Excellence in Cone and Seed Services

The First 50 Years

British Columbia Forest Service

Tree Seed Centre

BRITISH COLUMBIA
Ministry of Forests and Range

Acknowledgements

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Thank you to those individuals and organizations who have contributed in a variety of ways to "Excellence in Cone and Seed Services" over the past 50 years. Some of these individuals are present in the photograph below with a complete Tree Seed Centre's 50th Anniversary Honour Role listed on pages 36-38.

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Introduction

The purpose of this publication is to capture some of the events and to acknowledge the people that have been part of 50 years of "Excellence in Cone and Seed Services" at the BC Forest Service, Tree Seed Centre.

Forestry in BC began as a small and primarily coastal forest industry of the 1920s and 1930s, and developed into the province wide industry that it is today. Reforestation evolved from natural regeneration to planting a new mixed species genetically improved forest. A BC planting program that totalled 500 million trees planted between 1930 and 1974 progressed to a program of over 200 million trees planted on average each year since 1988. Seedling production progressed from a single forest research nursery in 1926, through the development of a number of government managed bareroot nurseries throughout the province, to public and privately run specialized large scale container complexes producing seedlings to specific standards.

Over time, seed use has evolved from one or two species of seedlots of questionable quality and source to all major BC coniferous species of known source and best possible quality. With the increased understanding of forest genetics, a tree improvement program was developed to establish managed seed orchard production of genetically superior seed.

Given that 95% of the forest land of British Columbia is Crown land, this public ownership brings with it a responsibility to regenerate the next forest. This next forest must be one that is ecologically best suited to survive and excel.

The decision to develop a seed extractory at the Duncan Nursery in the 1950s was to ensure a continuous tree seed supply. There were other suppliers of seed in the province but new forest policy and practices dictated that the BC Forest Service (BCFS) must take the necessary steps to ensure that they acquire and maintain an assured seed supply – seed necessary to meet the needs of planned forest harvesting with provision for natural disasters.

Cone and seed processing equipment and methods were developed primarily from processes and equipment used in agriculture, horticulture and mining. Further development and improvement of equipment and methods was largely influenced by forest nursery and silviculture practices' needs.

Province-wide forest harvesting increases had led to increased reforestation demand and to advances in silviculture practices. These changes meant that the extractory at the Duncan Nursery had to evolve into a seed centre. This evolution included the development of new procedures, new practices and the acquisition of new facilities and equipment at a new location in Surrey, BC where the provincial Tree Seed Centre continues to operate today.

The Tree Seed Centre's drive for excellence has been influenced by a number of factors including the changes in type, level and source of service requests, policy, economic conditions and changes in silviculture, nursery, seed orchard and private extractory systems. Cone crop variability, changes in demands among species, increased production of seed from seed orchards and issues such as the current mountain pine beetle devastation have also influenced how the Tree Seed Centre operates.

The Tree Seed Centre shares part of the reforestation responsibility to ensure and manage the seed supply to meet the seedling production needs of the current and future silviculture systems in use in BC. The Tree Seed Centre has responded positively to challenges faced, gained from the experience and continued on its road to "Excellence in Cone and Seed Services".

Additional information on Tree Seed Centre services, fees and seed biology can be found on our website: http://www.for.gov.bc.ca/hti/treeseedcentre/index.htm

Chapter 1
The Tree Seed Centre Today

The Tree Seed Centre (TSC) is located on 6.7 hectares of Agriculture Land Reserve on 32nd Avenue in South Surrey. The facility measures 3,623 square meters and is comprised of offices, cone preconditioning areas, cone and seed processing and distribution areas, seed laboratory, coolers and long-term freezer storage vaults. The facility is a one of a kind operation that is supported by a system of daily checks and inspections, backup power generators and security systems to ensure the maintenance of the seed for our future forests.

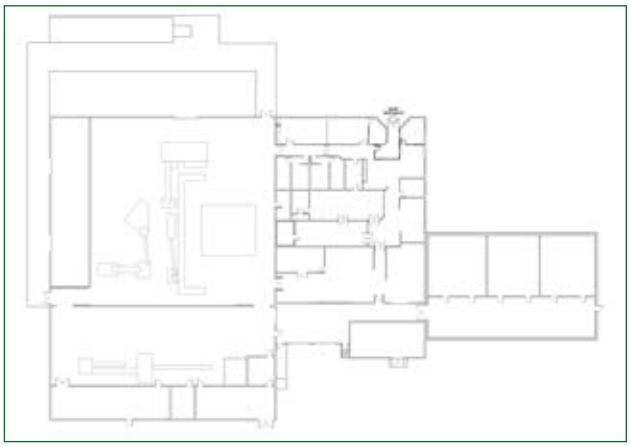


Figure 1. Floor plan of the Tree Seed Centre in Surrey.

The TSC, as part of the BC Ministry of Forests and Range (MFR), Forest Stewardship Division, Tree Improvement Branch (TIB), offers a wide range of highly specialized services to a large and diverse group of clients including forest licensees, Ministry of Forests and Range, seed orchards, forest nurseries, cone collectors, tree seed dealers, First Nations, researchers, educators, and the public.

TSC staff includes fourteen full-time and 6-8 part-time staff, supplemented by a variety of professional, technical and trades contractors.

Figure 2. Tree Seed Centre staff. March 2009.

For many years, the TSC mission has been "Excellence in Cone and Seed Services". The variety of services provided by the TSC, often referred to as the *Seed Handling System*, form a chain of custody and an integral link in a complex Genetic Resource Management (GRM) system. Seedlot diversity, identity, and quality must be maintained and carefully tracked during and after a seedlot's active life. The best scientific and technical information guide decision making and continuous improvement. The following quality assured cone and seed stewardship services are provided by the TSC.

Registration

All seed destined for Crown land reforestation is registered. The practice of seedlot registration began in BC in 1957. As part of this process, the TSC ensures that seedlots meet applicable collection criteria as specified in the *Chief Forester's Standards for Seed Use* (www.for.gov.bc.ca/code/cfstandards). The standards include minimum requirements for genetic diversity and physical quality for BC and several Pacific Northwest US species and sources. This information is also used to guide transferability of seedlots to avoid maladaptation and maximize forest productivity. All seed must meet the requirement of 97% or better purity and be between

4.0 and 9.9% moisture content to assist in maintaining long-term viability. Registration information and data integrity is maintained in a web-based Seed Planning and Registry (SPAR) System, which currently allows clients to apply for registration of seedlots online.

Figure 3. Spencer Reitenbach verifying cone collection information for seedlot registration.

Cone and Seed Processing

Processing of cones and seeds includes detailed seedlot evaluations, cone and seed conditioning, extraction of seed from cones and the removal of wings, debris and non-viable seed. Cone and seed evaluation services prior to and during collection and during interim storage are a part of cone and seed collection and processing.

Cone processing facilities include: cone conditioning storage for over 1,000 hectolitres (hl) of cones; semi-automated cone tray loading and seed removal systems; a natural gas fired forced air kiln to remove moisture and open cones; and a dedicated conditioning and processing area for *Abies* (true fir), cedar and hemlock species. Seed processing includes: initial screening machinery to remove debris from the seed product; a tumbler type dewinger to remove seed wings by wet and dry methods; liquid separation baths to remove debris, pitch, and non-viable seed; a continuous tray line seed dryer; and various table and pneumatic specific gravity seed separators. Other cone and seed processing services are related to returned seed, seedlot upgrading, research and small lot processing.

As a result of mountain pine beetle concerns and increasing orchard production, cone and seed processing volumes are currently three times that of the past 10-year

Figure 4. Christina Herman loading cones onto trays for kilning.

Figure 5. At work in the seed processing area to purify seedlots.

Figure 6. Cheryl Linden performing quality assurance assessments during seed processing.

average or about 10,000 hectolitres each year. In order to meet increasing production levels, cone and seed processing operations run throughout the year, sometimes on a multi-shift basis and 7 days per week. Staff at the TSC are also seeing an increase in requests for expedited processing, particularly for those production, family and research lots originating from seed orchards.

Seed Testing

Standard tests are performed on all new seedlots, and according to a standard retesting protocol, on the seedlots in storage. These tests include moisture content and purity to ensure the seeds meet the registration requirements and can be safely stored at -18C° for long durations. Seed weight and germination capacity are also determined. Seeds per gram and germination rates are derived from these principal test results and are used to calculate grams of seed required to produce a requested number of seedlings. X-rays of all new seedlots are taken as a long term record of initial seedlot quality. The procedures are in alignment with International Seed Testing Association (ISTA) and Association of Official Seed Analysts (AOSA) rules, Ministry of Forests and Range seedlot registration policy and TSC standards. Quality assurance tests are performed on a portion of a seedlot, at a specific point in processing, or on a specific sowing request. Seedlots and requests may also be subject to fungal assay testing. The seed testing business area also supports research trials.

Seed Storage and Inventory Management

The TSC is responsible for storing seed under optimal conditions for crown land reforestation. The seed storage facility consists of three secure metal vaults inside a concrete block building. The TSC has approximately 6,000 registered seedlots in storage that total over 74,000 kilograms of seed as of 2009. This is equivalent to 7.2 billion potential trees. In 2008, 5 metric tonnes of seed were added to long-term storage (the equivalent of nearly 600 million potential trees) and 3 metric tonnes were withdrawn.

Figure 7. Nora Galdert counting germinants.

The seed inventory also has a risk management role in the event of catastrophic losses resulting from wildfire, insects, disease, and climate change and includes a dedicated seed bank for genetic conservation purposes. Inventory management activities include: additions to the inventory with new and returned seedlots; seed withdrawals for reforestation, research, education and public relations; seed and seedlot quality and quantity assurance checks; and management of information related to seed availability, ownership, sales/transfers and history of use. Clients may request that seed be forwarded without treatment (dry), pelleted in the case of western redcedar and alder or stratified using standard or customized seed treatment methods.

Information Management

The TSC utilizes a two level information management system. The corporate Seed Planning and Registry (SPAR) web-based system captures seedlot and service request summary data. SPAR is an order entry and inventory and information system that is used by both the Ministry Forests and Range and industry clients.

Figure 8. Sherry Collins withdrawing seed from long-term storage at -18° C.

The Cone and Seed Processing (CONSEP) system captures detailed data and receives and sends summary data and information to SPAR. These systems work together to capture and report on request/seedlot information, schedule and report outcomes and support "just-in-time" service delivery, decision support and change management. Systems also support financial and administrative operations and play a key role in continuous improvement and knowledge management.

Administrative Operations

Finance and administration staff provide a key role in supporting TSC's operations, staff, budget and revenue management. The facilities and site operations team is dedicated to managing and protecting all site, building, and equipment assets. The TSC's one of a kind operation is supported by a system of daily checks and inspections, backup power generation and security systems to ensure maintenance of seed for our future forests. It is designated as Mission Critical within the Ministry of Forests and Range Business Continuity Plan.

Cone and Seed Improvement

The TSC conducts applied research and extension on tree seed throughout the entire seed handling system. This includes development and summarizing of research and quality assurance programs and the production of formal and informal communication activities. Activities in this area play a key role in addressing issues of importance to conifer seed science and technology.

Figure 9. Anita Rebner and Heather Rooke balancing the budget.

The People

It has been said that the hallmark of an effective organization is "having the right people in the right place at the right time". The people who have worked at and with the TSC over time, represent an amazing and diverse group of full, part-time and temporary staff, students, consultants, contractors and colleagues, both in and outside the BC Forest Service. Over the years the numbers of individuals, how they are organized and where they are located has changed but what has remained constant is their ability to embrace the concept of the art, science, and business of cone and seed services. For a number of years, staff have referred to themselves as "The Coneheads", an acronym as follows:

Client service is our focus

Open to new opportunities

Need to find solutions

Excellence in cone & seed services

Helping reforest British Columbia

Experienced (over 300 years)

Adaptable

Dynamic business environment

Science and best practices

Staff at the TSC are known for their exceptional client service, unique knowledge, technical competence, integrity and team based approach within their community of practice.

