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Cover

The past and the future meet at the Cowichan Lake Research Station. A 500-year old Douglas-fir and five-year old Teresa Carson.
Introduction

In 1929, the Forest Branch of the British Columbia Ministry of Lands designated land for a forest experiment station on the south shore of Cowichan Lake. Here, long term forest research was to be conducted on the tree species of the Douglas-fir region.

The forest experiment station was developed in two units; first the Mesachie unit, on the south side of Cowichan Lake where the present Research Station is situated, and the North Arm unit which was established in 1939 across the lake, about five kilometres from the village of Lake Cowichan. Today the two units total 300 hectares. A camp and cookhouse, built in the 1930s to house reforestation crews, are still in use.
Area Geography

Location
The Cowichan Lake Research Station is located on south central Vancouver Island, about 63 kilometres northwest of Victoria. The area is part of the mountain range which makes up Vancouver Island, and is characterized by a large glacially scoured valley which drains to the southeast. Cowichan Lake and Cowichan River are located in the valley, and the two units of the Research Station are found at the eastern end of Cowichan Lake. The terrain of the Research Station varies in elevation from 160 to 240 metres above sea level, and the mountains surrounding the area range from 420 to 1100 metres in height.

Mesachie unit from the air. The photograph shows a variety of research plantations and clonebanks, as well as the propagation center on the far right.
Climate

The climate in the region is characterized by mild, wet winters and relatively dry, moderate summers. The figures show the average monthly rainfall and the mean daily minimum and maximum temperatures over a 50-year period.

WEATHER DATA OVER A 50-YEAR PERIOD—
AVERAGES

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Highest and lowest temperature ever recorded 38°C and -18°C

Despite the high annual precipitation, soil moisture deficits generally occur during the summer months. A heavy winter snowpack can occur, although some winters pass without any snowfall. The mild, moist climate provides a long growing season, resulting in some of the most productive forest land in Canada.

Soils

The soils of the Mesachie unit are generally sandy loams, developed from glacial till. This soil overlays a hardpan layer which was created by glacial compaction. The hardpan layer restricts root and water penetration and causes lateral seepage of ground water. The water table fluctuates seasonally, and in the middle of the Mesachie unit, it extends to the surface resulting in a large swamp. The variable topography of this unit creates a variety of site types.

The North Arm unit is dominated by a deltaic deposit which was laid down by Meade Creek during postglacial

This Douglas-fir stand regenerated naturally following logging and burning in 1911, and currently contains a gross wood volume of about 600 cubic meters per hectare. A series of thinnings between 1929 and 1969 removed about 560 cubic meters per hectare.
times. In general, these soils are deeper and better drained than the soils at the Mesachie unit. Therefore trees have access to moisture and nutrients at greater depth than they do in the Mesachie unit, and are subject to less moisture stress during the summer. In light of these conditions, the North Arm unit possesses the best soils for tree growth found on the Research Station land.

Forest Cover Types

The forests regenerated naturally after logging and burning which occurred about 1894 at North Arm and 1908 at the Mesachie unit. On the areas which have not been cleared for nursery or gene archive development, approximately 90% of the forest consists of coniferous species and 10% of hardwood. Of the conifers, Douglas-fir (Pseudotsuga menziesii) occurs in almost pure stands and occupies approximately 70% of the productive forest area. There is also a component of western hemlock (Tsuga heterophylla), grand fir (Abies grandis) and western redcedar (Thuja plicata). In smaller numbers lodgepole pine (Pinus contorta), western white pine (Pinus monticola) and Sitka spruce (Picea sitchensis) can be found. The most abundant hardwood species is red alder (Alnus rubra), which forms even-aged stands. Also present, but only as single trees, are bigleaf maple (Acer macrophyllum), black cottonwood (Populus trichocarpa), willow (Salix spp.), Pacific madrone (Arbutus menziesii), western flowering dogwood (Cornus nuttallii) and Pacific crab-apple (Malus diversifolia).

Wildlife

The Research Station land supports a variety of wildlife. Coastal blacktail deer are common and frequently seen in the area. Raccoons, rabbits, mink, weasels, otters, and other animals make their home here, as do a variety of birds such as blue grouse, ruffed grouse, bald eagles, and several species of woodpeckers. Although less common, black bears and cougars are also seen occasionally. In some areas, deer and rabbits cause damage to trees by browsing shoots or nibbling the tender stems of seedlings and grafts. The fences around certain areas are designed to keep deer or rabbits out.
North Arm logging 1886. Teams of oxen were used for skidding logs from the forests during this period.
Early Logging

The British Colonist newspaper reported on June 22, 1885, "Exploring Cowichan - D.H. McNeil, Government Guide, leaves for Cowichan this morning for the purpose of exploring the land adjacent to Cowichan Lake and River." Mr. McNeil's trip prompted interest in the area, and one year later a road was pushed up the Cowichan Valley to the lake. At first, the forests were considered merely a nuisance by settlers who sought high quality farmland. Beginning in 1886, however, the value of the forests was increasingly realized and commercial logging started.

