

British Columbia's forest inventory program began as a general examination of the province and a search for the highest quality and most easily accessible timber. Over the course of nearly eight decades, forest inventory methods have become much more sophisticated and are currently designed to answer many questions that were not even asked until the 1990s.

FROM TIMBER TO BIODIVERSITY

THE EVOLUTION OF BRITISH COLUMBIA'S FOREST INVENTORY PROGRAM

The Rush for Green Gold: “Glorious, glorious.... It’s great; it’s fine! I want to buy it. I’ll give you \$2,500.” Such was the exclamation of young T.B. Merrill, a lumberman from Michigan, upon being shown 5,000 acres of prime Douglas-fir forest on the south coast of British Columbia. His guide

was veteran timber cruiser Moses Ireland and the year was 1882.^{1,2}

The forest industry was well underway, with companies concentrating on developing markets and making profits. While the B.C. Forest Branch would not exist for another 30 years, the government was concerned about timber rights and revenue generation. Since 1858 forestland was obtainable by Crown Grant and otherwise bought and sold until the further sale of unallocated timberland was prohibited in 1896. Enforcement of that provision was, however, somewhat loose due to the absence of “proper administrative measures.”³ From 1865 to 1907 timber rights were granted by leases and licenses, thus guaranteeing a continued interest in locating prime stands of timber.

Timber cruising was carried out by individuals such as Moses

Ireland and private firms. Sometimes they acted as free agents—staking timber claims and then selling the rights to mill owners, lumbermen, or investors. Timber rights were often the subject of much speculation, especially the renewable and transferable Timber Licenses issued between 1905 and 1907. That situation was described without exaggeration by a future Chief Forester of the B.C. Forest Branch, Martin Allerdale Grainger, in his novel *Woodsmen of the West*:

“There had arisen a fierce rush to stake timber. Hundreds and hundreds of men—experienced loggers, inexperienced youths from town—blossomed as ‘timber cruisers.’ The woods were furrowed with their trails. ... They had staked

BY JOHN PARMINTER



Moses Ireland, the father of British Columbia's timber cruisers.

the good timber, and then the poor timber, and then places that looked as if they had timber on them, and then places that lacked appearance.”⁴

It is clear that some timber cruisers had more experience and credentials than others. In any case, the work amounted to finding and assessing the best stands of timber and then staking them before someone else beat you to it.

The better timber cruisers' reports described the volume available for harvest, the species breakdown of the stands, expected timber quality, and development prospects. Those were the primary interests of the logging and lumbering firms. The methods used to calculate volumes were very much “rule of thumb” or “estimates.”⁵ Trees below 24” diameter at breast height (DBH), true firs, hemlocks, and less accessible timber were not included because they could not be utilized.⁶

TIMBER SUPPLY CONCERNS ARISE

“Until recently, upon the continent of America, men gave little thought to the extent of the forests and were contented with the vague idea that, like the water that ran to waste in every stream, the timber supply was inexhaustible.”⁷

Thus begins the section describing the forests of B.C. in the final report of the first Royal Commission of inquiry into provincial forestry matters, held in 1909 and 1910. The commissioners noted that inflated estimates of timber supply can lead to careless waste and “...distorted theories of annual destruction, by fire and by lumbering, enable alarmists to harm the common-sense campaign for conservation by their exaggerations.” This produces uncertainty in the business world and makes the government's task of “creating sound forest policies” more difficult.⁸

The Royal Commission estimated the total area of merchantable timber land in the province to be 15 million acres, supporting a standing timber volume of 240 billion board feet (exclusive of pulpwood).⁹ At the same time, the commissioners admitted that both calculations were based on limited information and involved a large amount of guesswork.

The commissioners recommended that all provincial government agencies dealing with forestry be consolidated into a Department of Forests, headed by a Chief Forester. In recognition of the need for accurate forest inventory information, it was made quite clear that the Chief Forester would be expected to begin a program to inspect, survey, cruise, and value the province's forest lands and timber resources.

THE B.C. FOREST BRANCH IS FORMED

Following consideration of the report of the Royal Commission, the first Forest Act was drawn up and passed into law on February 27, 1912.¹⁰ It created the B.C. Forest Branch, as the Forest Service was then called, and outlined its jurisdictions and duties.