The Future

There has been a long-standing culture of Continuous Improvement at the TSC. Change has and continues to be very much a part of the day to day environment. Reflecting back on the past 50 years gives rise to the question, "what might the next 50 years bring?" The TSC will need to maintain its ability to effectively adapt to changing circumstances. Recent examples are:

1) The substantial increase in cone and seed processing and the entire Seed Handling System resulting from the devastating impacts of Mountain Pine Beetle.
2) The need to respond to an increasing number of requests for customized and quick turnaround processing for both orchard and wild stand seed sources.
3) The need to subscribe to a forest and/or management based certification system, or at the very least, to continue to operate a certification-ready system.
4) Be able to demonstrate chain of custody process and accountabilities.
5) Delivering cone and seed services for species beyond conifers of commercial importance (e.g.) broadleaves, limber and whitebark pine for reforestation and/or genetic conservation/restoration purposes.
6) The need to continually test current knowledge and methodology to enable best practices available and delivery of a complex program with a diversity of services.
7) The ongoing requirement to integrate and enhance information management tools and technology associated with service delivery and corporate data, information and knowledge, and,
8) The ability to continue to realign our organization and internal delivery system to effectively meet legislative, economic and workforce demographic changes, succession challenges and variations in annual production levels and characteristics.

Summary

The TSC program and facility, the largest of its kind in Canada, continues to be regarded as world-class. The TSC plays a significant role in the Tree Improvement Branch's mission to protect, manage and conserve British Columbia's forest genetic resources through excellence in cone and seed services, seed production, policy including the *Chief Forester's Standards for Seed Use*, planning, decision support, information management and communication. The variety of functions provided by the TSC, often referred to as the *Seed Handling System*, form an essential and unique chain-of-custody and integral link in a complex genetic resource management system and reforestation cycle. The Provincial Tree Seed Centre's mission to provide "Excellence in Cone and Seed Services" continues to be a relevant and enduring part of the Ministry's forest stewardship role.

Chapter 2

The Early Years – Before the Tree Seed Centre

Beginning in the 1920s through the 1950s, several cone and seed processing facilities operated in the province. These facilities were for the most part privately owned and focused on overseas seed sales. It was a time of natural regeneration in the forests of BC. As planting became more important there was a gradual need for and development of Forest Service (FS) nurseries.

The Early Forest Nurseries

The 1926 Department of Lands, Forest Branch annual report stated that the "first ten nursery beds, 4 by 12 feet, were prepared and sown on Shelbourne Street near McRae Avenue in Victoria. The sowing included

Figure 10. The first BC forest nursery on Shelbourne Street. Victoria 1931.

Monterey pine, Sitka spruce, Douglas-fir, western redcedar and hemlock, and some Japanese species. In 1927, the Research Branch was established, and Arthur Pickford was placed in charge of this nursery, whose purpose was to provide seedlings for experimental plantings (a research nursery). In 1930, acreage was cleared at Green Timbers in Surrey to establish the first production nursery on BC's mainland. By 1933, the production at Shelbourne St. was transferred to Green Timbers in Surrey, and the Victoria nursery closed.

Significant changes had occurred by the 1930s, including the return of thousands of square miles of "Railway Belt" lands to the province. As part of Confederation, the Province of BC had transferred lands to the Dominion Government, including the CPR land belt, the Peace River "lieu lands" and 3,000 square miles on Vancouver Island. These returned lands were now the forest management responsibility of the province. Another significant factor in the development of forest nurseries was the need to reforest after significant fires, such as the 1938 Sayward forest fire on northern Vancouver Island. In 1938, the Minister announced that up to 10,000 acres of cut over (logged) lands would be reforested. This would require some 10 million seedlings per year and lead to the need for additional nursery capacity.

In the late 1930s, the British Columbia Forest Service (BCFS) established Campbell River Nursery. This bareroot nursery was scheduled to produce 4 million seedlings per year and in 1940 produced its first crop.

A fourth BCFS nursery was established in 1943 in Duncan between Chesterfield and Lakes Road. Development continued in 1944 and 1945, with the

Figure 11. Preparing bareroot beds for sowing Douglas-fir seed in Duncan. 1960.

first seed beds sown in 1946. Some 10 years later, in 1956, the tree seed extractory construction began on this site. In 1963 additional acreage was purchased and leased south of Duncan to become Koksilah Forest Nursery.

In 1949, the establishment of interior forest nurseries began and the first interior nursery beds were sown at the Elko Ranger Station. There were 28,000 two-year-old seedlings from these beds planted at Elko, the first plantation in the southern interior. In 1950, the first permanent interior nursery was established at Wycliffe, adjacent to Perry Creek, north-west of Cranbrook. This nursery continued operations until 1967 and was known variously as Wycliffe, Perry Creek, East Kootenay and Cranbrook nursery.

Tree planting in the province progressed from approximately 1 million in 1939 to 8 million in 1959 to 25 million in 1969 and to 65 million in 1979. This was achieved by major expansion of the Forest Service nurseries in the late 1960s and early 1970s. Red Rock Nursery and Research Centre and the expanded Koksilah nursery were officially opened in 1967. Nineteen sixty seven also marked the first sowing at Chilliwack River nursery. In 1968, acreage was acquired through a land exchange with the municipality of Surrey to become Surrey Nursery. A corner of this site would later become the Tree Seed Centre in 1986. Trial container nursery operations were established at Vernon, Telkwa and Red Rock in 1971. Two years later, in 1973, Skimikin nursery west of Salmon Arm began operation and in 1974, Harrop, east of Nelson, began operation as a test nursery with production to follow.

During the 1970s, nursery expansion continued with the development of container growing facilities. By 1979, seed for approximately 100 million seedlings was being sown. Licensee and commercial nurseries were now participating in seedling production, a major change from the previous Forest Service only production. In 1985, the last of the new container nursery facilities of the Forest Service was opened at Thornhill, near Terrace, BC.

In the latter part of 1987, the Provincial Government implemented forest policy changes to enable the privatization of most of the crown operated forest nurseries. By 1989, eight of the eleven Ministry nurseries (Campbell River, Chilliwack, Harrop, Koksilah, Telkwa, Thornhill, Red Rock and Vernon) were privatized. On September 1, 1988, six of these became Pacific Regeneration Technologies Inc. (PRT). Koksilah and Telkwa were sold separately with Green Timbers, Skimikin and Surrey Nurseries continuing as BCFS operations. Subsequently, Green Timbers Nursery was closed in 1999, Skimikin Nursery was privatized in 2002 and Surrey Nursery was privatized in 2004. In 2008, Surrey Nursery's final crop was harvested and facility closure occurred the following year.

When the new Tree Seed Centre was built in Surrey they were supplying a record number of nurseries and achieved a new record number of requests for seed. Seedling planting had increased from 3.2 million in 1956, to 26 million in 1969 to over 200 million by 1989.

The Early Tree Seed Extractories in BC

The first tree seed extraction plant in BC was operated by the Dominion of Canada Forest Branch, Department of the Interior. It began operations in 1922 in New Westminster. One of its prime objectives was to provide Queen Charlotte Island Sitka spruce seed, and BC Douglas-fir seed to reforest areas denuded in the United Kingdom during World War I. They also provided considerable Ponderosa pine to New Zealand and Australia, and seed for the railway granted lands in BC.

Forest resource administration was relinquished by the Dominion government to the Province in 1930. The Provincial Government was now responsible for the forestry activities on crown lands. The Federal Government no longer needed the New Westminster seed plant and it was closed in 1933.

Percy Ruth began his conifer seed extraction plant at Salmon Arm in 1927. This was the result of a request from the Dominion of Canada Forestry Branch for Douglas-fir, lodgepole pine, Ponderosa pine and Engelmann spruce seed. Percy Ruth supplied seed primarily to Great Britain and other European countries. He also sold seed to Manning Seed, Herbst Seed Company in the USA, and to the BCFS, primarily for post forest fire regeneration. In 1951, John Fleur de Lys became a partner with Percy Ruth and the company became known as Shuswap Seeds Ltd. Three years later in 1954 the company was sold to Manning Seed Company, Roy, Washington.

There were other private extractories in the province that sold seed and supplied seed on occasion to the Forest Service. Walker Perlstrom built and operated a rough seed extractory in cooperation with Manning Seed on the Queen Charlotte Islands between 1954 and 1967. Manning also operated an extractory at Qualicum Beach between 1956 and 1968. Manning Seed later became part of Silva Seed in Washington and Oregon operated by Brent Gerdes and Jack Cameron. Other extractories that operated in those early years included: Captain A. K. de Hurst extractory in Kamloops between 1936 and 1946; Henry Ford in Kamloops in the 1950s and 60s; and Torbin Lisberg extractory at Merville, near Courtenay, on Vancouver Island, between 1955 and 1967.

In 1936, Charles McFayden, who had worked at the Dominion of Canada extractory, built a new facility in Richmond. This facility's chief customer was the British Forestry Commission with some custom processing for the BC Forest Service. The extractory was sold to Gordon and Heber Roche, who continued to operate it until it was sold in 1974 to Reid, Collins and Associates Limited. During the 1970s, Reid, Collins did processing for forest companies in the province. In 1979, machinery from this plant was moved to the Reid, Collins Nursery in Aldergrove, where they continued to provide native plant and tree seed sales and services until 2001. Some of this equipment was transferred to the PRT operation in Prince Albert, Saskatchewan.

Figure 12. The Reid, Collins Seed Extractory. Richmond 1979.

Western Tree Seeds of Blind Bay, BC, Silva Enterprises of Prince George and Yellow Point Propagation, south of Nanaimo, were three other businesses that provided seed services in the province. Western Tree Seeds was established by Frank Barnard in 1966 at Blind Bay adjacent to Shuswap Lake on land that his father, Arthur had homesteaded. Frank had experimented with the seed business after a conversation in 1958 with Donald Ruth, son of Percy Ruth, the owner of the first extractory in the interior of BC. Frank, who was working as a Forest Service Assistant Ranger, was allowed to follow his interest as long as it "did not conflict with my Forest Service duties."

The building of his new extractory in 1966 proved fortuitous as 1970 brought a major contract for Western Tree Seeds to provide the British Forestry Commission with 2,000 kilograms of Queen Charlotte Island Sitka spruce seed. Frank continued to collect and process seed for overseas clients, as well as providing seed services to forest companies for their private land reforestation. Additionally, the BC Forest Service contracted Western Tree Seeds to provide extraction services in bumper cone crop years to augment the Tree Seed Centre facilities. Frank sold the business in 1997 to Doug and Sandra Gregory of Quality Seeds who continued the processing operations until 2003. They are still in the business of collecting native plant and tree seeds.

Silva Enterprises was started by Rolf Hellenius in 1965 when he moved to Prince George to become the Superintendent of Red Rock Nursery. The Silva Enterprises extractory was built by Rolf's son Lawrence near Red Rock nursery. Lawrence helped to keep the business going until Rolf retired in 1973. Rolf and his wife, Kathleen, would make annual trips up to the Yukon each year to collect lodgepole pine for clients in Sweden and elsewhere. Rolf's son Peter and his wife, Linda, acquired the business in 1988. The company provides cone and seed processing for the forest industry, has operated on contract to the Forest Service in bumper crop years and continue their overseas and domestic business to this day.

Yellow Point Propagation near Nanaimo owned by Don Pigott has provided tree improvement, seed and seedling, and native plant services since the late 1970s. Don was the recipient of many of the surplus seed processing equipment with the TSC move from Duncan to Surrey. The company continues to collect, process and sell cones and is becoming more active in the area of genetic conservation.

Chapter 3

The BCFS First Generation Tree Seed Extractory

The plans for a Forest Service seed extraction plant had begun by 1955. George Silburn, forester-in-charge of the Reforestation Branch, Alf Bamford "Mr. Reforestation" 2nd-in-charge, and Jack Long, Superintendant of Duncan Nursery had championed the need for an assured supply of seed. Seed was needed for the four BCFS nurseries at Green Timbers, Campbell River, Duncan and Cranbrook.

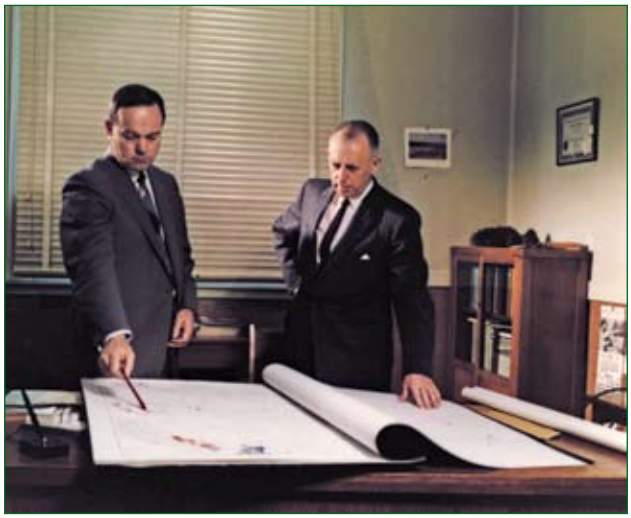


Figure 13. Alf Bamford and George Silburn champion the need for a seed extractory. Victoria 1961.