Hand falling and the use of oxen for skidding the logs were the only logging methods available at the time. It was slow and often dangerous work in the huge old-growth forests which once covered most of the area. One log taken from Nixon Creek measured 196 feet to a 26 inch diameter top. The use of oxen for skidding logs gave way to horses and eventually to steam-driven "donkey" engines. With the advent of the E&N railway in 1912, followed by the CNR in the mid-twenties, the tempo of logging surged. By the mid-forties there were three large sawmills in the area, located at Youbou, Mesachie Lake and Honeymoon Bay. A peak level of 200 million board feet (1.5 million m³) was produced by the three mills in 1947. Unfortunately this rate of harvest exceeded what the area could support on a sustained basis, resulting in the closure of the Mesachie Lake mill in 1968 and the mill at Honeymoon Bay in 1982.

Forestry remains the primary industry around Cowichan Lake, with all the communities in the area being almost entirely dependent upon it. Increased forest management activities, such as planting, fertilizing, juvenile spacing, and thinning will hopefully add to the employment opportunities in years to come.

The Early Years of the Station

Much of the early camp development was linked with unemployment relief programs during the depression years. These work crews built a cook and bunkhouse to serve up to 100 people, constructed roads and trails, many of which are still in use at the Station. After the depression, the Ministry's Reforestation Branch played an important role in maintaining the camp facilities at the Station. The camp served both as a base for Forest Service planting and snag-falling crews in the area, and provided room and board for staff on summer research programs. Until the mid 1960s, and with the completion of the Ministry's planting program in the area, a definite "camp atmosphere" dominated the Station. All workers, from foresters to labourers, stayed in camp and used it as a base for their work.

During these early years, the Station served as a centre from which studies were conducted during the summer months. The objective of this research was to learn how best to manage forests for future use. The studies involved growth and yield, thinning, stem pruning, and direct seeding. The experimental forest provided good opportunities for this, and study plots were established, primarily in Douglas-fir and alder stands. As well, a number of studies were done in soil mapping, site type classification, and cone and seed production.

The Canadian Forestry Service maintained a field lab at the Station for many years to study forest entomology and pathology problems such as the control of root rot fungi, Ambrosia beetle on stored logs, as well as cone and seed insects.

The tree improvement program was introduced in the 1950s followed by the establishment of clone banks, breeding arboreta, and test plantations. As a result, more interest was focused on the Station.
The Cradle of Tree Improvement in British Columbia

Tree improvement had been a significant part of European forestry for many years, when it was introduced to B.C. forestry in the early 1950s by Dr. A.L. Orr-Ewing. He was the driving force behind Douglas-fir tree improvement, and through his early work the Cowichan Lake Research Station became the site of pioneering tree improvement research. The first seedlings from controlled breeding of Douglas-fir were planted at the Station in 1952. These trees were part of an extensive inbreeding study which was directed at improving the genetic makeup of selected individuals.

In 1954, a study on the importance of parent tree selection began. It showed that even simple visual selection of the better-looking trees could result in offspring with improved growth and form. Included in this study are the first grafts of Douglas-fir which were done at the Station. These grafts were grown side by side with seedlings from the same parent, allowing comparisons to be made between survival, growth, seed production, and stem and branch form.

In 1957, the selection of Douglas-fir parent trees in B.C. began on a large scale. The selected trees were propagated and planted in clone banks at the Station for use in future breeding.

In 1963, a program was begun in which parent trees ranging from coastal B.C. to Arizona were crossed to see if hybrid vigour would result in the offspring. Encouraged by some promising early results from this ‘wide crossing,’ Dr. Orr-Ewing embarked on establishing a breeding arboretum of Douglas-fir to represent the whole range of the species. This would allow future breeders to have access at the Research Station to Douglas-fir from any area. In this breeding arboretum, coastal B.C. is represented by grafts from selected plus trees, while the remainder of the species distribution is represented by small provenance plantations. At its peak, the Douglas-fir arboretum contained seedlings from 320 different locations from Mexico to central B.C.