Rights to Crown timber were now to be sold by public competition following a timber cruise and evaluation by the Forest Branch—a system that would avoid timber-staking rushes. Thus, cruising focused on individual blocks of timber prior to sale and harvest. However, the Forest Act also directed the Forest Branch to examine Crown forestland and create reserves for the “perpetual growing of timber.” The Minister of Lands, the Hon. William Ross, announced that the Forest Branch would examine the timber resources to “...ascertain exactly what timber the Province contained.”¹¹

Under the guidance of Chief Forester H.R. MacMillan, recruited to the post in May of 1912, a forest reconnaissance program was soon underway. MacMillan had first-hand experience in timber cruising, forest surveys, and compiling summary statistics so he recognized the need to gather such information. Staff members H.K. Robinson, Chief of Forest Surveys, and R.E. Benedict, Chief of Operations, traveled around the province in the spring of 1912 and hired experienced timber cruisers for the work.¹²

Eleven forest districts were created, each headed by a District Forester. Technical Assistants looked after timber cruising and forest reconnaissance, while Head Rangers supervised field operations. Forest Rangers, Forest Assistants, Timber Cruisers, Scalers, Forest Guards, and Patrolmen looked after timber sales, logging inspections, scaling, land classification, surveys, fire protection, and improvement work.

In submitting his first annual report on January 7, 1913, MacMillan noted that ten forest surveys were carried out in 1912:

“The most urgent need for them is to supply information needed as a basis for efficient work in the creation of forest reserves, the construction of permanent improvements, and the distribution of the field force. While satisfying these needs, these forest surveys will yield at the same time detailed information regarding the stand of commercial timber in the different regions, its size and quality, and its availability for successful lumbering operations, which will be of great practical value to lumbermen and other forest-users, as well as in the development of a progressive public timber-sale policy.”¹³



Forest reconnaissance crew on a lake during the Babine area forest survey in northwestern British Columbia, 1926.

The work was called “forest reconnaissance” because it was not especially detailed, although certainly a step up from basic timber cruising. Timber volumes were usually just estimated but sometimes checked by measurements in circular plots or sample strips. In 1912, 5.6 million acres were examined and 12.3 million the next year. Given the province’s total forested area of 149 million acres, the program got off to a good start. Priority was given to lands adjacent to three new railway lines, previously undescribed timberlands in the central northern and central coastal regions and the more settled southern areas of the province.¹⁴

The fieldwork was done by special field parties, by foresters attached to crews doing triangulation surveys for the Surveyor-General and by the District Foresters and Forest Rangers. In 1914 some of the experienced Forest Assistants and Forest Guards carried out reconnaissance surveys. To some extent this was a consequence of more specialized staff leaving to enlist in the military, which continued over the next few years.

The forest reconnaissance reports follow the same general format for each area, including information on topography, soil, climate, agricultural and grazing potential, known mineral resources, settlement history, and transportation infrastructure for each area surveyed. Tree species presence, distribution, size, and quality characteristics precede descriptions of forest types and estimates of the area and volume of merchantable and other timber resources.

Land was classified as being statutory timberland (legally defined as of 1896 based on the timber volume present—at least 8,000 board feet per acre on the West Coast; 5,000 board feet per acre in the Interior), other forest land (mature stands with less

volume or immature stands), agricultural, burned over, barren (usually alpine), or other cover (wetlands or lakes). Differentiation between what should be reserved as forest land and what should be opened for settlement and development was an important aspect of the work, in response to policies designed to bring about appropriate land use.

Accomplishments in 1914 and 1915 totaled 27.5 million acres examined but the forest reconnaissance program ground to a halt in 1916 as wartime needs took priority. Not all was lost, however, as the Commission of Conservation of Canada was working concurrently to describe, assess, and quantify the forest resources of B.C.

THE FIRST PROVINCIAL OVERVIEW

The Commission of Conservation of Canada was created in May of 1909 as a consequence of the North American Conservation Conference, convened by President Theodore Roosevelt in February of that year. The Commission was composed of federal and provincial politicians and ministers of natural resources, academics, businessmen, and others. This national interdisciplinary body addressed the conservation and utilization of the natural resources of Canada, carried out inventories, disseminated information, and made management recommendations.

