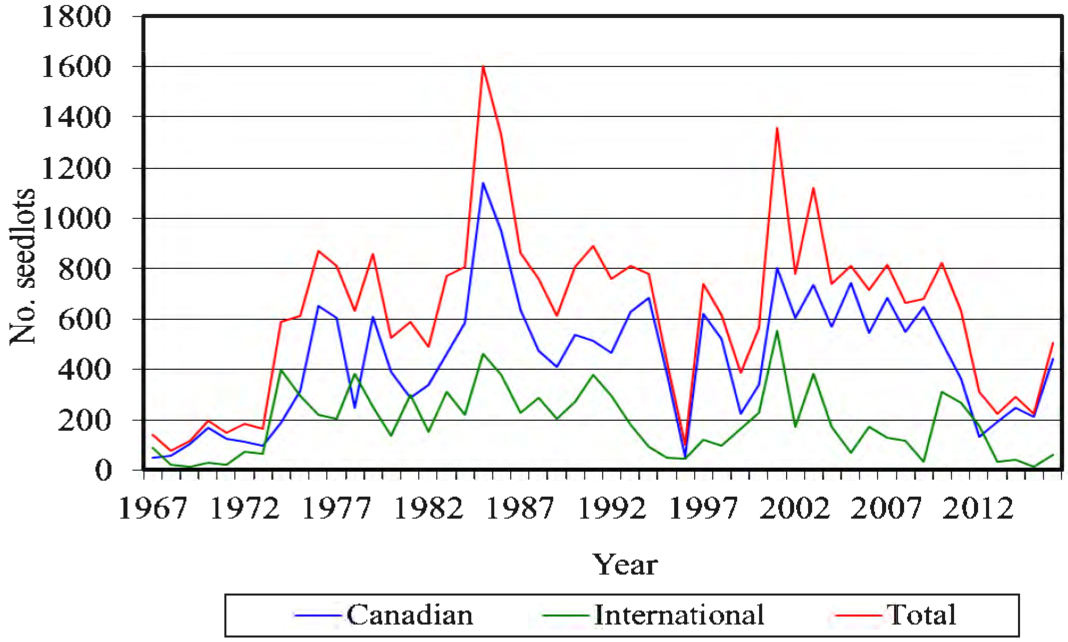

Figure 3. Number of seedlots sent to clients annually between 1967 and 2016.

SEED TESTING

Germination tests are performed on 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 tested, the number of seed is usually reduced. **Three hundred and seven germination tests** were carried out primarily on stored seed. 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. Annual fluctuations in the number of germination tests in particular are a function of the number of tests scheduled.

