National Tree Seed Centre

Annual Report

2007

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NATIONAL TREE SEED CENTRE ANNUAL REPORT 2007

EXECUTIVE SUMMARY

The National Tree Seed Centre celebrated its 40th anniversary. To celebrate the occasion several activities and events were undertaken to promote the Seed Centre. Seed Centre staff collaborated with NRCAN communications to plan activities throughout the summer and fall that included new seed board display panels with seed encased in epoxy resin and a silhouette of the tree and a color picture of a reproductive structure for each species; a poster highlighting the three main activities of the Seed Centre (Collection, Collaboration, and Conservation); a revised Impact Note to promote the Seed Centre; a mail out to clients who received seed over the last 10 years; an article titled "The National Tree Seed Centre Celebrates 40 Years" in the September/October issue of The Forestry Chronicle; participation in several shows and fairs including Balloon Fest in Sussex, Acadia Research Forest field day, and the Prince Edward Island Forestry Fair in Richmond.

Seed production was very poor in the Maritimes. Seed Centre staff traveled to Newfoundland as part of the 40th anniversary celebrations and took advantage of a fair seed crop. A total of 106 collections from 11 species were made in Newfoundland which greatly increases the inventory of seed from that province. Other significant collections included 15 red maple and 20 balsam poplar collection from New Brunswick, 32 jack pine collections from Nova Scotia, and 15 jack pine collections from Prince Edward Island. In total, 190 collections from 16 species were made.

The Seed Centre received a donation of 181 seedlots of prince pinyon pine, native to Mexico, from a PhD student who evaluated genetic variation within the species while attending University of New Brunswick. The seed were stored in the Centre's Gene Conservation collection.

A total of 68 requests for seed resulted in 814 seedlots provided for research. The majority of the requests were from Canada (60 requests; 684 seedlots) but seed was also sent to Israel (1 request; 10 seedlots), Slovakia (3 requests; 102 seedlots), Sweden (1 request; 4 seedlots), and United States (3 requests; 14 seedlots).

Seed testing consisted of 767 germination tests, 780 moisture content tests, and 482 thousand-seed weight tests.

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INTRODUCTION

This report covers the activities of the National Tree Seed Centre (NTSC) for 2007. Similar reports were prepared from 1998 – 2006. 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.

The NTSC is a major component of the National Forest Genetic Resources Centre. It was established in 1967 at the Petawawa Research Forest (PRF) in Ontario and was transferred to the Atlantic Forestry Centre in Fredericton, N.B. in 1996. The mandate of the NTSC is to: obtain, store, and provide seed of known origin and quality for forest research; carry out baseline research on seed of Canadian tree and shrub species; and preserve germplasm for gene conservation.

Seed is stored in four different categories: Seed Bank, Reserved, Tree Breeding, and Gene Conservation (Table 1). The total number of seedlots increased by 532 to 12 547 in 2007. The numbers in brackets in Table 1 represent the numbers reported in the 2006 Annual Report.

Table 1. Seed stored at the NTSC as of December 31, 2007.

Seed Bank		Gene Conservation		Reserved		Tree Breeding	
No. species	No. seedlots	No. species	No. seedlots	No. species	No. seedlots	No. species	No. seedlots
159 (171)	6,302 (6,157)	30 (22)	3,888 (3,521)	39 (38)	1,966 (1,947)	10 (10)	390 (390)

Seed Bank seedlots are the active collection that are available for distribution. Since 1998, the number of seedlots in the Seed Bank collection has increased from 3,079 to 6,302 (Figure 1). The increase represents the net gain after discarding seedlots due to low germination and the depletion of seedlots as they are provided to clients.

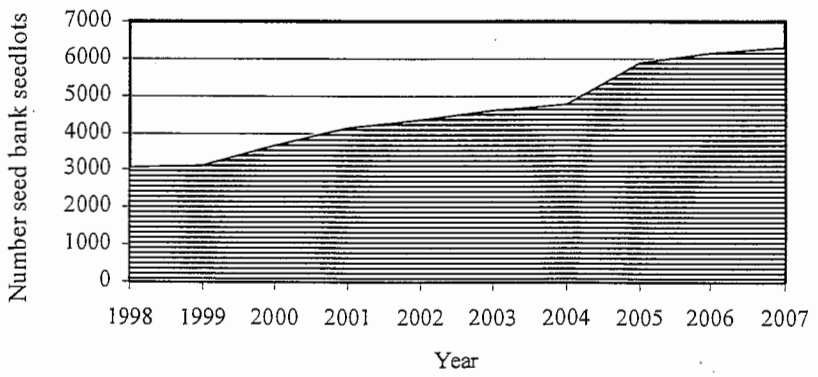

Figure 1. Increase in number of Seed Bank seedlots at the NTSC since 1998.