The ambitious project by the Commission to compile summary information about B.C.’s forest resources got underway in 1913, headed by Dr. Harry N. Whitford of Yale University. In four months he mapped 12.8 million acres in the southern interior, classified the land, and collected forest survey data from the B.C.

Forest Branch, Dominion Forestry Branch, Forestry Branch of the Canadian Pacific Railway, timber limit holders, and timber cruisers. Additional local knowledge was obtained from surveyors, prospectors and trappers.

In 1914 Whitford was joined by forester Roland D. Craig, who examined the coastal forests, including Vancouver Island and the Queen Charlotte Islands. By the end of that year they had collected information for a total of over 128 million acres. Following more fieldwork in 1915, then final data compilation and analysis, their report was submitted in 1916 and published two years later.

Whitford and Craig estimated the total standing timber volume of B.C. to be 366 billion board feet, or more than 50% higher than the Royal Commission's earlier estimate for merchantable sawtimber alone. The forest resources are described in detail for the Coast and Interior, by 66 geographic units. Their report goes far beyond a forest inventory—addressing geography, physiography, climate, soil, forest types, land tenure, forest administration on provincial and federal lands, forest policy, timber harvesting, and utilization. Along with a breakdown of land classification are estimates of timber volume by species, information on land alienation, the history of land use, and known natural disturbances.

This landmark publication served as the only source of summarized forest survey information for B.C., and much more besides, for nearly two decades. While the Commission of Conservation of Canada was dissolved in 1921, it made great progress in describing the forests of B.C., Ontario, and Nova Scotia and carried out many other investigations regarding Canada's natural resources.

HEADQUARTERS ROLE INCREASES

The provincial Forest Branch's staffing levels recovered soon after the end of World War I and forest surveys resumed in 1920. These surveys were carried out with more accuracy and attention to detail than was the case with earlier forest reconnaissance work. In some cases it was discovered that timber cruisers had staked overlapping timber licenses or included large portions of burned forest, alpine meadows, and glaciers.¹⁵

The shift to a centralized program, run from the headquarters level, began in 1923 when forester C.D. Orchard was put in charge of forest surveys. This centralization enabled and encouraged the development of a standardized forest survey methodology, essential if the data were to be summarized at the provincial level.

Fred Mulholland described the forest survey work carried out by the Forest Branch in the Okanagan Valley of southern B.C. in 1926 at the District Foresters conference. Maps from the Surveyor-General's department were used to establish sample strips from accurate survey points or other definite locations. Compass traverses were run along railways, roads and trails where necessary. No set interval was used for the sample strips but they were frequent enough to capture all forest types. The maximum strip interval was one mile, unless the forest was very uniform over large areas. If a single sample strip exceeded four miles in length, a compass bearing was taken and the distance measured to a known reference point.¹⁶

Merchantable timber was strip-cruised to 2.5% intensity, meaning that 2.5% of the total forested area surveyed was included in the sample strips and subsequently described and measured. The line plot method was used in young stands, with plots ranging from a square rod (16.5 x 16.5 feet) to a square chain (66 x 66 feet),



BRITISH COLUMBIA ARCHIVES. PHOTO #NA-04594

Nass area forest survey camp in northwestern British Columbia, 1922.

and established at regular intervals. In multi-aged stands, quarter-to-half-acre plots were employed, with subplots for smaller saplings.

Data forms allowed for recording tree species, DBH, total height, and age as required. Stand type, site history and quality, and evidence of tree defects and damage were noted. Measurements of ten-year periodic increment might also be made. After enough plots were established in young stands with trees less than 8" DBH, only the number of trees per acre, average DBH, height by species, and approximate age were subsequently recorded. Forest type boundaries and field notes were transcribed to 1:40,000 scale contour maps as sampling progressed.

The data obtained by these surveys permitted:

- differentiation between productive forest and non-productive land;
- division of productive forest based on type, age class, and site quality;
- estimates of current mature timber volumes and expected yields from young growth when it matures;
- rough estimates of sustained annual yield under proper regulation;
- determination of the volume and location of timber that should be harvested in order to bring the management unit into a normal age class distribution; and
- division of the management unit into blocks, working sections, and units based on topography and harvesting possibilities.¹⁷

These procedures enabled the development of forest working plans and preceded the formal adoption of sustained yield forest management by some 20 years.