Support for this extractory was also contained in the 1955 to 1957 Royal Commission on Forest Resources by Chief Justice Gordon Sloan that recommended the expansion of the planting and seed programs and experimentation with direct aerial and ground seeding.

Funding the new extractory was a challenge, ultimately solved in a unique way. A forest company official operating in the Cowichan Lake area made a proposal to Mr. Silburn that the forest service 'snagging crew' be used to cut snags for the company and the company would in turn pay for their wages. As the crew was already on the government payroll, funds were provided to the Reforestation Division and used to build some additional facilities at Mesachie Lake and a new seed extractory at Duncan Nursery.

Prior to the construction of the Extractory at the Duncan Nursery, there were two buildings on this site: a single storey, three bay garage constructed in the early 1950s, and a two storey warehouse building.

In 1956, a two storey concrete block building was constructed as the first BC Forest Service tree seed extractory. In 1957, processing equipment was installed and approximately 900 bushels (327 hectoliters) of cones processed. This initial trial led to the understanding that modification and expansion were required. In 1958, a single storey wooden building was constructed to house the cone kiln and boiler room. This expansion would allow kilning of approximately 100 to 140 bushels of Douglas-fir in a 24 hour period. This addition also included nursery office space and counter space for seed germination testing. A second cone storage building was also constructed and in 1964 a duplicate cone storage building was built.

Figure 14. Aerial view of Duncan Tree Seed Extractory.

Figure 15. Alan Lamb at Duncan Cone Shed. 1959.

The complex was now truly a cone extraction and processing facility with an oil-fired, hot water boiler and Moore Dry Kiln controls that could control temperature and humidity of the batch kiln just like a lumber dry kiln.

Figure 16. Alan Lamb and Jack Long in the kiln. Duncan 1959.

In 1959-60, a seed freezer storage facility was constructed in conjunction with the first Duncan nursery cold storage unit. Prior to this a small cooler was used to store seed in conjunction with Dr. Alan Orr-Ewing's tree improvement program. The new freezer consisted of two walk in units and a seed weighing work room. The freezer units operated at 0^0F (-18^0 C) and held 10,000 kilograms of seed.

In 1965, the size of seedling cold storage was doubled and a walkway added between the old and new units. These seedling cold storage coolers were also used for

Figure 17. The seedling cold storage unit and seed freezers 1 and 2. Duncan 1960.

Figure 18. Mary Cook at the gravity separator. Duncan June 1971.

seed stratification in late winter and early spring and in 1978 for cone conditioning. Three years later in 1968, two additional seed freezers were constructed, doubling capacity to more than 20,000 kg. In 1966 and 1967, the 2 storey warehouse was renovated to provide space for nursery offices and a seed laboratory. The lunch room areas in the extractory were converted to a seed cleaning area.

Bruce Devitt had been hired as a new forester in the Reforestation Division in 1957. He was initially stationed at Cowichan Lake but subsequently moved to Duncan. During the 1960s and early 1970s he was the person responsible for the seed program in the Reforestation Branch and thus the developments at the

Figure 19. Bruce Devitt examining the Douglas-fir cone crop in Duncan. August 1959.

Duncan Seed Centre. Jean Sicher, Ton Hamilton, Mary Heinrich/Hamilton and Rob Bowden-Green followed as "Technicians in charge of Seed".

The Mobile Extractory

During February of 1976, Jenji Konishi of the Reforestation Division, along with Bob Scott, and Bill Aten of Engineering Division travelled to Washington and Oregon to visit various forest nursery and seed facilities. This tour prompted a number of recommendations and initiatives including use of seedling cold storage units for conditioning and pre-drying of cones, improvements in dust exhausting from the extraction plant, the planning and designing of a new processing facility, and a mobile seed extraction plant to be available for full or partial processing of regional wild stand and seed orchard crops.

With the idea of expanding extraction capability, the plans and specifications of the Weyerhaeuser mobile extraction unit were obtained and subsequently a unit ordered from Wilkins and Associates of Tacoma, Washington.

In 1977, the unit was set up and tested as the Weyerhaeuser unit had been used primarily to process Douglas-fir seed orchard seedlots. A number of trials to test operation and production setting capabilities occurred. In 1978, after some modifications, the unit was moved to Red Rock nursery, in Prince George to provide extra processing capacity. It was used for rough extraction, followed by shipment of unprocessed seed to Duncan for final cleaning. With the development of the Westside Arboretum and Seed Orchards across the

Figure 20. The Mobile Seed Extractory. Duncan 1977.

Fraser River from Red Rock Nursery, the unit was moved there in 1986 to process seed orchard seed. It was used to process some Seed Orchard test lots but mainly used as a storage trailer for the Seed Orchard operations.

With the opening of the new Tree Seed Centre in Surrey in 1986, the mobile extractory was not required for production processing. In 1995, the unit was moved to Vernon to serve as a "co-operative" rough extraction facility for all Southern Interior Orchards. The unit was used periodically at the Seed Orchard to process small 3 to 5 sack research lots totalling up to 100 sacks annually. In 2007, the mobile extractory was sold as government surplus.

Figure 21. Aerial photo of Duncan nursery and seed centre (circled) adjacent to the Somenos Creek flood plain.

Flooding at Duncan

Duncan Nursery was situated between Lakes Road and Chesterfield Street on a flood plain west of Somenos Creek. Given the right conditions of precipitation, snow melt and high tides during the winter, the adjacent fields would flood. Minor-to-significant floods occurred at the extractory during several winters, sometimes more than once per year.

Significant floods occurred and staff recalled putting on chest waders and pushing a rowboat through cone sheds to rescue the sacks containing paper bags of individual tree collections of lodgepole pine cones – part of the 1967 Research Branch pine provenance studies.

Figure 22. Rob Bowden-Green canoeing to the Duncan office after extreme flooding. 1981.

Between 1979 and 1984 there were several floods; the worst of these being in 1981. During this year it flooded three times with over a foot of water in the plant and the loss of 15 days of production time. On one of these occasions the plumbing froze in the extraction plant because the heat and power had to be turned off.

The periodic flooding of the extractory at Duncan caused production shut downs, a potential hazard to staff at times, and a significant risk to tree seed required for the Province's silviculture program. Alleviating this risk would entail significant costs to upgrade or relocate the facilities but would be necessary by the 1980s to protect the thousands of kilograms of seed worth millions of dollars in replacement value.

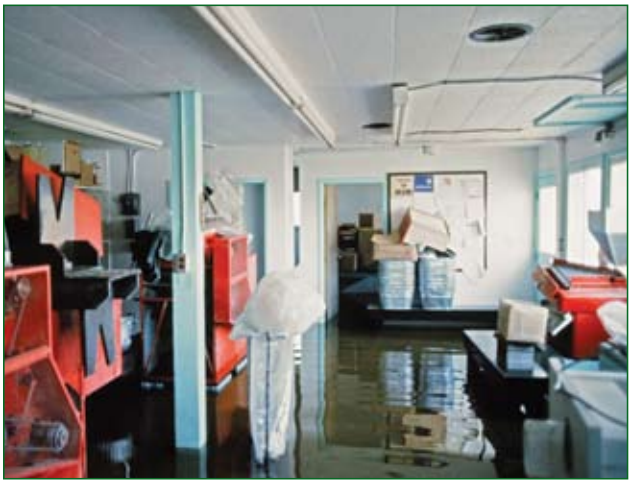


Figure 23. Flooding of the Duncan extraction facility. 1981.

Chapter 4

The Second Generation Tree Seed Centre

The process of obtaining approvals and funding, designing and building of the new Tree Seed Centre in Surrey was a long process. As early as 1976, Jenji Konishi, forester-in-charge of Seed Production, had recognized the need for additional seed processing, testing and storage facilities to meet the escalating tree planting program in BC. Jenji Konishi requested that John Bruce, forester-in-charge of Reforestation Division, approve building a new Tree Seed Centre and include funds in the 1979-80 Capital Budget.

The Seed Centre Planning Group was established and consisted of Jenji Konishi, Rob Bowden-Green, Dave Wallinger, Dick Clifford and Cam Bartram of Silviculture Branch and John Morgan and Bill Aten of Technical and Administration Services Branch. In November 1980, preliminary rough design requirements were circulated to cone and seed experts in Ontario, Alberta, the Petawawa National Forestry Institute and Weyerhaeuser Co. At this time Rob Bowden-Green and Jenji Konishi also toured the new facilities at Smoky Lake, Alberta and the Hilleshog seed processing line.

A Treasury Board Submission was made January 27, 1982 for 5.7 million dollars that included 0.4 million dollars for a rough extraction facility at Prince George. In June, 1982 a "Preliminary Plan Report for New Seed Centre" was produced and received input from Seed Centre Staff as well as expertise from Saskatchewan, Ontario, Quebec, New Brunswick, Washington, Oregon, Idaho, Colorado, Alabama, Sweden and Denmark. Rob Bowden-Green returned to Smoky lake to process some BC seed samples and John Morgan accompanied him to gather more detailed information on facility and equipment requirements.

The years 1982 and 1983 were a time of restraint in the Province of BC and the Treasury Board rejected the request for Engineering and Design Services and the budget submission.

In 1983, Winston Wai, an economist with Strategic Studies Branch was added to the planning group to provide an improved cost benefit justification. A new report "Ministry of Forests Options for Seed Centre Development" was then produced and presented to the Deputy Minister, Mike Apsey, Assistant Deputy Minister, Roy Cullen, and Chief Forester, Bill Young in March of 1984. Various interior and one coastal location for the new TSC were considered, ultimately it was decided that the best option was to build on land already owned by the Ministry.

The updated report recommended that a new facility be built adjacent to Surrey Nursery. It would include:

1. A new secure seed storage facility that would reduce risk.
2. A modern efficient cone kilning and processing system to support processing an average of 5,000 to 7,000 hl of cones per year.
3. The latest seed processing and cleaning equipment to provide the highest quality seed.
4. Testing and seed preparation facilities to increase productivity to meet the increasing nursery demands.
5. Administration reception and staff facilities to operate a Tree Seed Centre.

The Province of BC agreed to fund a new Tree Seed Centre facility as part of its 300 million dollar, five-year (1985-1990) Forest Resource Development Agreement (FRDA) Program. The Minister of Finance, Hugh Curtis, as Chairman of the Treasury Board, officially approved on June 7, 1985 the request from Tom Waterland, Minister of Forests, for 3.4 million dollars for the "Design and Construction of New Seed Centre and Purchase and Installation of Related Equipment".

Design and Construction

The FRDA Agreement and subsequent Treasury Board approval finally allowed the engineering and architectural design and construction of the new Seed Centre to proceed. This project was a major undertaking that required 5 years to plan and obtain approval and just 16 months to design, build and be operational.

Swan Wooster Engineering Co. of Vancouver was selected on May 22, 1985 as the design and engineering company. Site work began on October 1, 1985 and continued through the winter to complete the building foundations by the end of January.

Building construction was then awarded to Timrek Building Systems Ltd. and Stratford-Hill Construction Ventures Ltd. This was followed by a contract to Commonwealth Construction Co. Ltd. for mechanical and electrical installation, as well as the installation of the Hilleshog seed processing line. The Hilleshog line was designed and built in Sweden and transported in two containers by ship to Vancouver. The installation of the line occurred in the summer of 1986.

A separate contract was awarded to Lougheed Haggerty Engineering and Manufacturing Ltd. of New Westminster to design a direct fired natural gas

Figure 24. Timeline for construction of the Tree Seed Centre in Surrey.

cone processing kiln. The kiln was then constructed by Salton Fabrication Ltd. The cone stacking and tray loading (Bevco) system was designed by Roger Sayer of Applied Mechanical Systems.

Figure 25. The main entrance of the Tree Seed Centre under construction. Surrey 1986.