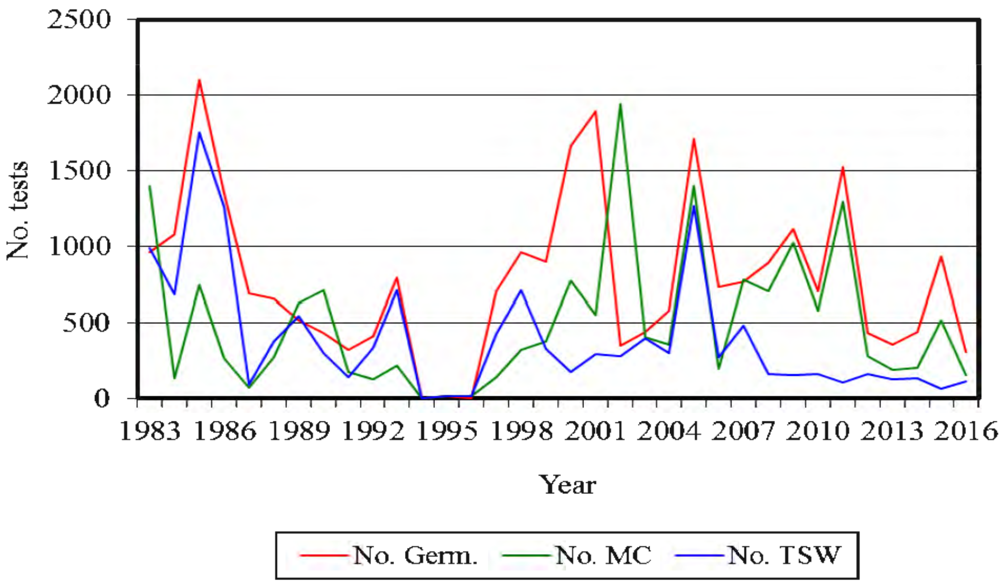

Figure 4. Number of germination tests (No. Germ.), moisture content tests (No. MC), and thousand-seed weight tests (No. TSW) carried out by the NTSC since 1983.

The target moisture content (MC) for orthodox seed is between 5 and 7%. Seed that are above this range are dried before being stored. **One hundred and fifty-seven 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. About 220 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 sixteen 1000-seed weights** was conducted.

RESEARCH AND DEVELOPMENT

Treating Highbush Cranberry (*Viburnum opulus* var. *americanum*) Seed to Promote Germination

The environmental reputation of Canada's oil sands is a high priority for the Government of Canada and concomitantly for the Canadian Forest Service. 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. One issue is the challenge posed by seed dormancy and the need to identify treatments to alleviate dormancy.

Seed of most *Viburnum* species are difficult to germinate. Seed from northern sources require warm stratification for radicle development followed by cold stratification to break dormancy of the epicotyl (Bonner et al. 2008). Various durations of treatments have been reported for *V. opulus* var. *americanum*: 60 days warm then 60 days cold (Kock 2008), 328 days warm or 14 weeks alternating between 7 days warm and 7 days cold (Fedec and Knowles 1973), 60−90 days cold followed by 60−90 days warm then 60−90 days cold (Prairie Moon Nursery, 2017), and 60−270 days warm followed by 60−120 days cold (Moore-Gough 2009). Clearly there are many prescriptions that work but many are different from each other.

Nurseries in Alberta grow most of their stock in greenhouses. It is important that seed germinates synchronously within a short period of time (several weeks) in order to efficiently manage the growing crop. Several nurseries indicated that they followed a regime of cold-warm-cold treatments. The literature frequently states that seed germinates in the spring of the second year. The regime used by these nurseries emulates what occurs in nature and therefore the treatments chosen for this trial were based on this.

Methods

Four bulk seedlots were used. Two were from New Brunswick (NB), Upper Little Ridge collected in 2015 and Prince William collected in 1997; and two were from Alberta, Edmonton and Bonneyville Beach, both collected in 2015. The seeds (stones) were removed from the fruit (drupes) by maceration in water using a milkshake mixer. Empty seed, pulp, and debris were floated off and the seed rinsed several times to dissolve any sugars remaining on the surface. The seed were air dried until the moisture content was less than 7%.

After drying, seed were mixed with moist peat (80% moisture content) in Ziploc® bags, and placed in various treatments. Treatments consisted of an initial chilling (4°C) in the dark for 0, 8, 12 or 16 weeks followed by incubation (21°C) in the dark for 12 or 16 weeks followed by chilling (4°C) in the dark for 16 or 20 weeks. Every 28 days bags were opened for at least 4 hours to allow for air exchange. Following treatment, seed were transferred to Petawawa Germination Boxes with each box containing four replicates of 25 seed of a seedlot. The boxes were placed in germination cabinets set for two different regimes (30°C for 8 h with light, 20°C for 16 h in dark) and (20°C for 8 h with light, 10°C for 16 h in dark) with 85% relative humidity. The cooler temperatures were chosen for comparison in case the warmer temperatures induced secondary dormancy which occurs in striped maple (*Acer pensylvanicum*) (Bourgoin and Simpson 2004). Germination was recorded every 7 days for 21 days. A seed was considered to be germinated when the radicle was as long as the seed.

Results and Discussion

There was little to no germination of the seed in the germinators. Germination took place during the second moist chilling treatment. Therefore germination data for seed destined for the 10/20 and 20/30 germination treatments following the second moist chilling treatment were combined (Table 7). Abnormal germinants were those that displayed damage such as: radicle or radicle tip decayed, radicle or hypocotyl decayed at junction with seed coat.