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, 2007, the NTSC Seed Bank had 6,014 seedlots from 114 Canadian species in storage (Table 2). An additional 61 exotic species (288 seedlots) are also stored. Exotic species are defined as those from which seed was collected outside Canada which may or may not be present in Canada. With the mandate of the Centre now concentrating on seed from Canadian tree and shrub species, the proportion of seed from exotic species is decreasing although some opportunistic acquisitions may still be made.

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

Province	No. species	No. seedlots	Percent
Alberta	12	49	0.8
British Columbia	32	290	4.8
Manitoba	6	65	1.1
New Brunswick	70	1,359	22.6
Newfoundland and Labrador	15	101	1.7
Nova Scotia	41	482	8
Ontario	50	2,335	38.8
Prince Edward Island	32	223	3.7
Québec	21	952	15.8
Saskatchewan	8	111	1.9
Yukon Territory	3	47	0.8
Total	114	6,014	100

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

The Gene Conservation category was initiated in 2000 using seed already in storage. Its purpose is to ensure that genetic material obtained from rare, endangered, and/or unique populations, as well as samples from throughout a species' range is preserved. This collection increased by 367 to 3,888 seedlots. Figure 2 shows the increase in the number of seedlots in this category since 2000.

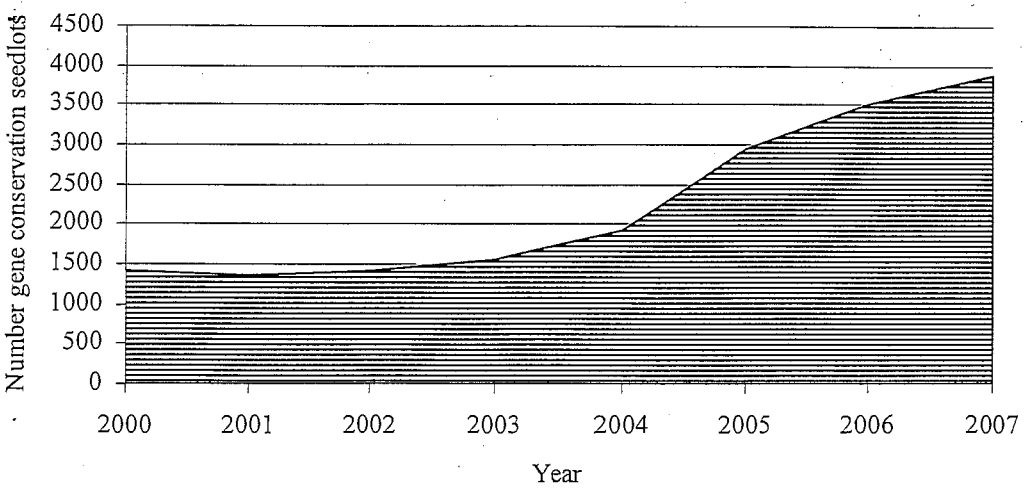

Figure 2. Increase in the number of Gene Conservation seedlots at the NTSC since 2000.