THE SECOND OVERVIEW

The Forest Surveys Division was created at the B.C. Forest Branch's headquarters level in 1927, with Fred Mulholland in charge, and a new provincial forest inventory soon began in the districts. It consisted of both a forest land classification system and a compilation of timber volumes. A forest atlas (at 1" to the mile) was developed and the accompanying statistics revised in response to harvesting, wildfire, other depletions, reforestation,

and stand growth. This allowed for periodic publication of the summary information.¹⁸

Land was classified as productive forest, non-commercial timber, or agricultural land. Fifteen forest types were mapped based on species breakdowns and volume per acre in mature forests, and species composition, stand density, and tree height in immature stands. Ten types were used for productive forest, three for non-commercial forest, and two for agricultural land (cultivated or open grazing). Each type was differentiated by specific colors and symbols.¹⁹

The information in the atlas was based on provincial land classification and forest surveys, timber taxation assessment cruises, exploratory reconnaissance and information supplied by private timberland owners. The forest districts did not include the far northern portions of the province and so Whitford and Craig's 1918 report still formed the basis for information for an area of about 68 million acres.

Mulholland designed standardized field methods similar to those of 1926, and they were issued as "Instructions for Forest Surveys" in 1928. These methods were employed, sometimes with minor modifications, until 1945. They were then revised, reissued and used until the early 1950s.

Baselines were established six miles apart and marked with posts at one-mile intervals. From those points cruise strips ran in both directions for three miles, which was considered to constitute "an average day's work." In merchantable timber, trees within a 66-foot wide strip were tallied by 2-inch diameter classes and sample trees measured for height and age. Sampling was less intense in large uniform types such as recent burns, scrub or young Lodgepole pine—with both fewer and narrower strips.

Timber volume estimates were based on the best utilization standards of the day. Generally that meant a minimum DBH of 11", sometimes as low as 8" in merchantable stands. Volumes were not calculated for immature stands or for trees likely to be wasted during harvesting in mature stands. The inventory did not account for improved future utilization but would be adjusted when utilization levels changed.²⁰

The work was carried out by several means:

"The average party consists of a forest engineer in charge, three estimators, a draughtsman, four compassmen, a cook, a packer, and eight or ten pack-horses. Expansion of provincial roads now allows most parties to use a truck for at least part of the season. Launches, open boats with outboard engines, canoes, dog teams in winter, are all used at times. Aeroplane work so far has been merely for reconnaissance to enable a field party to direct its attention with economy of time and expense to productive areas, eliminating some of the work on large burns and barrens. Aerial photography is too expensive for us as yet."²¹

The resulting forest atlas consisted of 174 maps, each averaging just under 12 square feet in size. In addition, 10 million acres of productive forest land were mapped at twice the level of detail (.5 inch to the mile), including topography as well as forest cover.

After a decade of new surveys and updates, a provincial summary was published in 1937.²² Expanding upon H. R. MacMillan's 1913 description of the value of forest surveys, Mulholland considered forest surveys to be required for many aspects of forestry:



BRITISH COLUMBIA ARCHIVES. PHOTO #NA-12716

Survey crew member of the Forest Surveys Section, Forest Economics Division, B.C. Forest Service, working on forest cover maps at a field camp on the Harrison area forest survey, 1939.

"A timber cruise, however detailed and thorough, is simply a crop survey; how much wood? How and at what cost can it be moved to the manufacturing plant? A forest survey is an economic survey, concerned with all branches of forestry; policy, management, silviculture, regulation of the cut, utilization, protection. Its ultimate object is to provide information to enable a forest to be administered for permanent wood production."²³

Mulholland's estimate of the total merchantable timber volume in the province (excluding the 68 million acres of the far north) was 254.5 billion board feet—close to the Royal Commission's figure of 240 billion board feet—but based on an area of 75 million acres of productive forest land rather than the 15 million acres considered merchantable by the commissioners. The results of the surveys confirmed the commissioners' statement that their estimates were largely based on guesswork. Also, the value of standing timber and wood products had increased and as sawmills were able to utilize smaller and smaller logs, more and more forests were considered merchantable and could be accessed and harvested.

THE INFLUENCE OF TECHNOLOGY

As suitable new technologies developed they were gradually incorporated into the forest inventory program. Air photos were first used in 1931 and by 1933 over 530,000 acres of forest had been typed by air photo interpretation.²⁴ Gerry Andrews, later to become the province's Surveyor-General, promoted the use of air photos in forest survey work and saw the area covered by forest type maps prepared from air photos grow to total 10.8 million acres by 1940.²⁵ From that point on, base maps were prepared from air photos prior to all forest inventory field work.