Table 7. Percentage of highbush cranberry seed that germinated normally and abnormally during the second chilling treatment.

Treatment	% Germ.	Range	% Abnormal	Range	Total Germ.
0/12/16*	7.5	2−18	3.1	0−8	10.6
0/16/20	15.3	5−23	16.0	1−36	31.3
8/12/16	18.1	11−38	11.8	0−28	29.8
8/16/20	11.2	5−17	33.1	11−52	44.3
12/12/16	13.8	4−35	11.3	0−24	25.1
12/16/20	12.0	4−27	25.5	1−44	37.5
16/12/16	12.1	2−34	14.3	1−29	26.4
16/16/20	14.1	3−41	43.3	12−65	57.3

*e.g., 0 = no chilling, 12 = 12 weeks warm incubation, 16 = 16 weeks chilling

With the exception of the 0/12/16 treatment there was little difference in germination among the other treatments (Table 7). Germination was highest in the 8/12/16 treatment. The proportion of germinants that were abnormal varied by treatment but treatments with the second chilling duration of 20 weeks had the highest percentage of abnormal germinants compared to treatments with 16 weeks of chilling. Total germination represents the sum of germination and abnormal. Again the treatments with 20 weeks of chilling had the highest total germination albeit the proportion of abnormal germinants contributed to this.

The Bonnyville Beach, Alberta seedlot consistently had the highest germination and the percentage of abnormal germinants was generally a bit less than for the Edmonton seedlot. The two seedlots from Alberta tended to have more abnormal germinants than the two NB seedlots. Germination of the Prince William, NB seedlot, which had been in storage for 18 years, was better than that of the freshly collected NB seedlot only for the first four treatments. The longer duration of the last four treatments appeared to have a detrimental effect on germination along with fewer abnormal germinants for the Prince William seedlot.

As mentioned previously, the longer the duration of the second chilling treatment the greater the number of abnormal germinants. Starting with the 8/16/20 treatment and all subsequent treatments the highest proportion of abnormal germinants was due to the radicle or hypocotyl being decayed at the point of emergence from the seed coat. One possible explanation for this is fungi growth on the surface of the seed coat due to sugar residue remaining from seed processing. These fungi were able to invade the tissue of the hypocotyl or radicle. Another possibility is the presence of fungi in the peat.

The two treatments with the better germination and lowest abnormal germinants were 8/12/16 and 12/12/16. The germination details of these treatments are presented in Figures 5 and 6 for each seedlot. The Bonnyville Beach seedlot had the best germination with the lowest proportion of abnormal germinants compared to the Edmonton seedlot for both treatments. The two NB seedlots performed best in the 8/12/16 treatment although marginally so for the Prince William seedlot compared to the 12/12/16 treatment.