Figure 26. Hans Bjorkmar, Rob Bowden-Green and Bo Ericson during installation of the Hilleshog seed processing line. 1986.

Figure 27. John Morgan inspecting the kiln prior to installation at the Tree Seed Centre.

The Move to New Facilities

The physical move to Surrey from Duncan involved moving some of the still valuable seed processing equipment (gravity tables and M2B seed cleaners), lab supplies and equipment including the four Conviron Germination chambers. The big challenge was moving the Province of BC's irreplaceable ten or more year supply of seed totalling 42,000 kg and worth millions of dollars. Thousands of boxes and bags of seed had to be catalogued into numerous 4 x 4 foot plywood crates in cold storage. These crates were then trucked by refrigerated semi-trailers to Surrey to then be catalogued into the new freezer units.

The other challenge was the household move of each of the seven staff members. The staff, whose jobs moved to Surrey in August 1986 included: Rob Bowden-Green, Heather Rooke, Dianne Wilson, Chuck Woodward, Betty Sommerfield, Diana Yzerman, and Therese Bird. Two auxiliary staff, Trish Nuyten and Jeanne Berryman, also decided to make the move from Duncan to Surrey.

The Tree Seed Centre was officially opened by Graham Bruce, the MLA for Cowichan-Malahat, Parliamentary Secretary to Dave Parker, Minister of Forests and Lands, who presided over the ribbon cutting opening ceremonies along with the mayors of the City of Langley and the Township of Langley on May 5, 1987.

Figure 28. Staff who moved from Duncan to the new Surrey Tree Seed Centre. August 1986.

Chapter 5

Changing Procedures and Processes

The escalation of the reforestation program, particularly through the 1970s and 80s led to many demands for expansion and change. The Forest Service was changing from a small bare root nursery program (26 million trees planted in 1969) to precision bare root sowing, to developing container seedling production for producing in excess of 200 million seedlings annually. The need for improved seed quality along with greater volumes of different species as the Forest Service changed from predominately coastal to a province wide program demanded new methods and more space.

As well as demands for change and expansion, the need for preventative and ongoing maintenance and improvements to the Duncan facilities were ever increasing and added incentive to the plan for new replacement facilities. Knowledge of cone collection, post collection handling, seed processing, etc., shared among the British Columbia Forest Service, the forest industry, cone collectors, seed dealers, nursery staff, researchers and others led to significant seed quality improvements and some of these changes are discussed below.

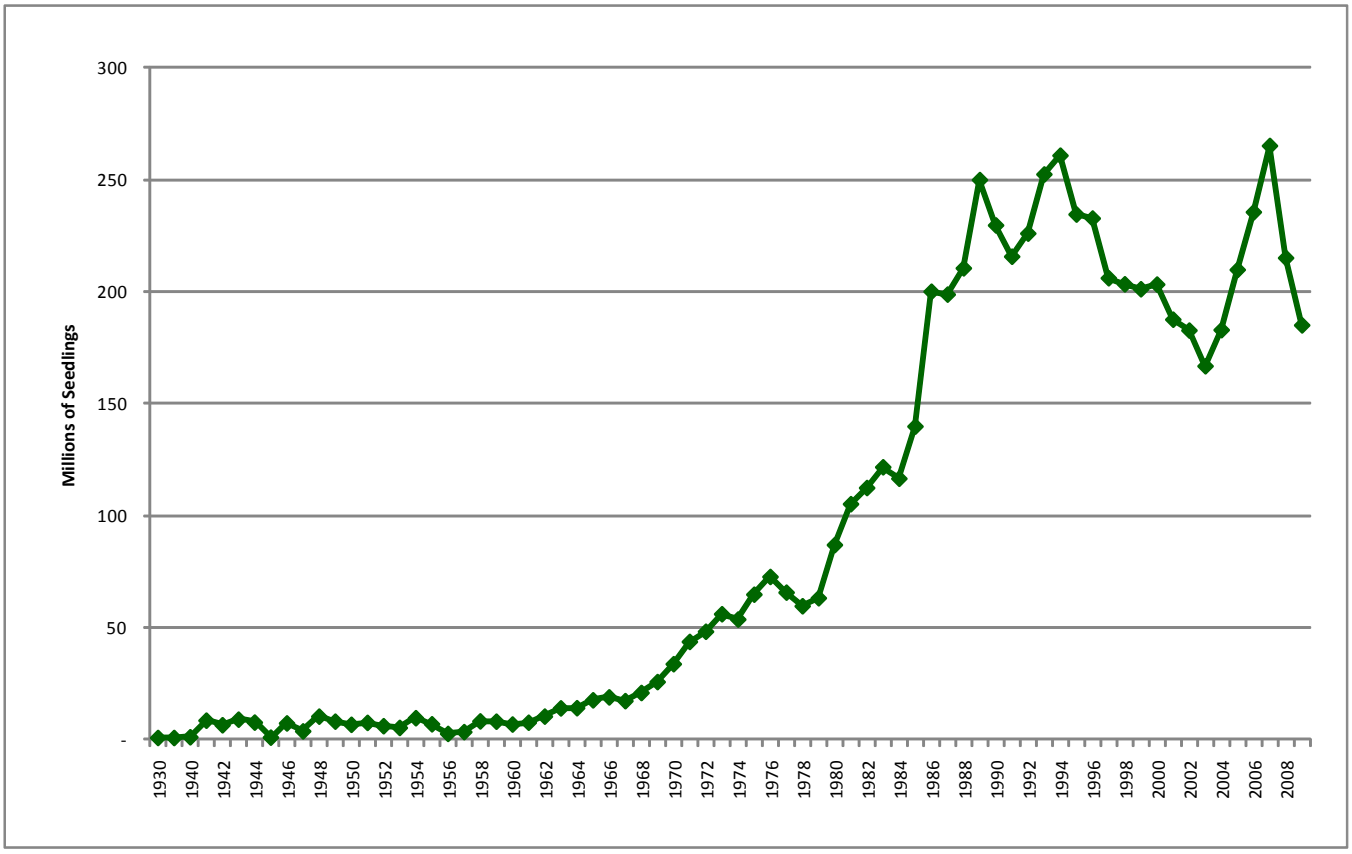


Figure 29. The size of the tree planting program for British Columbia from 1930 to 2008.

Cone Storage and Transport

Cone storage in the field is a necessary part of a successful collection with the goal of reducing moisture content after harvest to allow for safe transport. Cone storage facilities were constructed by the Forest Service at various locations around the province. These were usually in conjunction with Nurseries or Ranger Stations and also used for implement or vehicle storage. Often these facilities were inadequate to meet the storage capacity needs in large crop years so other ad hoc facilities (barns, etc.) and temporary shelters were used.

The cone storage at Duncan was designed as a holding and conditioning area for the extractory and could not handle the entire province's collections all at one time. In the major cone crop years of 1959, 1966, 1968 and 1979, all the barns of the Agriculture Fair Grounds at Duncan and the garage and sheds at the Cowichan Lake Experiment Station had to be used to handle the thousands of sacks of cones.

Figure 30. A comparison between early cones sheds in Duncan to the current cone sheds at the Tree Seed Centre Surrey.

The new Tree Seed Centre in Surrey was built with a transport truck unloading bay, a cone storage shed and a separate dedicated *Abies* conditioning area. The cone storage area soon became inadequate. In 1990, an additional metal-roofed cone storage facility was constructed. This facility, like the original storage and conditioning area included wire covered metal self stacking storage racks that could be easily moved by fork lift to the extraction line. This building added between 400 and 1,000 hectolitres of storage capacity to the TSC at any one time, depending on the tree species. Cone storage evolved from simple structures using pallets, racks or poles to mobile metal racks that improved aeration and distribution of cones in sacks, allowing cone sacks to lay flat and be more easily turned.

Cone transport and handling has also changed radically over time from uncovered transport to reefer transport with cone sacks often appreciatively loaded on pallets to facilitate rapid unloading with forklifts.

Figure 31. A comparison of early cone transport versus preferred form in covered trailer on pallets. Cheryl Linden, Debbie Picard and Sherry Collins in lower photo.

Cone and Seed Processing Changes

Cone and seed processing have seen large changes due to better appreciation of cone and seed biology, improvements in equipment used, and the individualized (vs. standardized) approach to seedlot processing. These improvements have laid the groundwork to be able to deal with the large cone collections of lodgepole pine from mountain pine beetle killed trees. These seedlots contain cones collected from dead or dying trees that would have been historically rejected. With huge tracts of killed lodgepole pine and relatively slower progress of the lodgepole pine seed orchard program these collections were required to ensure a future seed supply. With the relatively poor quality cones, there were great efforts expended to obtain the maximum amount of seed. This often resulted in grading and producing several seedlots of varying quantity from a single collection.

Another example relates to the curing of hemlock and cedar species which contain resin vesicles and were historically kilned to open cones. These species are now cured like *Abies* species, on trays in a cool chamber, and no longer kilned, greatly reducing the risk of damage to these sensitive species. An added advantage with cedar is that the foliage, that is commonly included with cones, remains pliable and easier to remove compared to the kilned foliage that breaks into seed-size debris particles. Two specific examples with cone and seed processing, *Abies* processing and dewinging, are further elaborated upon as they have been some of the greatest challenges faced by the TSC in cone and seed processing.

Abies Species Processing

Up until 1975 only small quantities of *Abies* species had been processed at Duncan. The process was to store cones in sacks until there was enough volume to process a kiln load. The cones were then spread on trays and kilned at a cool 90^0 F for up to 60 hours. The mass of resin that accumulated on the kiln trays and in the cone tumbler provided a great challenge. Dewinging in small batches in the Kason Dewinger along with seed cleaning and separation proved labour intensive, expensive, and often resulted in poor quality seedlots.

The challenge had been raised by Jenji Konishi to come up with a better plan for processing *Abies* spp., based on the successes of Brown Seed Co. and others. During 1978 and 1979 nearly 200 seedlots of *Abies* species were processed at Duncan. First steps involved reducing the volume of cones in sacks from 40 to 20 litres per sack to allow room for expansion and allow for better aeration. Then the *Abies* cones were spread on trays in the seedling cooler to further improve air circulation and allowed the disintegration of the cones in trays. This marked the end of kiln processing of *Abies* species by the Seed Centre.

The volumes in 1978 did become a space problem which was temporarily solved by using unheated greenhouses to store large poly bags of partially processed *Abies* seed. This proved satisfactory until the greenhouses began to warm up on sunny days in late winter prompting some of the seeds on the outside edges to begin germinating. It was a valuable lesson in how not to store *Abies* cones.

In the spring of 1979, Rob Bowden-Green was able to attend a Western Forest and Range Seed Council meeting with Dr. Carole Leadem of Research Branch. They were able to visit with Mr. Charlie Brown of Brown Seed Co. who was quite successful in processing *Abies*. He took them on a complete tour of his facilities, explained the processes and this confirmed that they were on the right track for processing *Abies* species.

Figure 32. Storage of Abies cones on trays in the seedling cooler. Duncan 1979.

The facilities at Duncan were then modified to process *Abies*. The seedling cold storage was temporarily converted into a forced air cool-conditioning chamber. An old batch cone tumbler was used to complete the cone disintegration with the resulting product run over an old modified soil screener as a scalper to remove cone scale debris. The rough processed product was

Figure 33. Abies seed stored in bags in the greenhouse. Duncan 1979.

then stored in the cooler. A large number of screen-bottomed wooden trays had been constructed to spread out the cones and move them into the cool-conditioning chamber. Keeping the seed cool was the key to dewinging and cleaning *Abies* without damaging the resin vesicles and creating a sticky mess.

The new Tree Seed Centre at Surrey was developed with dedicated *Abies* processing facilities. This included a fork lift accessed cone conditioning area with temperature controlled air circulation. Hundreds of new stacking plastic trays with mesh bottoms replaced the old much repaired wooden trays. Additional fans had also been incorporated to improve air circulation and uniformity of drying these sometimes very moist cones. Moisture content testing of cones and seed was initiated to prioritize seedlots for processing. For cone processing, a new larger capacity dedicated screening machine for separating the seeds from the scale and cone debris provided increased processing efficiency and quality of seeds.