There is seed from 30 species in Gene Conservation with the number of seedlots ranging from 1 for buttonbush (*Cephalanthus occidentalis)* to 1,635 for white spruce *(Picea glauca)*. Other species and number of seedlots are: Manitoba maple (*Acer negundo,* 15 seedlots); striped maple (*A. pensylvanicum*, 17 seedlots); red maple (*A. rubrum*, 65 seedlots); mountain maple (*A. spicatum,* 46 seedlots); yellow birch (*Betula alleghaniensis,* 14 seedlots); eastern flowering dogwood (*Cornus florida*, 4 seedlots); white ash (*Fraxinus americana,* 215 seedlots); black ash (*F. nigra,* 120 seedlots); red/green ash (*F. pensylvanica,* 17 seedlots); Northern red ash (*F. pensylvanica* var. *austini*, 40 seedlots); pumpkin ash (*F. profunda*, 1 seedlot); blue ash (*F. quadrangulata*, 1 seedlot); tamarack (*Larix laricina,* 246 seedlots); black spruce (*P. mariana,* 363 seedlots); red spruce (*P. rubens,* 16 seedlots); jack pine (*Pinus banksiana,* 80 seedlots); limber pine (*P. flexilis,* 100 seedlots); prince pinyon pine (*P. pinceana*, 181 seedlots); pitch pine (*P. rigida,* 4 seedlots); eastern white pine (*P. strobus,* 32 seedlots); Scots pine (*P. sylvestris,* 12 seedlots); balsam poplar (*Populus balsamifera*, 20 seedlots); largetooth aspen (*P. grandidenta,* 13 seedlots); trembling aspen (*P. tremuloides,* 16 seedlots); pin cherry (*Prunus pensylvanica,* 61 seedlots); choke cherry (*P. virginiana,* 321 seedlots); eastern white cedar (*Thuja occidentalis*, 34 seedlots); and eastern hemlock (*Tsuga canadensis*, 168 seedlots).

The Reserved category contains seedlots that have been reserved by researchers. Many of these seedlots were collected for special projects. There was no significant change in this category in 2007.

The Tree Breeding category is composed of seedlots that originated from the genetics program at PRF and were transferred to the Seed Centre for storage. There was no change in this category in 2007.

SEED COLLECTIONS

Seed production was poor in the Maritimes but there was a moderate seed crop in Newfoundland and staff were able to coordinate collections as part of a trip to celebrate the Seed Centre's 40th anniversary. In order to ensure good quality seed, seed is only collected during good seed years. Seed collected in poor seed years may be of lesser quality because of poor pollination. Also, the time required to collect sufficient seed increases when there is a poor seed crop. A total of 190 seedlots from 16 species was collected by Seed Centre staff.

Seed from jack pine (*Pinus banksiana*) was collected from sites in Nova Scotia (32 collections) and Prince Edward Island (15 collections). Jack pine is not common in Nova Scotia and is considered rare in Prince Edward Island. Seed from 15 red maple (*Acer rubrum*) trees was collected in southeastern New Brunswick while 20 collections of balsam poplar (*Populus balsamifera*) seed were made in northern New Brunswick. Most of the remaining collections were made in Newfoundland. The collections made in Newfoundland are important since this will double the number of collections from that province. Significant collections from balsam fir (*Abies balsamea*, 36 seedlots), black spruce (*Picea mariana*, 20 seedlots), white spruce (*P. glauca*, 15 seedlots), and white birch (*Betula papyrifera*, 10 seedlots) were made. Seed was also collected from green alder (*Alnus crispa*), speckled alder (*A. rugosa*), mountain paper birch (*B. cordifolia*), yellow birch (*B. alleghaniensis*), bog birch (*B. minor*), mountain maple (*Acer spicatum*), and choke cherry (*Prunus virginiana*). Table 3 provides a complete list of the collections made.

Table 3. Seed collections made by Seed Centre staff in 2007.

Species	NB	NL	NS	P.E.I.	Total
Abies balsamea		36			36
Acer rubrum	15				15
Acer saccharinum	1				1
Acer spicatum		1			1
Alnus crispa		6			6
Alnus rugosa		3			3
Betula alleghaniensis		6			6
Betula cordifolia		5			5
Betula papyrifera		10			10
Betula minor		1			1
Picea glauca		15			15
Picea mariana		20			20
Pinus banksiana			32	15	47
Populus balsamifera	20				20
Prunus virginiana		3			3
Quercus rubra	1				1
Total	37	106	32	15	190

The NTSC acquires seed through collections made by Seed Centre staff, donations, and purchase. In addition to the 190 seedlots collected by Seed Centre staff, 181 seedlots of prince pinyon pine (*Pinus pinceana*) from Mexico were donated by Carlos Ramirez and stored in the Gene Conservation collection. This seed was used for Carlos' work on genetic variation of *Pinus pinceana* that lead to his doctorate in forestry at the University of New Brunswick. Table 4 shows the number of seedlots acquired by the NTSC since 1996.

Table 4. Number of seedlots acquired by the NTSC through collection, donation, and purchase between 1996 and 2007.