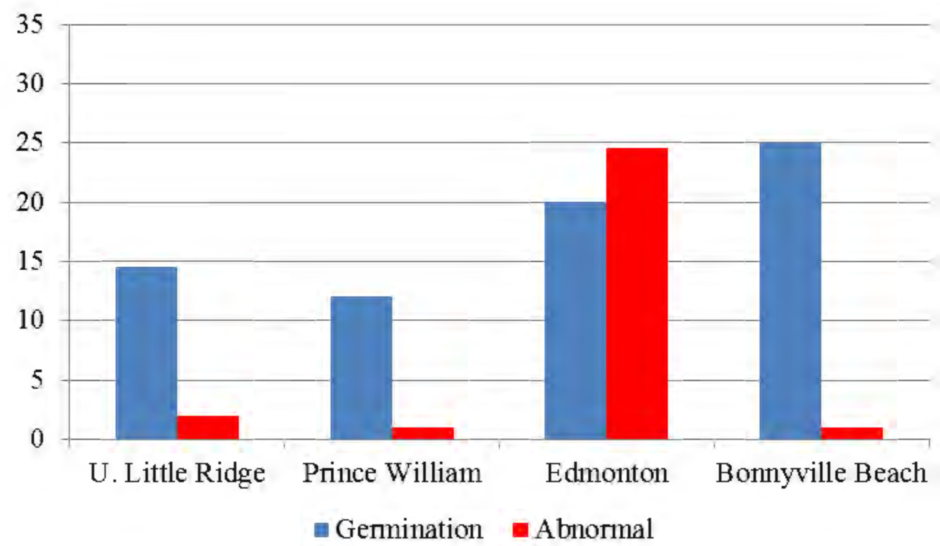

Figure 5. Percent germination and abnormal germinants of highbush cranberry seed after 8 weeks of chilling, 12 weeks of incubation and 16 weeks of chilling.

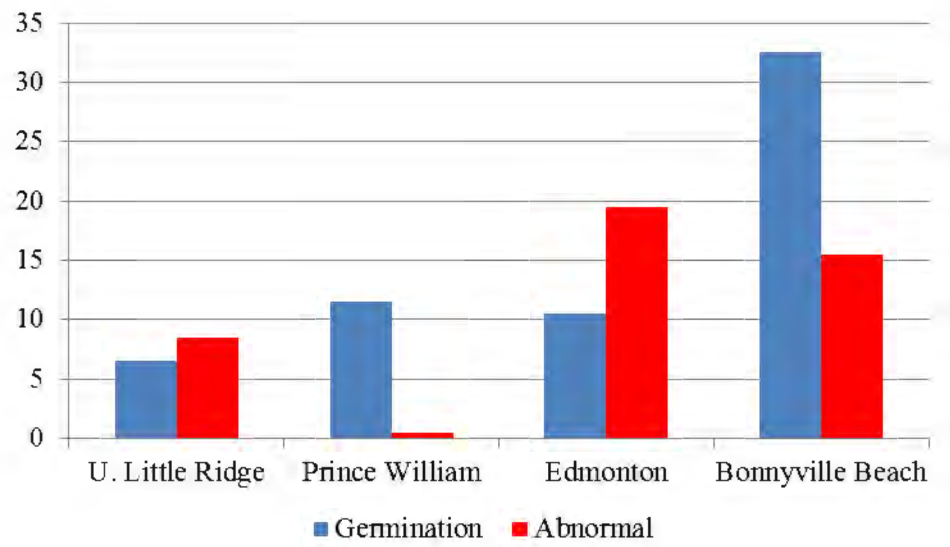

Figure 6. Percent germination and abnormal germinants of highbush cranberry seed after 12 weeks of chilling, 12 weeks of incubation and 16 weeks of chilling.

Conclusions

Treatment combinations and durations were chosen based on treatments employed at several nurseries. However, the results were not as expected particularly the high proportion of abnormal germinants which was likely due to dormancy being alleviated early for those seed allowing them to germinate and be exposed to fungi longer than other seed that germinated later. It was anticipated that there would be little germination during the second chilling treatment and most of the germination would occur in the germinator which was not the case. Nurseries have three options to grow highbush cranberry. 1) Sow the seed in containers and expose the containers to the dormancy breaking treatments. 2) Place the seed in bags in a moist medium, expose the bags to the treatments then sow the seed in containers. 3) Remove seed from the bags as they germinate and plant them in containers. If germination is protracted this will lead to an uneven crop which poses management challenges.

Another trial should be set up and not include an initial chilling treatment. Instead, concentrate on various durations of warm incubation and chilling. The germination time should be extended to at least 10 weeks.

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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 25 years (Figure 7) due to less demand from European importers. A total of 56 kg of certified seed was exported in 2016. Grand fir (*Abies grandis)* accounted for 2 kg while 54 kg of Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) were exported.