Seed Dewinging

The removal of wings from conifer seeds in order to facilitate nursery sowing and reduce seed storage space has probably been the area of biggest challenge. The evolution followed the increasing expectations on seed quality from broadcast sown beds to more precise bare root sowing to precision systems used in greenhouse container growing. Initially, Douglas-fir used in the bareroot nursery could be satisfactorily dewinged in the large capacity Danish auger dewinger. Incomplete wing removal, extra loose wing material and a small percentage of damaged seed was acceptable at that time.

Figure 34. Abies cones stored on stacking plastic trays with additional aeration supplied by fans to assist in drying.

The Danish dewinger was subsequently used for dewinging some large volume *Abies* species seedlots. With careful manipulation of the machine and ensuring that the seed was kept cold, wing removal could be successful. For complete wing removal, the tendency was to overwork these delicate resin vesicle containing seeds and end up with sticky seeds that had been damaged.

During the 1960s and 1970s, the large commercial vacuum cleaners with the hose knotted proved to be successful in dewinging spruce and pine species. At one point the vacuum cleaners were set up to receive the seed directly off the Fanning mill. This method, however, did crack and dehusk some of the seed resulting in damage that lowered germination results.

Figure 35. Close-up of the Danish auger dewinger.

Figure 36. Standard Fanning mill screener with vacuum dewinger attachment.

One of the early attempts to improve dewinging was to build, in 1972, a US Forest Service Coeur d'Alene Nursery "Chicken Plucker" style dewinger. This was a small lot device consisting of a metal cylinder mounted on a slope with a centre shaft containing rubber flaps (the same ones used in plucking feathers from chickens), a variable speed motor and a vibrating feeder. Seed would be forced through the tube by the rubber flaps which would remove the wings. The model developed in BC was not particularly successful and in retrospect, the lack of a suitable soft rubber liner was probably the missing key to its success. In May of 1975, a Kason dewinger was obtained. It was a metal tub of approximately 2 cubic foot capacity with a rubber-like compound lining. It was driven by an acentric weighted motor that produced a vibration which caused the seed to rotate and spiral at the same time. This agitation along with a mist of water would separate the wings of pine and spruce species. Along with this method, a dryer was needed, so a cabinet dryer was constructed. It was a batch process of small quantities that was labour intensive but provided clean dewinged seed with less possibility of the damage to seeds than with the other methods. The Kason was also used for dry dewinging, particularly *Abies* species.

For Douglas-fir that required the breaking of the seed wing, a brush dewinger was designed and built in 1977-78. This machine proved to operate better than the large auger dewinger but was still causing seed coat damage – the seed travel distance through the machine was too long and the brush was a little too abrasive.

Figure 37. Chicken plucker style dewinger. Duncan.

Figure 38. Kason Dewinger. Duncan 1978.

The next method to try was a cement mixer. The rotary tumbling action proved to be the best method of wing removal without seed damage for both dry and wet dewinging. In 1980, an additional large cement mixer was obtained to increase the capacity for pine and spruce dewinging, and to provide dewinging for Douglas-fir.

The new Hilleshog equipment included a modern tumbler dewinger with variable speed rotation, hydraulic dumping, compressed air, and water mist controls. The acquisition of this dewinger was a major step in achieving optimum dewinging without damage to the seeds. The dewinger allowed for direct removal of dry dewinged species or the streamlined integration of wet dewinged species through a secondary cleaner and optional liquid separation bath for the removal of pitch and other debris denser than water and therefore sinking. This Swedish equipment line also included an automated tray dryer line to remove excess moisture and attain the appropriate seed storage moisture content of 4 to 9.9 percent. The dewinger was later equipped with foam rubber inserts to protect delicate seed species.

Figure 39. Brush dewinger. Duncan 1978.

Figure 40. Large cement mixer dewinger. Duncan 1980.

Figure 41. The Hilleshog /BCC Dewinger on the platform and aluminum liquid separation tank below at the Tree Seed Centre Surrey.

Seed Upgrading

A large effort was extended by the TSC (1990 to 1993) in seed upgrading to improve seed quality. The quality is often thought of as germination, but a large part of our upgrading program has dealt with improving purity and/or adjusting moisture content. Seed upgrading gained further significance with IDS (Incubate-Dry-Separate) and DSP (Density Separation Processing) processes as means to move beyond specific gravity as the final cleaning step. These processes utilize differences in seed physiology, specifically the ability to hold water, to separate viable from non-viable seeds.

Much of the initial work on conifer seed upgrading was based on European research conducted by Drs. Frank Simancik, Milan Simak and Urban Bergsten. Initial work in BC was funded by the Canada–BC Forest Resource Development Agreement (FRDA) which supported the early laboratory work of Dr. George Edwards and Mishtu Banerjee. In 1992, a nursery survey was conducted on the performance of upgraded seedlots of spruce at twenty nurseries throughout BC. In general, operational germination gains were less than those observed in the lab, but there was an increase in germination speed and reduction in the levels of seed-borne *Fusarium*. This led to the development of a "Density Separation Processing (DSP) User's Manual" at the TSC and in 1993 a large scale operational upgrading program was initiated. This 1993 program upgraded a total of 131 kg of seed from 42 sowing requests across seven species. The results were mixed and not very efficient on a sowing request basis and the same level of resourcing was never again dedicated to this program.

Some seedlot upgrading continued to be performed on a client request basis and the TSC assisted some nurseries in developing their own upgrading programs. This was quite successful and allowed for a wide variety of investments at the nursery from a simple post-stratification soak to improve purity levels to a full blown physiologically based upgrading program which proved especially effective with *Abies* spp. Even without a full-blown DSP program, there is much that was learned from upgrading efforts including: improved cutting test methodology, a better appreciation of what technique worked for which species, quantifying gain and losses not solely by Germination Capacity and finally the tool that has actually expanded in use at the TSC – Pre-Vac.

This technique places imbibed seed in a water column under vacuum to remove air from cracks in the damaged seeds. Once the vacuum is released the damaged seeds sink and viable seeds continue to float. Certainly not a tool that is useful for all seedlots, but when required is indispensable.

Waste Cone Disposal

The original extractory at Duncan was equipped with a small metal conveyor that transported the waste cone material from the end of the tumbler through the side of the building. In order to get rid of the cones a bee-hive type burner was constructed. Unfortunately it did not operate well, was dismantled and the piles of waste cones were then burned on site.

After several on-site fires this practice of burning adjacent to the extractory was discontinued. Waste cones were conveyed directly into a dump truck and taken to the nursery 'land-fill' site, initially at Duncan and later at Koksilah. The land-fill would periodically be set on fire to destroy the cones.

The cones were subsequently donated and used for making crafts, pot-pourri, a nursery ground cover and as fuel for one of their furnaces. The TSC did treat waste cones as a commodity that was used for craft material or in pot-pourri. The craft market has been saturated with material and currently waste cones are shipped at our expense for use as a soil amendment.

Seed Storage and Inventory

The first long term storage freezer was built in 1959 with a capacity of 10,000 to 15,000 kilograms of seed. As the seed inventory and sowing withdrawals escalated, a physical inventory of all seed in storage was undertaken on an annual basis. At Duncan this was not only to ensure accuracy but to relocate seed within the limited freezer space and gain efficiency. By the end of 1978, however, the four seed storage freezers were filled to capacity (approx. 20,000 kilograms). In 1979, a used 8 by 20 foot mobile seedling cooler was obtained from Vancouver Forest Region and converted to run at -12^0 C as a seed storage unit. During the next few years, several of the 8 by 20 foot units that were modified to operate from 0 to -18^0 C were borrowed to hold seed at various stages.

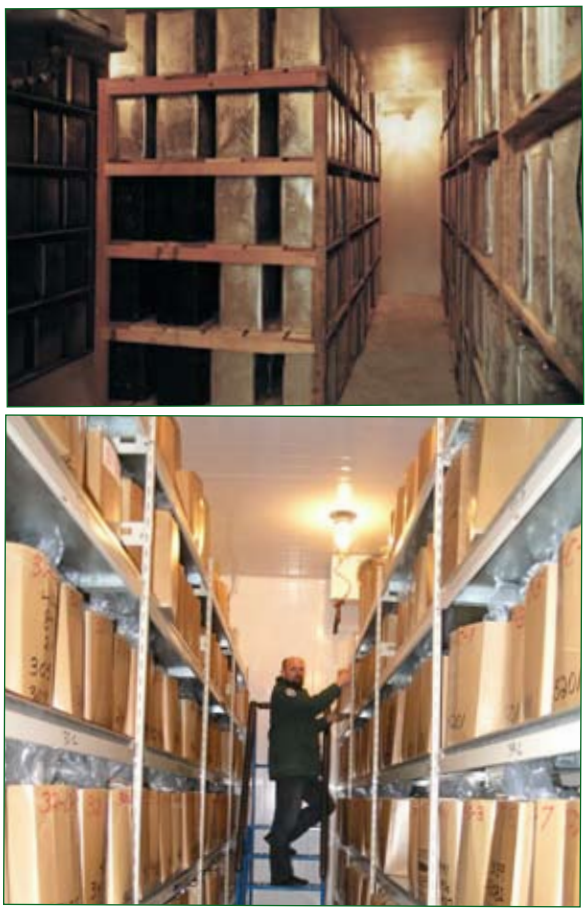


Figure 43. A comparison of freezer facilities and seed storage containers at the Duncan site with the Tree Seed Centre in Surrey. Dave Kolotelo in lower photo.

With a good seed crop in 1978 and a major crop in 1979, which included *Abies* species collections, more freezer storage space was needed. There was now approximately 30,000 kilograms of seed. In 1980, a new 12 by 40 foot Artisan Mobile Seed Freezer was obtained. At this time a roof extension was added to the rear of the seedling cold storage building to allow better access to this new freezer and for use as an *Abies* processing area. Along with obtaining the new freezer, the staff also reviewed, upgraded and/or eliminated some of the poor quality seed in storage. An additional seed storage unit was obtained in 1983 and included a weighing room foyer connecting the two freezers.

The freezers at Surrey were built with stationary shelves that could hold approximately 8,000 boxes and a total capacity of 60,000 to 65,000 kg. This seemed adequate at the time with 40,000 kg of seed to be maintained. In 1993 with nearly 55,000 kg in storage it was time

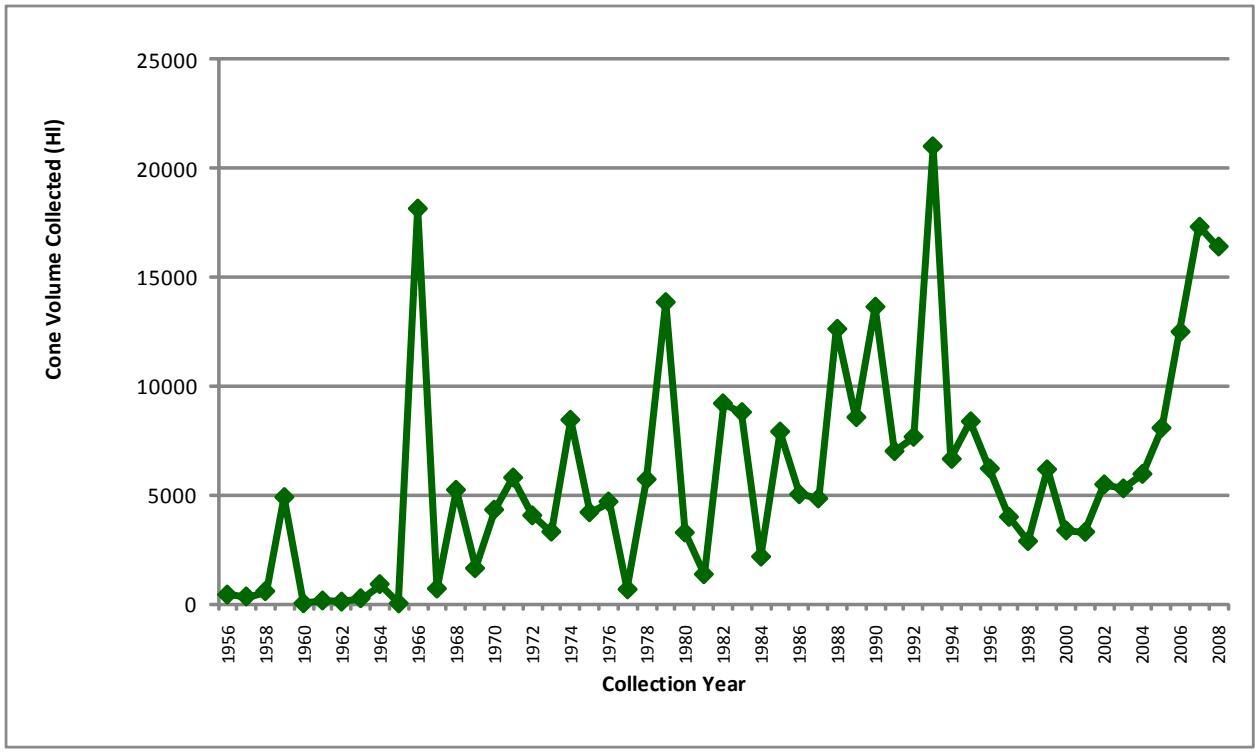


Figure 42. The volume of cones (hl) collected in BC. (1956-2008).

to retro fit the freezers. A rolling shelf system was installed in each of the units between 1994 and 1996 to increase the capacity to more than 90,000 kg. There is currently about 74,000 kg in storage. The annual physical inventories are now confined to seedlots that have incurred a withdrawal in the last year.