Year	Number of Seedlots			
	Collection	Donation	Purchase	Total
1996	239	22		261
1997	75	245		320
1998	284	47	9	340
1999	139	80		219
2000	195	673		868
2001	137	122	45	304
2002	367	36		403
2003	69	142		211
2004	549	381	137	1,067
2005	142	29	3	184
2006	329	42	30	401
2007	190	181		371
Total	2,715	2,000	224	4,939

SEED REQUESTS

It is the Seed Centre's policy to provide seed, at no cost, for scientific research. Seed is also provided, on occasion, to universities and other educational institutions for educational purposes and to arboretums. A seed request form must be completed by the client before a seed order is processed. The purpose of this form is to gather information on the type of research being carried out and to serve as a means of screening requests. All seed requests received from outside Canada are referred to the Canadian Food Inspection Agency (CFIA) to determine if a phytosanitary certificate and/or import permit is required.

During 2007, a total of 68 requests representing 814 seedlots was processed. The majority of the requests were from Canada but seed was also sent to Israel, Slovakia, Sweden, and United States (Table 5). The number of seedlots provided by the NTSC since 1967 has ranged from a low of 99 in 1996 to a high of 1,603 in 1985 (Figure 3). Canadian researchers received 69% of the seed while seed sent to researchers outside Canada accounted for the other 31%.

Table 5. Number of requests and number of seedlots shipped by country in 2007.

Country	No. requests	No. seedlots
Canada	60	684
Israel	1	10
Slovakia	3	102
Sweden	1	4
United States	3	14
Total	68	814

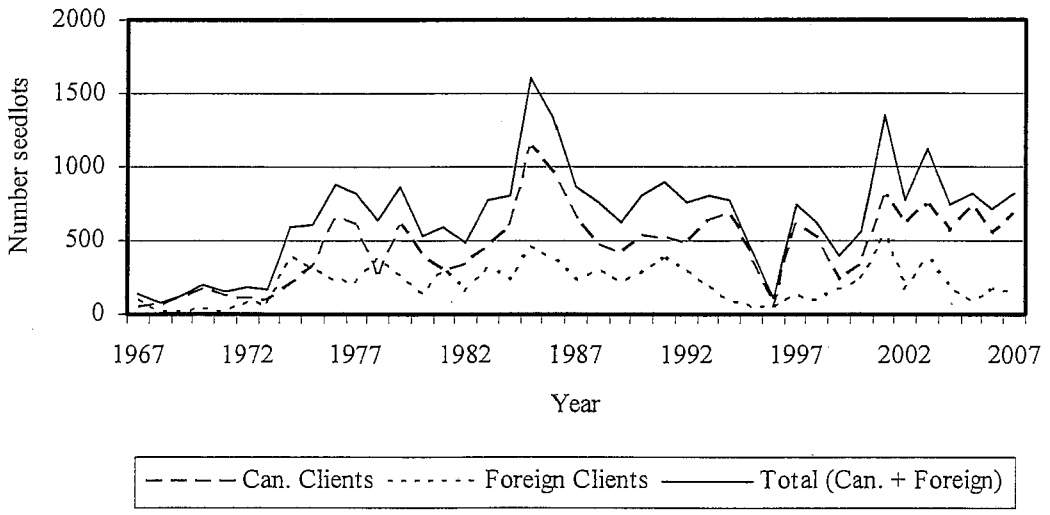

Figure 3. Number of seedlots sent to clients between 1967 and 2007.

SEED TESTING

Germination tests are performed on all freshly collected seedlots as well as seedlots in storage that have not been tested for several years. In most cases, due to small seedlot size, four replicates of 50 seeds each are placed on moistened VersaPak™ in Petawawa germination boxes. When larger seed is being tested, the number of seed is usually reduced. **Seven hundred and sixty-seven germination tests** were carried out.