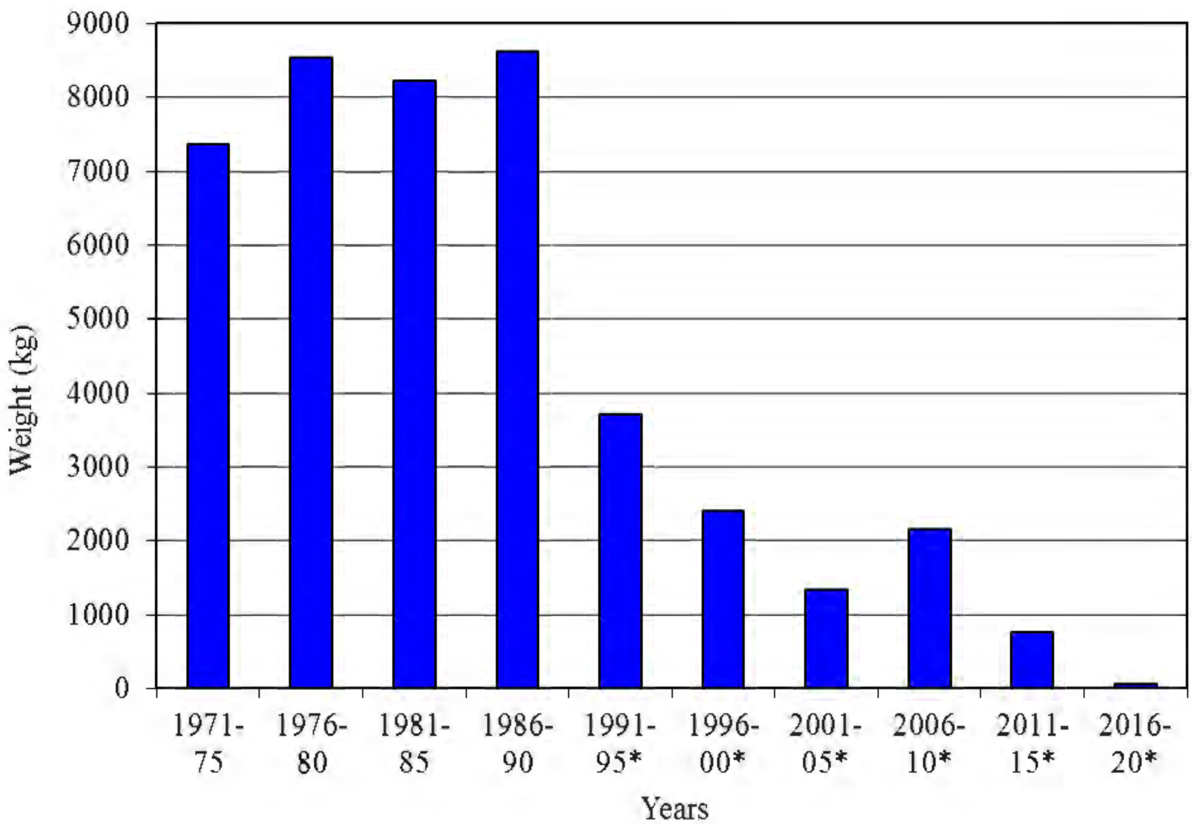

Figure 7. Weight of seed OECD certified or exported* by 5-year periods.

Officially established in 1967, the OECD Scheme for the Control of Forest Reproductive Material Moving in International Trade 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 and 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 (seeds) 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. It is called the OECD Forest Seed and Plant Scheme.

The Scheme is always looking for opportunities to expand the membership. In 2016 Bulgaria officially applied for membership.

Issues and topics that are being discussed and developed include: revising and updating the Rules to reflect technical and regulatory changes in Member countries, undertaking a survey of breeding programs in member countries, analyzing the potential impacts of climate change on the certification of forest reproductive material (FRM), developing guidelines on best practices in the marketing of FRM in Member countries, and clarifying definitions of commonly used terms such as variety, cultivar, clone, clonal forestry, etc. in the framework of the Scheme.

PUBLICATIONS AND PRESENTATIONS

Simpson, D. 2016. National Tree Seed Centre. Pages 17−18. *in* J.D. Simpson, ed. 33rd Meeting Canadian Forest Genetics Association, Part 1. 22−25 July 2013, Whistler, BC.

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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 2016 are included below.