The standard procedure during the late 1940s was to prepare base maps and forest type maps from air photos for field crews to use during their summer surveys:

"Our best and most experienced men are doing the preparation work which involves obtaining the base map and the corresponding photographs, making the preliminary area classification, plotting all logging and burn history and existing cover information on to the photos, delineating known type lines and laying out the work to be done in the field to complete the survey. The field staff takes the prepared area into the field and supervises the student assistants who do the examination work. The salient feature of our preparation and field work is that the photographs themselves are the field map and are marked progressively to show all the type detail and descriptions."²⁶



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Inventory crew member, Sig Tetchy, beside a large Douglas-fir on the Kyuquot area survey, Nootka Island, 1947.

This detailed delineation and classification of forest types through air photo interpretation meant that subsequent field sampling could be less intense. It dropped to 1.25%, or one sample strip per mile, from the earlier standard of 2.5% for merchantable timber. Field sample data were averaged for each stand class and extrapolated to a larger geographic unit, a general

procedure that is used to this day. The data included timber volumes classified into 11 forest type groups, 5 age groups, 4 height groups, and 3 stocking classes for each geographic zone.

In 1938 the inventory data were first coded on to punched (Hollerith type) cards, enabling sorting, extraction, and tabulation of any information in the provincial forest inventory database. From that time onward it was considered to be a continuous inventory, under constant revision.²⁷

PROGRAM EXPANSION

The next major influence on British Columbia's forest inventory program was The Canada Forestry Act of 1949. This federal legislation addressed a wide array of programs—the creation,



PHOTO BY DOUG FLUGG

"Dotters" Barbara Crawford and Heather Clarke of the Planimetry Section of the Forest Surveys and Inventory Division, calculated forest cover polygons areas by dot counting. These women were known as the "Dotters of the empire." Circa late 1950s.

management, and protection of national forest lands and experimental areas; forest products research laboratories; forest resource utilization and federal-provincial agreements "...for the protection, development or utilization of forest resources."²⁸

The last provision resulted in federal funding to assist British Columbia's forest inventory work and an agreement made on April 1, 1951 set out the terms of a seven-year program. The federal government would pay for half the costs as long as the inventory work met certain specifications and the province also promoted sustained yield forest management. This fast-track program compensated for reduced survey activity during the Depression and the nearly complete suspension of fieldwork due to World War II.

As of 1950, forest inventory work was carried out exclusively at the headquarters level. A separate Forest Surveys and Inventory Division was created on January 1, 1951—formed from part of the Forest Economics Division, which had included forest surveys and inventory personnel since 1939. The new director was H.M. "Mickey" Pogue. Staff levels increased to handle the huge new workload and they were affectionately called "Pogue's Army."

The work followed the same basic approach used in the 1940s, with stratification of forest land into types by air photo interpretation, transfer of that information to base maps, stratified

random field sampling of forest type groups, data entry on computer cards, and ultimately data compilation to integrate area statistics with volume information. The data collected provided estimates of gross wood volume, recoverable sound wood volume, and annual net forest growth. Depletions from the standing timber inventory due to wildfire, insects, diseases, weather events, harvesting, and conversion to other land uses were also tracked.

Stands were classified according to structure (e.g. immature deciduous forest, mature coniferous, non-commercial cover), species composition and a number of age, height, and stocking



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Boats such as the M.V. Forest Surveyor were used for coastal forest surveys. A barge accommodating a helicopter and fuel was towed along, 1961.

classes. Fieldwork involved air observation, mapping, and classification as well as ground sample plots.²⁹ Sample plots were now circular, in groups of four, as the sample strip approach was judged to be too laborious and time-consuming for the scale of this endeavor.

The cost of the accelerated inventory program was \$8 million, averaging 3.5 cents per acre, and the results were published in 1958.³⁰ The commercial forest area was estimated at 118 million acres, with 306 billion cubic feet (3.67 trillion board feet) of sound wood in trees greater than 10" DBH. Annual growth was put at 2.3 billion cubic feet (27.6 billion board feet) and depletions at 2.2 billion (26.4 billion board feet).