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

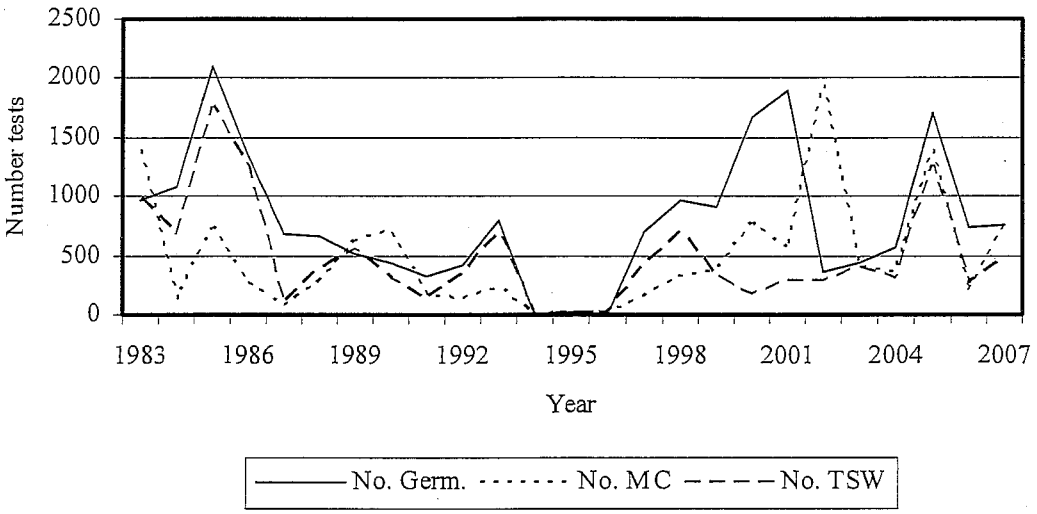

Figure 4. Number of germination tests (No. Germ), moisture content tests (No. MC), and thousand-seed weights (No. TSW) carried out by the NTSC since 1983.

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

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

Eastern White Cedar Seed Storage Experiment

There are two species of *Thuja* native to North America: *Thuja plicata* (western red cedar) and *Thuja occidentalis* (eastern white cedar). In Canada, western red cedar is found almost exclusively in British Columbia while eastern white cedar is common in New Brunswick, Québec, and Ontario but can also be found in parts of Nova Scotia and Prince Edward Island. The species is listed as vulnerable in Nova Scotia and is not common in Prince Edward Island.

Seeds of both species do not require pre-chilling (AOSA, 2002; ISTA, 2008). The seed are considered orthodox and can therefore be dried and stored in sub-zero conditions. There is uncertainty as to how long *Thuja* seed can be stored and retain viability. Seed with a moisture content of 6–8% and stored at low temperatures should retain viability for up to 5 years (Young and Young 1992). Mean germination of eight eastern white cedar seedlots collected in 1991 and 1992 and stored at -20°C for 10 and 11 years at the NTSC remained constant at 61% (Table 6).

Table 6. Germination (%) of eight eastern white cedar seedlots collected in 1991 and 1992 and stored at -20°C at the National Tree Seed Centre for 10 and 11 years.

Seedlot	Germination (%)	
	Tested 1992 and 1993*	Tested 2003
9130051	63	55.5
9130052	45	58.5
9130053	58.5	41
9130054	33.7	44.5
9230090	72.0 *	62.5
9230095	88.8 *	94
9230096	72.8 *	68.5
9230097	54.2 *	65.5
Mean	61	61.3

Thuja seed measure about 6 mm in length and have an attached wing, making the seed almost as wide as it is long (Young and Young, 1992). Thousand-seed weight varies between 0.75 and 1.50 g. The seed cannot be de-winged and the light seed weight and the attached wing make the seed difficult to clean. Consequently seed germination is often mediocre unless good seed set occurs.

In 2006, the NTSC received 15 single tree collections of eastern white cedar cones from the Petawawa Research Forest. The seed were processed and moisture content and germination were determined. Seed quality was very good and the quantity of seed received provided an opportunity to set up a seed storage experiment.

Seed from 12 trees were put in 20 ml screw cap vials which were then placed into 250 ml Mason jars for storage at 4°C and -20°C and in 10 ml screw cap cryogenic vials for storage in liquid nitrogen (LN (-196°C)). Before setting up the experiment, seed were placed in LN for 7 days to determine the impact of storage under these conditions. The germination results of the pre-storage and 7-day storage in LN are given here. Sufficient seed is stored for germination and moisture content assessments at 1, 2, 4, 8, 16, and 32 years.

Four replicates of 50 seed each were placed on moistened Versa–Pak™ and put into a Conviron G30 germination cabinet for 21 days. Germination conditions consisted of a daily cycle of 8 hours at 30°C with light and 16 hours at 20°C without light with a constant relative humidity of 85%. Seed were assessed every two days starting at day 7. A seed was considered to have germinated when the cotyledons were visible and the hypocotyl and radicle were well developed.