On March 8, Catherine Ste-Marie, Climate Change Research Coordinator, CFS, paid a visit to discuss how the Seed Centre could be involved in some of the new CFS research initiatives.

On June 28, Alexa Alexander-Trusiak, Donald Baird, and Joseph Culp from Environment Canada and Climate Change were provided with an overview of the Seed Centre.

SEED CENTRE STAFF

Dale Simpson, Manager, continued to maintain essential functions such as scheduling/supervising various activities, filling seed orders, entering data into the database, and setting up/assessing germination tests for trials and experiments.

Peter Moreland continued to provide technical support for seed processing, conditioning, and germination testing. Mr. Moreland worked the equivalent of 40 weeks over the course of the year. Kathleen Forbes spent the equivalent of three weeks learning how to accession seed and entering data into the database. Donnie McPhee spent four weeks completing the accessioning of 300 seedlots donated by Agriculture and Agri-Food Canada in 2015 and evaluated germination tests for a *Thuja occidentalis* seed storage experiment. Donnie spent the fall months being mentored by Dale on all aspects of managing the Seed Centre. Melissa Spearing from Bethany, Ontario completed a four week study term to learn more about a seed centre's operations. She participated in germination testing, seed conditioning, determining equilibrium relative humidity, and conducting thousand seed weights. Figure 8 summarizes the number of Aextra@ work weeks provided to the Seed Centre. The chart assumes that there was a full-time seed technologist.

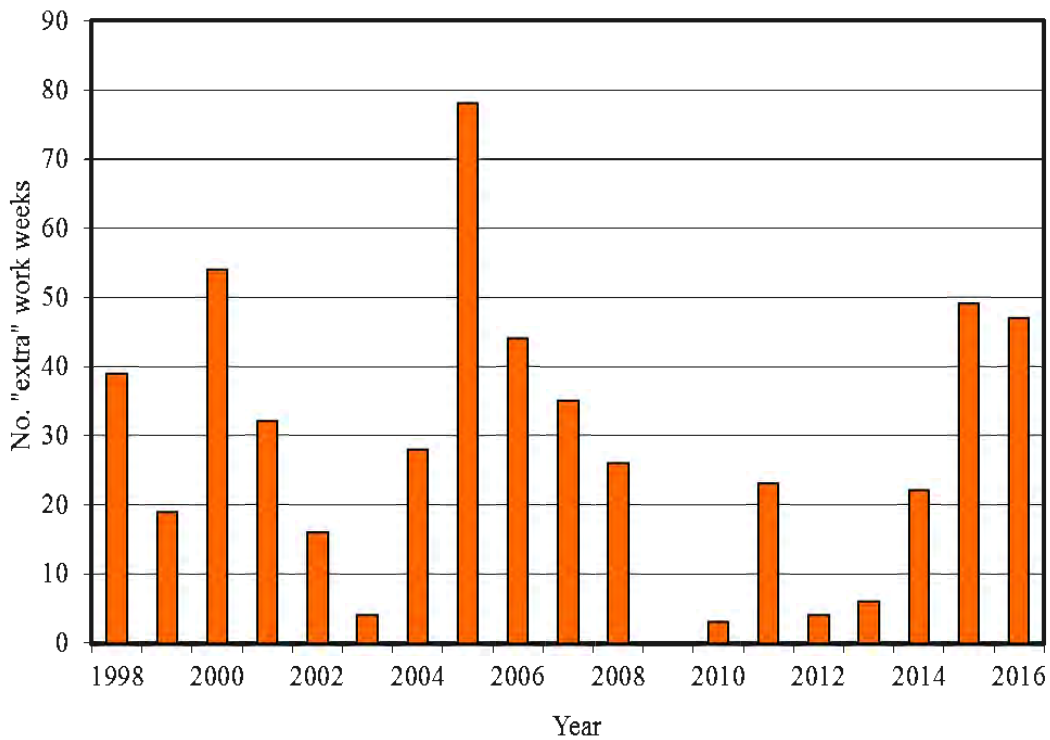

Figure 8. Number of Aextra@ work weeks provided to the NTSC between 1998 and 2016.