A variety of containers have been tried over time for seed storage. Large tin cans with friction fit lids (previously used for storing fish livers) had proved a good method in the 1960s while they were available. Subsequently, cartons made from the same waxed cardboard material used for seedling transport proved to be the best available method. These boxes approximately 9 x 9 x15 inches containing 4 to 6 mil poly bags tied tightly at the top proved easy to handle and protected the seed well. Each box would contain between 3 and 12 kilograms of seed depending on the species stored. The poly bags could be tied to reduce air space around the seeds, and allow for more than one seedlot per box when necessary, thus optimizing the space.

With increased importance and value, the province's inventory also came under greater scrutiny and required greater due diligence in its management. The importance of our inventory is a primary driver providing the TSC designation as a Mission Critical facility. Several physical security systems are currently present to protect the inventory including: video monitoring, fire alarms, intrusion alarms, daily electronic and manual monitoring of temperature, and visual inspection off-hours by our resident caretaker.

Seedlot Sampling and Testing

Although there is no history of seedlot preparation prior to 1958, there is indication that there was some rudimentary testing of seedlots prior to this to determine nursery sowing rates. In 1958, seed germination testing was being conducted by Jean Sicher, in a small laboratory oven type cabinet with temperature control using round petri dishes containing perlite. These germination results were then used to calculate required seed quantities for nursery sowing. The development of the new laboratory in 1967 and the subsequent acquisition of a controlled environment (CONVIRON) growth chamber allowed the staff to adopt procedures that paralleled the Association of Seed Analysts (AOSA) and the International Seed Testing Association (ISTA) rules. Initially the testing included both dry and stratified germination tests with the use of a perlite substrate and blotting paper in a petri dish.

To ensure that the Seed Centre was providing the necessary excellent seed services for the nursery container program, Jenji Konishi requested Dr. Carole Leadem,

Tree Physiologist, Research Branch, MOF to conduct a Technical Audit of the TSC sampling and testing procedures. Carole and her staff met at the Seed Centre in Duncan in April 1984 and reviewed step by step the procedures from post process handling, sampling and storage through testing to seed preparation for nurseries, pelleting, and the handling of poor quality seedlots. In September of 1984, the audit continued with further discussion with Dr. George Edwards, Research Scientist, at the Pacific Forestry Centre (PFC), Canadian Forest Service (CFS) laboratory and with Dr. Leadem to modify the TSC procedures to more closely adhere to ISTA rules.

Figure 44. Jean Sicher Loading Germinator Cabinet. Duncan 1959.

Figure 45. Heather Rooke with Conviron Germinator. Duncan 1981.

The move to Surrey included a dedicated laboratory and two Conviron germinators with an additional one added soon after arriving at the new facilities. Shortly after arriving in Surrey the germination test media changed from perlite to kimpack and the germination dishes changed from petri dishes to square dishes specifically designed for germination testing. More recent changes include direct weight entry from analytical balances; keypad data entry of germination results; scheduling tools for germinator usage and resource levelling; labelling tools to eliminate transcription errors and several daily reports that allow for immediate response to changes in request status or required lab activities.

Current lab procedures are still generally guided by ISTA rules, but changes have been integrated over time in terms of optimum pretreatment regimes, germinator conditions, and germinant classification. Various

Figure 46. A comparison of early germination tests conducted on perlite in round petri dishes with the current tests performed on kimpack in square dishes designed for germination testing.

research trials and operational Quality Assurance results have helped move the testing area forward, especially with our deeply dormant species: yellow cedar, western white pine and most *Abies* spp. Testing was traditionally a new seedlot function, but with the growing inventory at Duncan the need for germination retesting became apparent. This was initially targeted for every second year, but currently germination retesting frequencies are based on an analysis of seed deterioration rates along with the seedlot size, useage, and length of storage.

X-Ray Radiographs

In 1973, an x-ray radiograph unit was obtained to provide a permanent record of a sample of each and every seedlot. This record could display seed development, particularly of the embryo, seed damage and seed insects. The TSC has recently upgraded to a high resolution digital specimen radiography system. This will provide access to virtually instantaneous diagnostics with improved image quality which can be stored digitally and easily shared with clients.

Figure 47. A comparison between seed lab facilities at Duncan with Diana Yzerman and Betty Sommerfield (top photo. 1981) and the Tree Seed Centre lab in Surrey with current lab staff: Laura Klade, Katherine Rapske and Nora Galdert. 2009.

Figure 48. Mary Hamilton at x-ray machine. Duncan 1973.

Figure 49. X-ray radiograph of Ponderosa pine seed.

Seed Preparation Treatments

At Duncan, the seed preparation practice for most species evolved to a process of: weighing out the required seed for each request; soaking the seed in water filled poly bags for 24 hours; draining the seed through mesh screens; placing the screens of seed on to trays in the cone kiln to surface dry; and placing the seed back in bags in the cooler for 3 to 4 weeks prior to shipping to the nursery. The process was very labour intensive and often conflicted with cone kilning. For somes species seed would be placed in damp cotton bags, and buried in flats of sand in the cooler. The sand would be kept moist and the seed would be checked periodically for

Figure 50. Betty Sommerfield surface drying seed in preparation for stratification. Duncan 1974.

seed germination activity. Initial attempts without the aid of cotton bags presented some extra challenges separating germinating seed from sand.

During the 1960s and 1970s when Ton Hamilton, then Mary Heinrich and then Betty Sommerfield, were responsible for seed preparation, several species were treated with the fungicides Captan, Thiram or Arasan which are skin and eye irritants and potential carcinogens. Trials later indicated that although the fungicides did inhibit the fungus, many seedlots did not have a significant fungal problem to begin with, and the treatment was often detrimental to germination, thus providing no net gain to the nursery. This pre-treating of seed with these phytotoxic fungicides was abandoned by 1980. Other treatments that were used included coating seeds with aluminum powder and/or colour pigments. These proved to be a disaster in the nursery as the coated seeds did not germinate well, were attractive to the birds and not necessarily good for the bird's health.

The building of the new Surrey facility included a seed preparation area with a dedicated drying room. Various surface drying configurations were tried until settling on the current open top cabinets with a down draft air flow system that provides efficient surface drying without contamination problems. At Surrey the seed for stratification is weighed into mesh screens and soaked in tanks of running water. This running water reduces seed-borne pathogens, eliminates germination inhibitors associated with the seed coat and reduces

Figure 51. A comparison of seed preparation facilities between Duncan (1984) with Louise Linnell and Kim Young and the Tree Seed Centre in Surrey (2008) with Spencer Reitenbach.

cross contamination by soaking contaminated seedlots separately.

Communications between the TSC staff, the nursery growers and the seed owners (seedling users) has continued to develop along with better understanding of seed use. Managing seed withdrawal has also improved by facilitating the ability of owners and growers to calculate seed required for seedling production instead of using the BCFS standard calculations. Related to this issue is the return of unused seed. The TSC has now made provision to accept, retest and in many cases reuse this seed which is in keeping with legislated requirements that all seed be stored at the TSC.

The biggest changes in seed withdrawal and preparation have been in volume of seed and species used. Fifty years ago seed was required to produce 10 million seedlings per year, predominantly Douglas-fir. Today seed is withdrawn to produce between 180 and 250 million seedlings annually across 15 species.

Pelleting Western Redcedar Seed

Western redcedar seed had proved to be particularly difficult to precision sow. In January 1983, seed was shipped to the Harris-Moran Seed Co. in California for pellet coating with diatomaceous earth and a polyvinyl alcohol binder. Operational trials of sowing and growing the pelletized cedar were conducted at Koksilah nursery. The following year, 1984, the redcedar seed for the sowing requests were shipped to California for pelleting by the Harris-Moran Seed Co. They continued to supply this service until the year 2000.

During 1987 and 1988, Dr. Paul Trussel (a retired research scientist) did trials to develop the technique locally. In 1989, he began contracting with the Tree Seed Centre to provide this pelleting service at the Tree Seed Centre facility. He continued this service until selling his business in 1997 to Carl Happel. Carl moved the business to Vernon BC and by the year 2000 the pelleting service could be done entirely within BC.

Seed Transport to the Nurseries

As more nurseries developed and the number of seedling requests increased, the shipping of prepared seed to the nurseries became a concern. Frequently the nursery section employees would be travelling between nurseries and would be handed bags of seeds to deliver. Seedlot requests were often boxed in seedling boxes and shipped along with boxes of seedlings in transport trucks from one cooler to another. This proved to be a potential disaster. On at least one occasion, several seedlots went missing for days, only to be found in the back of a stack of seedling boxes in one of the nursery coolers.

Figure 52. Dr. Paul Trussel pellet coating western redcedar seed at the Tree Seed Centre. Surrey 1995.

In the 1970s and 1980s, a series of changes were made to improve this. The initial change was to obtain shipping boxes that were labelled TREE SEED in bright red letters rather than the usual "Trees for Tomorrow" printed in green. The next change was shipping using overnight courier service which was to ensure speedy delivery and tracking of all seed packages.

By the time the TSC moved to Surrey in 1986, styrofoam transport coolers of various sizes, which had been developed for the fish industry, became available. The TSC now uses an overnight courier service, shipping coolers with adhesive seed labels, and chill packs to ensure that seed is delivered safely around the province overnight.

Quality Assurance Program

The Quality Assurance Program (QA) involves the evaluation, monitoring and management of information and practices. It is our internal and external feedback loops for continuous improvement. It has been formally recognized in some areas (i.e. germination testing of sowing requests), but it also extends to avoiding contamination, procedure standardization, thoughtful observations, information management and the construction of process controls. The QA program extends beyond solely improving the services to providing accurate and up-to-date information on cone and seed attributes for the reforestation community.

Figure 53. Rita Mutcher packaging seeds for transport. Surrey 1995.

Quality Assurance has been part of the TSC from the beginning in a variety of forms. As knowledge on seed science and technology has advanced, so have the QA programs. Some of these are quite formalized and some are basic components of employees' job requirements – all are critical.

Here is a short list of some of our Quality Assurance initiatives – a) cone and seed maturity collection trials, b) cone storage trials, c) cone and seed evaluations, d) testing a sample of sowing requests at time of shipping for germination and moisture content, e) testing the efficiency of the pelleting contractor(s), f) fungal assay testing of species of concern, g) changing processing methods based on machine operation and extraction efficiency trials, h) changing stratification methods, or germination test types through trials, i) determining germination retesting schedules through analysis of test results. Additional details on some aspects of the QA program can be found at the following link: www.for.gov.bc.ca/hti/treeseedcentre/tsc/csio3.htm

Extension

With a rapidly growing reforestation program there was a substantial increase in cone collection activities and a need for information on best practices. One of the earliest responses was to organize a Joint Cone and Seed Committee between the BC Forest Service and Pacific Forestry Centre, Canadian Forest Service to produce a set of guidelines. The authors (R.C. Dobbs, D.G.W. Edwards, J. Konishi and D. Wallinger) produced an interim set of guidelines in 1974 and subsequently published the first "Guidelines to Collecting Cones of BC Conifers in 1976". This publication would be a valuable tool for the extension of best practices. In addition to the guidelines, there were also several taped slide presentations prepared on a variety of topics from seed production, sampling and evaluation, collection, extraction and testing. These were initiated in 1979 (How to Build a Better Seed), but reached their peak in 1984 with production of the remaining subject areas.