Mean moisture content and germination prior to storage was 6.5% and 86.3%, respectively (Table 7). After 7 days in LN mean germination decreased to 83.5%. Moisture content was not determined.

Table 7. Moisture content and germination for 12 eastern white cedar seedlots prior to storage and for germination after 7 days storage in liquid nitrogen (LN).

Seedlot	MC (%)	Germination (%)	
		Control	7 days LN
20063264	6.1	92.5	88.5
20063265	5.6	83.0	87.5
20063266	6.0	98.0	98.5
20063267	5.6	59.5	39.5
20063268	6.2	89.5	82.0
20063269	7.1	89.5	81.0
20063270	6.8	87.0	89.5
20063271	7.1	93.5	94.0
20063272	7.0	85.5	82.0
20063273	6.6	93.5	91.0
20063274	6.7	70.0	72.5
20063278	6.7	94.0	95.5
Mean	6.5	86.3	83.5

This preliminary result indicates that eastern white cedar seed can be stored in LN. Most of the loss in germination is attributable to a single seedlot (20063267) whose germination decreased from 59.5 to 39.5%. If this seedlot is removed, the loss in mean germination is less than 1%.

Literature Cited

AOSA. 2002. Rules for testing seeds. Association of Official Seed Analysts. 166 p.

ISTA. 2008. International rules for seed testing. Edition 2008/1. Int. Seed Test. Assoc., Bassersdorf, Switzerland.

Young J. A. and C. G. Young. 1992. Thuja L. — Arbovitae. Pages 338–340. *In* Seeds of woody plants in North America.. Discorides Press. Portland, Oregon.

SEED CERTIFICATION

Since 1970, Canada has been applying the OECD (Organization for Economic Cooperation and Development) tree seed certification scheme. 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. Most seed is certified in the Source-identified category.

Demand for certified seed, which was high in the 1970's and 1980's, has declined the past 15 years (Figure 5). However, a total of 665 kg of certified seed was exported in 2007, which was about double that of 2005. The increase was due to 593 kg of lodgepole pine (*Pinus contorta* var. *latifolia*) from Yukon Territory exported to Sweden as well as 62 kg of grand fir (*Abies grandis*) exported to Europe as Source-Identified. Ten kilograms of Sitka spruce (*Picea sitchensis*) was exported certified as Untested Seed Orchard. The European Union (EU) implemented a revised certification Directive on January 1, 2003. There has been concern about equivalence between this directive and the OECD Scheme. Fortunately, the EU has granted equivalence to Canada for *Abies grandis*, *Picea sitchensis*, *Pinus contorta*, and *Pseudotsuga menziesii* seed to be imported as source-identified and untested seed orchard.