MODERN CONCERNS, MODERN CHALLENGES

By the mid-1960s, inventory methodologies had been both refined and expanded to include more non-forest cover types, site quality classes, and disturbance history information. For the first time some attention was given to snags (standing dead trees), woody debris (logs on the ground), and understory shrub species. An Environmental Protection Forest designation—forest land declared inoperable and required for soil preservation, recreation, aesthetics, or fish and wildlife habitat protection—was added in the 1973, reflecting growing environmental concerns.

The much-revised *Forest Act* of 1978 required the Chief Forester to inventory the province's lands and assess their potential for growing trees, providing for recreation, producing forage for livestock and wildlife, and accommodating other forest uses.³¹ The

Forest Service's inventory program became even more sophisticated to meet these requirements, using tools such as low-level 70 mm aerial photography, computer-assisted mapping, geographic information systems, and satellite imagery in the late 1970s and early 1980s.

While the standard forest inventory's aims, objectives, and methods had gradually evolved since the 1920s, they were about to undergo a significant transformation. The Forest Resources Commission, a multi-disciplinary public body formed to investigate various forest management issues, recommended in 1991 that the timber inventory procedures be examined, redesigned, and then implemented to update the provincial database within 10 years.³² About a year later the Old Growth Strategy Project recommended that old-growth forest attributes be added to the forest inventory database to enable delineation of old-growth forests on the landscape.³³

These recommendations made it very clear that the forest inventory methodology was in need of modernization. In response, the Vegetation Inventory Working Group was formed in 1993 to carry out this work, under the auspices of the provincial Resources Inventory Committee. The result is the current Vegetation Resources Inventory—expanded from a timber inventory focus to include a wide spectrum of forest resources and values.

Essentially a merging of ecological survey methods with an updated timber inventory, the Vegetation Resources Inventory became operational in 1997. The field sampling includes descriptions, assessments or measurements of ecological site conditions, soil, all vegetation (mosses, lichens, herbs, shrubs and trees), tree attributes for wildlife, disturbance history, and special characteristics used to define old-growth forests such as canopy structure and the number, size, and condition of live and dead trees and coarse woody debris. The timber inventory aspect includes the usual tree measurements (DBH, height, and age samples) and classifications (canopy class and condition) as well as net factoring and call grading. The latter two are used to accurately calculate net wood volume and assign log grades.

In addition to providing information about forest types, age classes and volumes, the Vegetation Resources Inventory database can be used to assess forage productivity, wildlife use, habitat suitability and the extent of old-growth forests defined by



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The area of forest cover polygons was calculated by hand drawing and dot counting. Circa early 1970s.

more than just tree size and age. The data also enable evaluation, monitoring and modeling of the criteria, elements, and indicators used to evaluate the status of sustainable forest management in Canada.

Broad-level criteria include the conservation of biological diversity, ecosystem condition and productivity, global ecological cycles, and the multiple benefits of forests to society. Relevant elements are ecosystem and vegetation species diversity, ecosystem resilience, total vegetation biomass, carbon budget contributions, and non-timber forest values. Elements are subdivided into specific indicators used to define conditions and monitor trends (e.g. the area of different forest types and age classes, mean annual [tree volume] increment, and wildlife habitat availability).³⁴

LOOKING AHEAD

Today's inventory program functions at all levels of the B.C. Forest Service—headquarters, regions, and districts. The inventory no longer focuses primarily on timber values to estimate logging prospects or calculate allowable annual cuts, although the latter is still of critical importance. The inventory is now designed to collect a variety of ecological data reflecting a wide range of environmental values.

New technologies significantly influence the means by which information is obtained, stored, analyzed and distributed. For example, by scanning and digitizing air photos, inventory personnel can quickly obtain measurements of individual tree attributes (such as height and live tree crown dimensions) prior to commencement of field sampling. Computer networks permit clients to remotely access the data and a suite of analytical tools.

The Vegetation Resources Inventory will continue to evolve as needs change and more applications are found for the data. Some proportion of the sample plots will become permanent plots, used to assess tree growth and monitor changes in the forest overstorey and understorey that are important to resource managers and the general public. This approach is a far cry from the days of Moses Ireland in the 1880s and a significant change from the inventory methods of only a few decades ago. □

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NOTES

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