These slide presentations were used in a variety of ad hoc road shows around the province by TSC staff and Drs. George Edwards and Carole Leadem who played key scientific roles in early extension efforts. At this time the Tree Seed Centre was producing brief one to two page extension notes on a variety of subjects and answering queries directly via the telephone. Greater feedback to clients regarding seedlots was also initiated with the Processing and Testing (PROTEST) summaries for each seedlot.

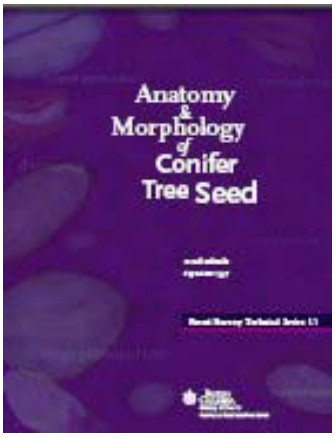
A variety of cone and seed extension activities occurred throughout the 1980s involving Regional, District, licensee and seed dealer involvement. In the early 1990s Silviculture Branch extension specialists played a key role and a more formal Tree Seed Workshop occurred in 1992. This workshop covered seed physiology, seed pathology and the operational processing, testing, storage and pretreatment of seed. Tree seed workshops continued to play a key extension role with workshops in 1993, 1996, 1998, 2001, 2005 and 2007.

The TSC also put out a handout package on "A Guide to Cone and Seed Services" that explained our role and function in the reforestation stream. This served a useful purpose until we had a dedicated webpage to discuss cone and seed biology, our services, legal requirements, and fees for services. The TSC also put on specific seed handling and seed preparation workshops throughout the province. During this time our mission statement "Excellence in Cone and Seed Services", our TSC logo (coastal Douglas-fir cone with disseminating seeds), and our Conehead title were developed. In the spring of 1992, the Cone and Seed Improvement Program was born with the hiring of Dave Kolotelo with extension as one of the position's roles.

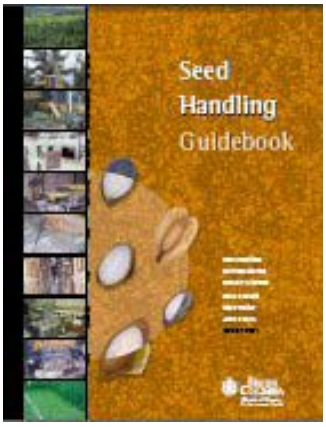
Additional cone and seed extension to foresters occurred through the Silviculture Institute of BC (SIBC) program. Other items of significance were the "Seed biology, collection and post-harvest handling" chapter in regenerating BC's forests publication and the production of the "Secret Life of Tree Seeds" poster.

Extension was also facilitated through the provincial Seed and Seedling Extension Newsletter (and later TIC*talk*) and the national Tree Seed Working Group Newsbulletin.

In 1997, the "Anatomy & Morphology of Conifer Tree Seed" was published as a means of extending information on conifer seeds and their basic biological properties. In 2001, a more operational "Seed Handling Guidebook" was produced to extend seed handling practices within the chain of custody referred to as the Seed Handling System. The role of extension has also changed from one providing basic biological principles to the required increases in efficiency that come along with increased seed value from a monetary and genetic perspective. This movement was celebrated with a Seed Use Efficiency meeting in 2008 that also helped to celebrate 50 years of "Excellence in Cone and Seed Services".



http://www.for.gov.bc.ca/hti/publications/misc/anatomymorphology.pdf



http://www.for.gov.bc.ca/hti/publications/misc/seed_handling_guidebook_hi.pdf

Figure 54. Extension activities ranging from helping clients to increasing the technical knowledge of staff. Dawn Stubley in photo on left.

Chapter 6
Seedlot Information Management

During the 1960s and 1970s, Dr. Alan Orr-Ewing, the father of Tree Improvement in BC, preached that "good seed does not cost, it pays". When that message became generally accepted, seedlot information management became a critical component of reforestation and Genetic Resource Management processes. To be deployed on crown land a seedlot must be registered with information such as collection origin, collection type, volume, dates of collection, number of trees collected from, and seedlot ownership. When seed is needed for reforestation, seedlot data such as registration number, quality assurance testing, and inventory are combined with seed transfer and seed sowing rules to produce a seed sowing request order for the correct amount of seed to be sent to a nursery for sowing. Users of seedlot information include BCFS, forest licensees, forest nurseries, cone collectors, tree seed dealers, First Nations, and researchers. The seedlot data is used for collection and deployment planning, inventory reporting, facilitating seed sales, and research.

Early Seedlot Information

The information on early seedlots was limited as most collections occurred locally and were only performed as needed, resulting in a seed supply that would only last a year or two. Examples of the earliest seedlot collection information were Douglas-fir on Vancouver Island referred to as "U" upper Island, "M" mid Island, and "L" lower Island. The performance of seedlots was also recorded, for example "U" upper Island Douglas-fir seed from the Merville area produced strong fast growing stock.

In the 1950s, Dr. Alan Orr-Ewing of the BCFS Research Branch introduced a registry of seedlots that included a classification system to differentiate between special seed and natural stand seed. In 1957 the BCFS introduced a policy that required seed to be registered and the seedlot registry information be managed at the Seed Extractory in Duncan. This seed registry included data such as seed class, seedlot number, year of collection, topographic map grid of collection, and collection elevation. The seedlot or registration number evolved from a single letter, then, two-letters, to numbers which are still used today.

During the 1960s and 1970s, Dr. Orr-Ewing and others continued seed deployment research resulting in the development of Seed Zone Boundary maps and the policy that seed was to be used in the zone it was collected. In 1974 a Chief Forester policy directive stated that BCFS maintain an adequate supply of quality controlled and tested seed. This directive meant that testing, quality assurance, and seed ownership information would be included in the seed registry.

Seedlot Information History – The Card System and Computerization

Seed information and data was recorded by the seed collectors on cone collection forms that were developed and modified throughout the 1960s and 1970s.

During the tenure of Tree Seed Centre Superintendents, Ton Hamilton and Mary Hamilton, the provincial reforestation program expanded and the seed inventory grew. To accommodate the increased record keeping requirements the Tree Seed Register became a two part manual card and binder system. The binder listed basic seed data such as seedlot number and ownership. In case of a disaster or emergency a backup binder was maintained offsite. The card system listed the seedlot collection, inventory/transactions, and seedlot testing information. In the mid-1970s, reporting of seedlot inventory information was accomplished by entering a copy of the Tree Seed Register data into a computer

database. Data Systems Analyst Insha Khan worked with Tree Seed Centre staff and by 1981 a computerized Tree Seed Register and Inventory System (TSR) was operational and the card based registry and inventory system was no longer updated. Betty Sommerfield was one of the first BCFS staff responsible for updating the TSR data entry sheets.

During the 1970s, seed sowing requests were processed using manual paper spreadsheets that were forwarded to the Tree Seed Centre for seed withdrawal and preparation and then forwarded to the nurseries for sowing. Withdrawal information was entered into the TSR system as a batch update at the end of the sowing season; the TSR inventory module was therefore only accurate at the start of the sowing season. To improve on this manual system Insha Khan and Tree Seed Centre staff worked together to define the systems requirements and in 1982 the computerized Sowing Request System was implemented and much of the paper work was replaced with punched cards. The Sowing Request System was linked to the Tree Seed register via a "Batch" process, but, the TSR data was not accurate for much of the year.

Information Management Needs – CONSEP and SPAR

After the TSC move to Surrey in 1986 and with the advancement of personal computers and local area networks in the late 1980s TSC staff were able to start using local data entry and reporting programs that could exchange data with the mainframe TSR system on a nightly batch basis. Dennis McMillan was providing systems maintenance on TSR mainframe system and also developed the PC based data entry and reporting systems that were stand alone for each Tree Seed Centre function. These systems include the Seed Storage Ledger (SSL), Lab Control System (LCS), Germination Record System (GRS), and the Sowing Request Action System (SRAS). The nightly data exchange with TSR used the Tree Seed Register Data Entry (TSRDE) system. The TSR system was also able to print reports directly to the Tree Seed Centre printer. The local programs combined with local reporting and the nightly data exchange provided accurate seedlot inventory that had not been available in the past. Also during this time, Dennis McMillan implemented a 'Lantastic' local area network.

In the early 1990s a Business Area Analysis of the information systems requirements of the Tree Seed Centre was completed and an implementation plan was developed. A project team that included Dave Bates as Project Leader, Ron Robb, developer and programmer, Cheryl Edwards, BCFS Business Analyst, and Tree Seed staff, the result was to build the Cone and Seed Processing System (CONSEP). This system integrated many modules that were similar to the stand alone systems that were already being used at the TSC into a single database warehouse. In 1993 CONSEP was implemented and manages the thousands of individual data records for each seedlot at the TSC. CONSEP included a batch module that facilitated a nightly two way data exchange with the newly built Seed Planning and Registry (SPAR) System. CONSEP is currently maintained and enhanced by Michael Postma, TSC Information Systems Officer.

In the early 1990s Rob Bowden-Green led a team that included Cheryl Edwards and others to plan and develop SPAR, the information system that brought together the Tree Seed Register and Sowing Request database into one application. It was designed as a registry, an order entry and inventory management systems that automated the seed transfer guidelines and various Tree Seed Centre business processes. SPAR is used to manage the higher level information that is available to clients. SPAR is used by FS staff at headquarters, regions, and districts, industry clients which include forest licensees, nurseries, tree seed dealers, cone collectors, First Nations, and researchers.

SPAR users can enter, view, and report seedlot information such as registration status, ownership, inventory, and test results in real time. Seedlots that meet registration, inventory, and transfer criteria can be selected as suitable seedlots in a sowing request. SPAR calculates the amount of seed required for a sowing request order and also calculates the correct action steps and dates for the TSC to prepare, process, and send the seed to the nurseries for sowing. SPAR includes order entry screens for Tree Seed Centre services such as cone shipping to the TSC; cone and seed processing requests; and requests for seed withdrawal with or without preparation treatments. The generation of invoices for these chargeable TSC services is also accomplished through SPAR.

Quality Management, WEB based SPAR, and *Chief Forester's Standards for Seed Use*

During the early 2000s and in preparation for forest industry certification requirements the TSC investigated the requirements to achieve ISO 9001 Quality Management Standards and was found to be certification ready.

Under SPAR Project Team Leader and TIB Seed Information Officer Susan Zedel the application was modified and enhanced as follows. In 2001 to 2002, as part of the larger BCFS project Virtual Machine Applications Revitalization (VMAR), SPAR was converted from an IBM mainframe application to a WEB based application, facilitating easy access to SPAR via the internet. In 2005 WEB based SPAR was enhanced to meet the legislation requirements of the *Chief Forester's Standards for Seed Use* including new modules for Application for Seedlot Registration and the Parent Tree Registry database used by Seed Orchards and MFR research branch. SPAR also includes gametic contribution calculations to quantify effective population size (Ne) for select seed and spatial calculations such as the ability to calculate the seed planning zone and biogeoclimatic zone of a seedlot or seed sowing request.

To assist with seed planning and deployment, a web based mapping tool called SeedMap was developed. This allows seedlot collection and transfer information to be displayed via digital online maps. This spatial data can be used by all SPAR clients and includes the ability to overlay the available BC digital mapping layers (such as forest cover, elevation, and seed planning zones) with the seedlot data.

Tree Seed Centre Employee List 2008-2009

The following represents the staff employed at the Tree Seed Centre during our 50th Anniversary year.