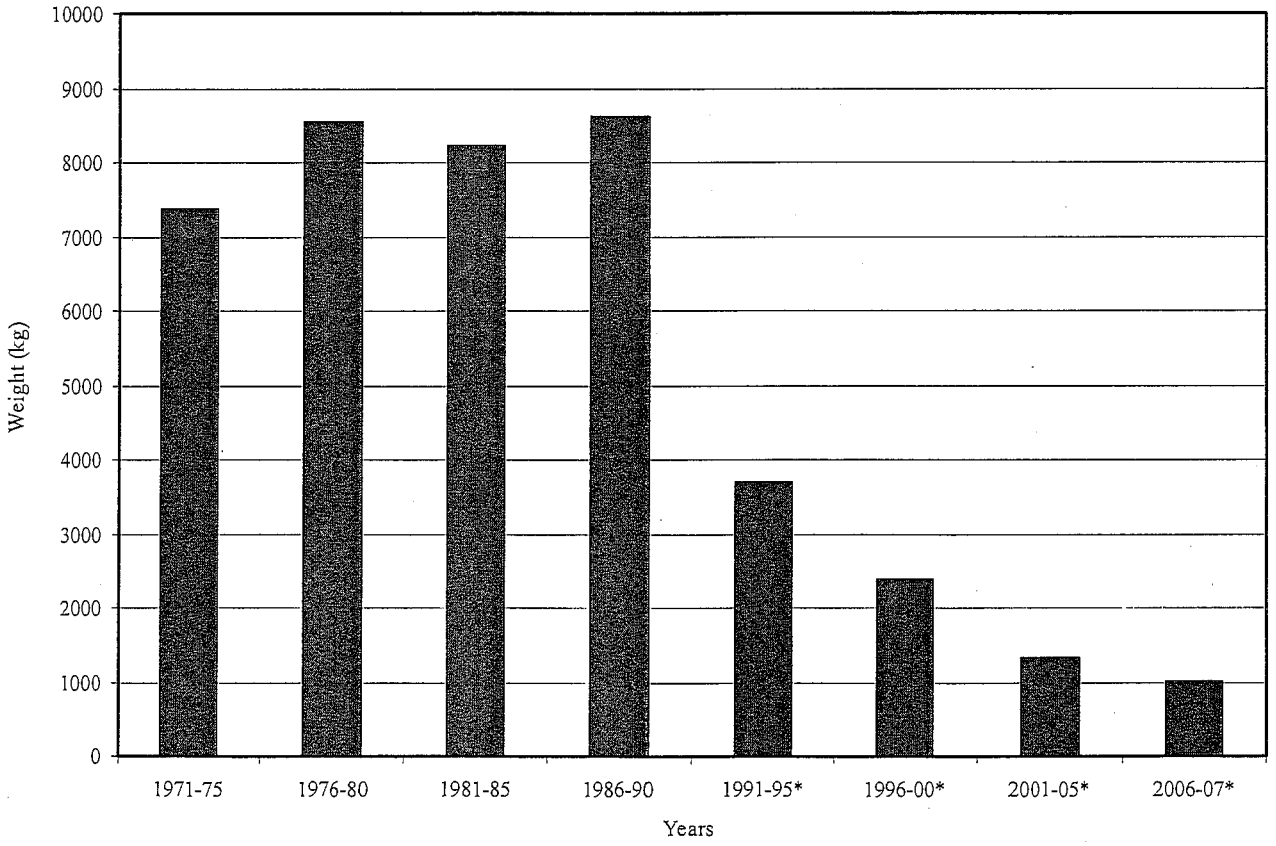

Figure 5. Weight of seed OECD certified or exported* by 5-year periods.

Officially established in 1967, the OECD Scheme for the Control of Forest Reproductive Material Moving in International Trade developed rules and procedures that were adopted in 1974. From its early implementation by a limited number of countries for Douglas-fir seed exported 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. To date, the Scheme includes 22 participating countries and three official applicants, working with more than 250 different species.

During the last decades, it became apparent that the 1974 Scheme required revision because of changes in forest management in addition to wood production (environmental and social aspects, biodiversity conservation, etc.) and the growing importance on the market of new types of reproductive material derived from forest tree breeding programs. This resulted in the formation of a Group of Experts that worked between 1992 and 1996 to prepare a comprehensive proposal.

A revised Scheme was presented to the Committee for Agriculture in November 1996 but could not be accepted at that time, mainly due to divergences on the matter of identifying new types of trees derived from modern biotechnology. During the following years, a number of solutions were explored to reach a compromise, in particular for the more advanced categories of forest reproductive material.

At the Biennial Meeting of Representatives of the National Designated Authorities held in Hungary on 5-6 October 2006, delegates discussed the matter and agreed to amend the Scheme to include only the "*Source-identified*" and "*Selected*" categories as these would immediately benefit all stakeholders, including new applicant countries that are strengthening their domestic control systems for forest reproductive material. The two "advanced" categories of forest reproductive material ["*from Untested Seed Orchards*" and "*Tested*" categories of the current Scheme, "*Qualified*" and "*Tested*" categories of the previous proposal] would be suspended, given the lack of a unanimous agreement for the time being. Discussion on wording for these two "advanced" categories of forest reproductive material will continue with the hope that they can be added to the Scheme as soon as possible.

The revised Scheme was circulated for approval by member country delegates in early 2007. It was submitted to the OECD Committee for Agriculture and OECD Council and was approved for adoption on 20 June 2007. The Scheme is now equivalent to the European Union Directive for seed certification for the Source-identified and Selected categories. As a result of these updated categories it is hoped that the Scheme will be an incentive for other countries to join.

PROMOTION OF THE SEED CENTRE

The National Tree Seed Centre celebrated its 40th anniversary. This provided an opportunity to further promote the NTSC to our clients and to increase its profile through various activities. Some of the more notable events are mentioned below.