Breeding Programs

The huge gains in agricultural production due to plant and animal breeding have long benefitted mankind. Although breeding of forest tree species is a younger science, the potential for genetic improvement of desirable traits is as good as that for agricultural species. The prospect of a ten percent gain in tree growth from the use of genetically improved strains has great socio-economic implications. Such a gain is analogous to a ten percent increase in the forest land base, without an increase in costs such as roads and fire protection. Early estimates for Douglas-fir indicate that a ten percent gain in the first generation of breeding is conservative, and in the second and third generations, gains as high as twenty-five and forty percent may be within reach. The importance of tree improvement to the future of forestry has become more obvious in recent years. An increasing demand for wood coupled with a decreasing land base for producing timber makes it necessary to find faster, more efficient ways to grow trees. Breeding trees with faster growth, better form and greater resistance to insects and disease is one way of doing this.

The current Douglas-fir and western hemlock breeding programs were started in 1975 and 1977 respectively. They follow four basic steps:

1. selection of parent trees,
2. propagation of parent trees,
3. controlled breeding,
4. testing in plantations, progenies resulting from the controlled breeding.

This procedure is repeated with a second generation of parents which is selected from the progenies of the first generation.

Douglas-fir parent tree number 66. At 119 years of age, this tree is 60 meters tall, and contains about 13 cubic meters of wood.
Parent trees in the first and subsequent generations are chosen on the basis of fast growth, straight stem and other characteristics desirable for wood production. Once selected, these parent trees are propagated and established in clonebanks at the Research Station or planted in seed orchards. The genetic type of the parent trees is then available, without the expense and difficulty of returning to the original site of the parent.

When ramets from the parent tree produce flowers in the clonebanks, they are mated under controlled conditions. The resulting seed is grown into seedlings of known parentage. These seedlings are then established in plantations on a variety of sites located throughout the areas to be used for operational reforestation. The performance of the seedlings is monitored, and the best ones are selected for the next generation of seed orchards.

**Douglas-fir**

The current Douglas-fir breeding program was started in 1975. About 1,000 parent trees have been selected from a variety of areas and elevations throughout the coastal range of Douglas-fir in British Columbia, as well as from coastal Washington and Oregon. Since the start of this program, about 30,000 seedlings of known parentage have been grown each year, and planted for testing in a variety of elevations and climatic conditions.

**Western hemlock**

The western hemlock breeding program began in 1977. About 1500 parent trees have now been selected and propagated, with many established in first-generation seed orchards. Breeding of this species is simplified by its ability to respond to cone-inducing treatments, such as moisture stress, fertilizing and hormonal sprays, and by its rapid production of cone-bearing shoots on relatively small propagules. The time from selection of a tree in the forest to the planting of its offspring is six years versus 10 to 15 years for Douglas-fir. Monitoring of seedling performance and selection of the best individuals will be done as described for Douglas-fir.

**Western white pine**

Following the signing of an agreement with the Canadian Forestry Service in 1983, the Station will be involved in propagating and rearing grafts from carefully selected white pine in a program of breeding for blister-rust resistance.

![Controlled pollination on Douglas-fir.](image-url)
The Research Station Today

In 1979, the Coastal Tree Improvement Co-operative was formed by the Ministry of Forests and major forest companies to coordinate Tree Improvement activities in the Province. This increased the responsibilities of the Research Station to include the propagation of all stock needed for seed orchards and clonebanks throughout the Vancouver and Prince Rupert Forest Regions and the development of a master clonebank for all important coastal tree species.

The Research Station today organizes its activities into three sections, with one person responsible for the management of each. These sections are:

1. nursery, propagation centre and camp,
2. gene archives, and
3. support research.

Nursery, Propagation Centre and Camp

The nursery was established in 1963 to produce stock for provenance tests and tree breeding programs. Greenhouse-container facilities were added in 1974, but the major expansion took place in 1979, with further development of the nursery and the construction of propagation facilities. Approximately 25,000 grafts and up to 60,000 rooted cuttings are made annually in the following species: Douglas-fir, western hemlock, sitka spruce, Engelmann spruce, amabilis fir, grand fir, lodgepole pine, western white pine, western redcedar, and yellow-cedar.

The camp and cookhouse operate on a full-time basis and house training courses, Ministry work crews and visiting groups. With the closure of many logging company cookhouses, the station cookhouse is the only one of its kind in the area. As such it has been designated a Forest Service Heritage Building.

Sitka spruce, Douglas-fir and yellow-cedar grafts being grown for seed orchards and clonebanks. The Research Station produces about 25,000 grafts annually.