Heather Rooke	Manager
Dawn C. Stubley	Cone and Seed Operations Officer
Dave Kolotelo	Cone and Seed Improvement Officer
Chuck Woodward	Facilities and Site Operations Officer
Michael Postma	Information Systems Officer
Anita Rebner	Financial Services Officer
Spencer Reitenbach	Inventory Management Supervisor
Debbie Picard	Cone and Seed Processing Supervisor
Sherry Collins	Operations Technician
Laura Klade	Testing Supervisor
Nora Galdert	Testing Technician
Katherine Rapske	Testing Technician
Aggie Ellis	Finance and Administration Clerk
Kaela Simon	Office Assistant
Dave Cripps	Facilities Operations Technician
Christina Herman	Auxiliary Seed Technician
Diana Walker	Auxiliary Seed Technician
Cheryl Linden	Auxiliary Seed Technician
Bryan Barker	Auxiliary Seed Technician
Kristen Picard	Auxiliary Seed Technician
Ross Macdonell	Auxiliary Seed Technician
Nancy Elias	Auxiliary Seed Technician

Tree Seed Centre Historical Personnel List

The following list of names includes those people who worked with the Tree Seed Centre through its 50 year history at the extractory at Duncan Nursery, the Duncan Seed Centre and the Tree Seed Centre in Surrey BC. This listing includes full and part-time staff and students. As this listing is undoubtedly incomplete, additional names are welcomed and can be forwarded to the Tree Seed Centre.

Gordon Allen
Debbie Anderson
D. Andrew
M. Andrews
Sue Askew
Harbinder Aujla
Anne Bailey
Bryan Barker
Valerie Barker
Liane Beattie
Jeanne Berryman
Keith Bird
Therese Bird
Ulf Bitterlich
Jeanine Bond
Cherylann Boomhower
Andy Bousbourous
Rob Bowden-Green
Roger Braulin
Tom Brimmell
Chad Bristow
Mike Collard
Cheryl Calam
Sherry Collins
Mary Cook
Therese Courchene
Dave Cripps
Sonia Custock
Audrey Davies
Evan Davies
B. Dearden
Jon DeGroot
L. Deslauriers
Bruce Devitt
Dan Dobie
P. Doubt
Malcolm Dunphy
Nancy Elias
Aggie Ellis
Glen Finnila
K. Foerter
S. Friesen
Joe Freisenecker

L. Gagne
Nora Galdert
Tom Gamba
Janice Gerbinski
William Gibbons
Kelly Gibson
Jan Glen
Barry Glendinning
P. Goodine
Kerry Goodridge
Debbie Graham
V. Guyot
S. Hadway
Michael Hampton
Ton Hamilton
Kristen Hannam
Les Hegarty
Ron Hembrough
Stan Hembrough
Mary Heinrich/Hamilton
Christina Herman
Daryl Hoffman
P. Hoffos
Franz Huegle
Leslie Ingram
W.J. Inkster
I.A. Janssen
P. Janze
Arlene Jelles
Arlene Keenan
Laura Klade
Dave Kolotelo
Shannon Kobliuk
Jenji Konishi
Anita Kowark
L. Ladd
N.K. Lalach
Murugi Larsen
N.R. Lawson
Mary Leach
George Leger
Cheryl Linden
Louise Linnell

Jack Long
Ross Macdonell
Michelle Macmorland
Darren Macklin
Barb Marples
Neil Marshall
D.W. Mather
J. McCann
A. McCauley
Cynthia McCracken
Jackie McKay
Bruce McPherson
Mike Meagher
Wendy Meilleur
Jerry Merritt
Eadie Meyer
J. Meza
Trevor Minten
Nora Mohammed
Gord Morrow
Rita Mutcher
Barb Newbery
V. Nicholls
N. Norman
Trish Nuyten
M. Oboril
Paul Obrovac
J. Olinek
M. O'Mara
B.C. Parnell
Amanda Perkins
Bunny Peters
Debbie Picard
Kristen Picard
Lucille Pinette
Stephen Pinter
Jennifer Pollard
Michael Postma
Anna-Liisa Prabhu
Tony Priddy-Camson
Bill Quail
Mark Rappaport
Katherine Rapske

Anita Rebner
Spencer Reitenbach
Wilf Rhodes
T.C. Roberts
Nancy Robertson
Joan Rodgers
A.E. Roe
Heather Rooke
Dan Rudolph
Melissa Sattler
Trevor Sawatzky
Ted Scully
Jamie Sharbinin
Ron Sharp
Kaela Simon
Walley Sinneman
Ron Smith
Betty Sommerfield
Stephanie Sopow
James Stewart
Dawn Stubley
Daniel Talstra
Brad Tamplin
S. Trainor
Elaine Ullrich
Janet Wadsworth
Diane Walker
P.M. Walker
C. Walker
M.S. Wall
Chris Walsh
A. Walter
P. Watts
Roy Webster
John Weins
Dianne Wilson
R.C. Woodgate
C. Woodman
Chuck Woodward
Bill Wright
Kim Young
Diana Yzerman
K.D. Zeleschuk

Excellence in Cone and Seed Services
TSC 50th Anniversary Honour Role

As part of the TSC's 50th Anniversary celebrations, a luncheon was held in August 2008 to acknowledge and thank those individuals and representatives of organizations for their significant contributions over the past 50 years and over a variety of disciplines as follow: Leadership; Client Support; Communication and Extension Services; Cone and Seed Services; Engineering and Infrastructure; Information Management and Technology; and Seed Science and Technology. This acknowledgement included a special award to Jenji Konishi for his significant and long-term contribution to Excellence in Cone and Seed Services.

Jenji Konishi. Surrey 2009.

Name	Agency	Recognition Category
Jenji Konishi	Ministry of Forests (MOF) Retired	Leadership, Seed Science & Technology, Cone & Seed Services, Engineering & Infrastructure, Information Management & Technology
John Elmslie	Winton Global	Client Support
Dan Gaudet	Vernon Seed Orchard Co. Ltd.	Client Support
Rocky Hudson	Genesis Reforestation Consultants	Client Support
Lynn Kingham	PSA, Office of the Merit Commissioner	Client Support
John Kitchen	Pacific Regeneration Technologies	Client Support
Cathy Leahy	TCG Consulting Ltd.	Client Support
Tim Lee	Vernon Seed Orchard Co. Ltd.	Client Support
Allan McDonald	MFR BCTS Nursery and Planning Extension	Client Support
Cliff Manning	Federation of BC Woodlot Associations	Client Support
David Reid	Ministry of Forests & Range (MFR) TIB Seed Production	Client Support
Tim Sheldan (or designate)	MFR Operations Division	Client Support
Joe Wong	Woodmere Nursery	Client Support
Jack Woods	Forest Genetics Council of BC	Client Support
Annette van Niejenhuis	Western Forest Products	Client Support
Diane Douglas	MFR Tree Improvement Branch (TIB)	Communication & Extension
Tim Mock	President, TM NewMedia Inc.	Communication & Extension
Don Summers	MOF TIB Extension Retired	Communication & Extension
Dave Trotter	Ministry of Agriculture and Lands	Communication & Extension
Eric van Steenis	Terralink	Communication & Extension

Name	Agency	Recognition Category
Debbie Anderson	MOF Tree Seed Centre Retired	Cone & Seed Services
Bryan Barker	MFR Tree Seed Centre	Cone & Seed Services
Frank Barnard	Western Tree Seeds	Cone & Seed Services
Rob Bowden-Green	MFR Tree Seed Centre Retired	Cone & Seed Services
Cheryl Calam	MOF Tree Seed Centre Retired	Cone & Seed Services
Lloyd Cavanaugh	MFR Tree Seed Centre	Cone & Seed Services
Sherry Collins	MFR Tree Seed Centre	Cone & Seed Services
Barbra Fairclough	MFR Tree Seed Centre	Cone & Seed Services
Nora Galdert	MFR Tree Seed Centre	Cone & Seed Services
Doug and Sandra Gregory	Quality Seed Collections	Cone & Seed Services
Ton and Mary Hamilton	Sorrento Nurseries	Cone & Seed Services
Carl Happel	Happel Pelleting	Cone & Seed Services
Peter and Linda Hellenius	Silva Enterprises Ltd.	Cone & Seed Services
Christina Herman	MFR Tree Seed Centre	Cone & Seed Services
Arlene Keenan	MFR Tree Seed Centre	Cone & Seed Services
Laura Klade	MFR Tree Seed Centre	Cone & Seed Services
Dave Kolotelo	MFR Tree Seed Centre	Cone & Seed Services
Cheryl Linden	MFR Tree Seed Centre	Cone & Seed Services
Cynthia McCracken	MOF Tree Seed Centre Retired	Cone & Seed Services
Rita Mutcher	MOF Tree Seed Centre Retired	Cone & Seed Services
Debbie Picard	MFR Tree Seed Centre	Cone & Seed Services
Kristin Picard	MFR Tree Seed Centre	Cone & Seed Services
Don Pigott	Yellow Point Propagation Ltd.	Cone & Seed Services
Stephen Pinter	MFR Tree Seed Centre	Cone & Seed Services
Michael Postma	MFR Tree Seed Centre	Cone & Seed Services
Katherine Rapske	MFR Tree Seed Centre	Cone & Seed Services
Anita Rebner	MFR Tree Seed Centre	Cone & Seed Services
Spencer Reitenbach	MFR Tree Seed Centre	Cone & Seed Services
Heather Rooke	MFR Tree Seed Centre	Cone & Seed Services
Jamie Sharbinin	MFR Tree Seed Centre	Cone & Seed Services
Kaela Simon	MFR Tree Seed Centre	Cone & Seed Services
Dawn Stubley	MFR Tree Seed Centre	Cone & Seed Services
Diana Walker	MFR Tree Seed Centre	Cone & Seed Services
Dianne Wilson	MOF Tree Seed Centre Retired	Cone & Seed Services
Chuck Woodward	MFR Tree Seed Centre	Cone & Seed Services
Diana Yzerman	MOF Tree Seed Centre Retired	Cone & Seed Services
Mike Bruhm	MOF Prince George Deceased	Cone & Seed Services
Betty Sommerfield	MOF Tree Seed Centre Deceased	Cone & Seed Services
Roy Scully	MOF Prince Rupert Deceased	Cone & Seed Services
Bill Clifford	Integrated Land Management Bureau	Engineering & Infrastructure
Dave Millard	MFR Project Manager	Engineering & Infrastructure
John Morgan	MOF Tech and Admin Retired	Engineering & Infrastructure
John Robertson	Westmar (Swan Wooster Engineering)	Engineering & Infrastructure
Roger Sayer	Applied Mechanical Systems (Bevco)	Engineering & Infrastructure
Cheryl Edwards	MFR Information Management Branch	Information Management & Technology
Insha Khan	Integrated Land Management Bureau	Information Management & Technology

Name	Agency	Recognition Category
Leslie McAuley	MFR Tree Improvement Branch	Information Management & Technology
Dennis McMillan	Compupro Systems Ltd.	Information Management & Technology
Mike Pelchat	MFR District Quesnel	Information Management & Technology
Ron Robb	Blue Shale Technologies Inc.	Information Management & Technology
Susan Zedel	MFR Tree Improvement Branch	Information Management & Technology
Ken Baker	Forestry Innovation Investment Ltd.	Leadership
Brian Barber	MFR Tree Improvement Branch	Leadership
Bronwen Beedle	Ministry of Aboriginal Relations	Leadership
Henry Benskin	MOF Retired	Leadership
Bruce Devitt	MOF Retired	Leadership
Dr. Dale Draper	MFR Climate Change and Forest Carbon Working Unit	Leadership
Doug Konkin	MFR Deputy Minister	Leadership
Jack Long	MOF Retired	Leadership
Jim Snetsinger	MFR Forest Stewardship Division	Leadership
Craig Sutherland	MFR Forest Stewardship Division	Leadership
Evert van Eerden	MOF & Pacific Regeneration Technologies (PRT) Retired	Leadership
Bob Jones	MOF Deceased	Leadership
Alf Bamford	MOF Deceased	Leadership
Charlie Johnston	MOF & PRT Deceased	Leadership
Dr. Robb Bennett	MFR Tree Improvement Branch	Seed Science and Technology
John Dennis	Pacific Forestry Centre (PFC) Can. Forest Service (CFS)	Seed Science and Technology
Dr. George Edwards	PFC CFS Retired	Seed Science and Technology
Dr. Yousry el-Kassaby	University of British Columbia Forest Sciences	Seed Science and Technology
Dr. Carole Leadem	MOF Research Branch Retired	Seed Science and Technology
Mike Peterson	Applied Forest Science Ltd.	Seed Science and Technology
John Revel	MOF Prince George Retired	Seed Science and Technology
Dave Wallinger	MOF Retired	Seed Science and Technology
Dr. Rita Winkler	MFR Southern Interior Region Kamloops	Seed Science and Technology
Dr. Paul Trussell	Pellet Contractor Deceased	Seed Science and Technology