A new seed board with display panels was developed. The seed board features seed in encased epoxy resin as well as a silhouette of the tree and a color picture of a reproductive structure.

A poster highlighting the three main activities of the Seed Centre (Collection, Collaboration, and Conservation) was produced.

Dale Simpson, manager of the NTSC, made a presentation at CFS - Atlantic (Corner Brook). An article titled " Local seed being collected for national centre" was published in the Corner Brook newspaper The Western Star.

Bernard Daigle attended the PEI Forestry Fair which was held in Richmond PEI on October 20. The fair included exhibitors from the three Maritime provinces and was intended for landowners, businesses, and the general public.

An article titled "The National Tree Seed Centre Celebrates 40 Years" was published in the September/October issue of The Forestry Chronicle.

The Impact Note for the National Tree Seed Centre (Impact Note N° 45) was updated and is being distributed to clients who request and receive seed.

Dale attended the annual Balloon Fest event in Sussex, New Brunswick.

The Seed Centre hosted an Open House for staff. Displays were set up in the atrium on Level 0 as well as in the lab.

The NTSC set up display booths for Maple Fest 2007 held at the Hugh John Flemming Forestry Centre and for the Acadian Forest Science Conference, October 10-13, 2007.

An information package was sent to clients who received seed from the NTSC over the past 10 years. The package included a letter from CFS-Atlantic Director General Dr. John Richards, a copy of the NTSC Impact Note, and a copy of the seed poster. In addition to past clients, the information package was also sent to most Canadian universities with science programs as well as some universities in the United States.

Article by Meaghan Philpott in NRCAN "The Source" entitled "Contribution, Collaboration, Conservation".

SEED CENTRE STAFF

The amount of work carried out by the Seed Centre during 2007 was increased through "extra" work weeks that were funded through FSWEP/ASEP and the Federal Public Sector Youth Internship Programs. These programs enabled the Seed Centre to acquire employees without having to cover their wages.

James Bird was hired through the Federal Public Sector Youth Internship Program. His term began on October 23, 2006 and continued to the end of April 2007. His work consisted mainly of seed processing and testing.

Michelle Perley was hired through FSWEP/ASEP funding and worked full-time from June to the end of August. She returned to UNB and was able to provide 1 day/week until the end of December. Her work during this period involved assisting with field collections and processing and testing seed in the lab.

These employees provided an "extra" 35 weeks of work to the Seed Centre. The number of "extra" weeks worked in 2007 is at the 10-year average of 35 extra weeks (Figure 6).

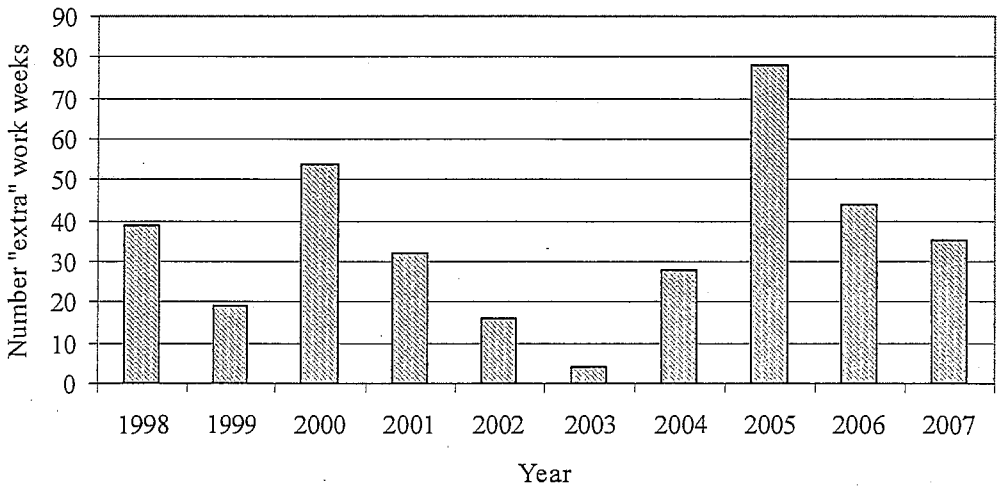

Figure 6. Number of "extra" work weeks provided to the NTSC between 1998 and 2007.

PRESENTATIONS / PUBLICATIONS

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