Western hemlock cuttings, hemlock seedlings, and Douglas-fir rootstocks grown for the coastal tree improvement program.
Gene Archives

The gene archives at the Station contain plantations of interest for operational or research purposes. The largest portion of the gene archives are grafted clonebanks of parent trees which were selected from natural stands for the tree improvement programs. There are currently about 20 hectares of clonebanks representing Douglas-fir, western hemlock, western redcedar, yellow-cedar, amabilis fir, grand fir, Sitka spruce, and Engelmann spruce. The clonebanks are expected to cover about 70 hectares following their initial development stage. Other trees being maintained for research and demonstration purposes include:

a) a large collection of Douglas-fir inbreds resulting from years of earlier research and breeding;

b) Douglas-fir trees grown from seed collected at 216 locations within the species range, from north of Prince George (latitude 55°) to as far south as central Mexico (latitude 19°);

c) an arboretum of the different species in the *Pseudotsuga* (Douglas-fir) and *Tsuga* (hemlock) genus;

d) a native tree arboretum;

e) a lodgepole pine collection from throughout its coastal range; and

f) a yellow-cedar hedging orchard for the production of cuttings.

The possibilities of using these plantations in research projects is being realized, and the number of projects started yearly in the gene archives is steadily increasing.

*Douglas-fir clonebank with pollination bags for controlled breeding.*

*Delayed incompatibility is a problem in Douglas-fir grafting. The photograph on the left shows a compatible graft union, and that on the right an incompatible union. This graft will likely die from incompatibility within a few years.*
Support Research

With the introduction of the Tree Improvement Program some support research became necessary at the Station. Incompatibility at the graft union between the rootstock and scion was appearing in a large number of the Douglas-fir grafts, prompting a search for more compatible rootstocks. This work has been going on for a number of years and involves the identification of compatible clones, breeding these, and testing their progenies as rootstock. Since using improved rootstock, a marked improvement has been observed in the graft compatibility of Douglas-fir.

Experiments to enhance the flowering of clones have also been conducted at the Station. Two types of mechanical stress treatments have been developed for achieving this: root pruning and stem girdling. Problems have been encountered with both methods, but when applied correctly, each works well and greatly increases the flowering.

The introduction of propagation on a large scale has partially shifted the emphasis of research projects to improving the cultural techniques in the production of propagules for seed orchards and clonebanks. These experiments are often carried out on production stock, allowing research findings to be implemented continuously, and ensuring an end product of high quality. As the species and type of project change, this work will be adjusted to meet new situations.

Outlook to the Future

The Cowichan Lake Research Station has been in operation for over 50 years, providing a firm foundation for continued development. Research objectives have changed throughout the years, but now more than ever, the role of research in increasing the productivity of the new forests is being realized. Tree improvement and seed orchard development represent two of the vital research areas. The gene archives surrounding the Station serve to preserve breeding material and offer great opportunities for supporting research projects.

The Station serves as a centre for tree breeders and continues to provide facilities and assistance for other scientists from the Ministry of Forests, Industry, the Canadian Forest Service, and Universities.

Growing public interest in the outdoors and in forestry activities has prompted a steady increase in visitors to the Station in recent years. The high demonstration value of established experiments and plantations is recognized, and public and professional education is a willingly accepted function of the Station. An example of this is the information centre built at the North Arm unit in 1984.

In coming years, breeding programs for other species may be started. In addition, the attractive natural environment surrounding the Station may well offer new project opportunities in fields other than forestry. Whatever the research direction, there is confidence that the challenges of the future will be met at the Cowichan Lake Research Station.
Glossary

Clonebank
- a plantation of grafts or rooted cuttings of selected parent trees.

Cone induction
- various treatments (cultural or chemical) designed to cause a tree to produce cones.

Controlled breeding
- pollinating the female flowers of a tree with pollen from a known source to produce seed of known parentage.

Grafting
- attaching a small branch (scion) from one tree to the stem of another (rootstock) with cambial contact allowing a union to form.

Graft incompatibility
- a physiological difference which causes the rootstock to reject the scion.

Inbreeding
- mating between close relatives, or mating one tree with itself.

Parent tree
- a tree in the forest selected because it exhibits desirable characteristics such as fast growth, straight stem, small branches and high wood density.

Progeny testing
- comparing the offspring of different parent trees under controlled conditions

Propagule
- a grafted tree or rooted cutting which is genetically identical to a known parent tree.

Provenance
- the original geographic origin of a tree or seed

Seed orchard
- a plantation grown specifically to produce seed of improved genetic quality for reforestation.

Thinning
- removal of competing trees to make more light, water and nutrients available to the trees which are left.

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