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A history of Australian Capital Territory Arboreta 1928–2003

James W. Shirley
Shirley & Werner Associates, Jamison Centre, ACT 2614

Introduction

Between 1928 and 1968, thirty-six arboreta were established by the Commonwealth Forestry Bureau (CFB)[1] and its successors, in the Australian Capital Territory (ACT), predominantly west of Canberra in the Brindabella Range, but including two at Jervis Bay on the east coast, and one at Jerilderie in western New South Wales (NSW). The original purpose of these arboreta was to assess the suitability of a wide range of species for plantation development in south-eastern Australia. The CFB directed the establishment and management of the arboreta, many of which were located on land managed by the CFB's Afforestation Branch and, subsequently, by ACT Forests.

In 1928 Cyril Cole, a forester with the Territory's Afforestation Branch, established two unnamed arboreta, and a third, called Laurel Camp, at Pierces Creek in the Brindabella foothills west of the Murrumbidgee River. Lane Poole, Inspector-General of the CFB[2] and principal of the relocated Australian Forestry School (AFS) at Yarralumla, established an arboretum at Blundell's Farm in 1929 and, subsequently, a series of arboreta in the ACT.

By 2002, twenty-three of the FTB's thirty-six arboreta were extant, the remainder having been either abandoned or burnt. Their role had

been extended to provide sites for experimental plantings of a wide range of species and provenances from around the world, and for new material created by selections and crosses from the earlier plantings. On 18 January 2003, all the remaining arboreta in the ACT to the west of Canberra, except Bendora arboretum near the Brindabella summits, were burnt in wildfires.

The arboreta played a significant role in forestry development in south-eastern Australia. Much of the material describing their establishment, measurement, management, and significance lay scattered in various archives, files and publications. This paper is a summary of a much larger report (Shirley 2008), which describes the programme and its contribution to the development of south-eastern Australian plantations.

The Arboreta

Two of the arboreta established by Cole at Pierces Creek were wholly or partly destroyed by fire in 1939, as were the arboreta established at Blundells, in 1929, and at Reids Pinch South, in 1932. The latter two were re-established in 1939. By 1954, seventeen arboreta had been established, increasing to thirty-six by 1968. The last planting in an arboretum occurred in 1970 at Jerilderie. The arboreta established in the ACT are listed in Table 1, where the fate of each is also given.

The arboreta were situated predominantly in the Brindabella Range west of the Murrumbidgee River (Figure 1), but three were in Kowen Forest, east of the city of Canberra, two were at Jervis Bay on the east coast about 150 km south of Sydney, and one was at Jerilderie in NSW.

Historical Context

Early importations of radiata pine seeds to Australia were used for ornamental purposes, but Sydney Botanic Gardens obtained one seedling off the ship *Duncan Dunbar* in 1857 (Fielding 1957). Radiata pine was also growing in Melbourne's botanic gardens in 1858 (Grant 1989), and von Mueller distributed radiata pine seedlings in Victoria and South Australia in the 1860s for ornamental plantings and farm windbreaks (Wu et al. 2007).

In South Australia, Schomburgk[3] planted *P. halepensis, P. pinea,*

Table 1: Arboreta in the ACT

Arboretum Name	Fate	Arboretum Name	Fate
1 Blundells	Burnt 2003	19 Halls Block	Burnt 2003
2 Reids Pinch North	Burnt 2003	20 Kowen, Cpt* 60	Abandoned
3 Reids Pinch South	Burnt 2003	21 Green Hills	Burnt 2003
4 Picadilly Circus	Burnt 2003	22 Kowen Cpt 71	Abandoned
5 Bendora	Extant	23 Blue Range	Burnt 2003
6 Snow Gum	Burnt 2003	24 Kowen Cpt 73	Abandoned
7 Stockyard Creek	Felled 2002	25 Vanitys Crossing	Abandoned
8 Blue Range	Burnt 2003	26 Mt Ginini	Burnt 2003
9 Blue Range	Burnt 2003	26a Mt Ginini Underplanting	Abandoned
10 Blue Range	Burnt 2003	27 Wombat Creek	Burnt 2003
11 Bendora South	Abandoned	28 Neds Block	Burnt 2003
12 Mountain View	Burnt 2003	29 Cotter Homestead	Abandoned
13 Blue Range	Burnt 2003	30 Uriarra, Pabral Block	Burnt 2003
14 Pierces Creek	Burnt 1991	31 Jervis Bay Hole in the Wall	Burnt 1972
15 Uriarra Cpt 84a	Abandoned	32 Jervis Bay Hole in The Wall	Burnt 1972
16 Halls Block	Burnt 2003	33 Boboyan	Abandoned
17 Laurel Camp	Burnt 2003	34 Jerilderie#	Abandoned
18 Westbourne Woods§	Abandoned	Poplar, adjacent Blundells	Burnt 2003

* Cpt = Compartment, an administrative unit of a forest.

This arboretum is outside the ACT, but was established and managed by FTB, and is included for the sake of completeness.

§ Remnants of this large arboretum occur on the former CSIRO campus at Yarralumla, but most of the remainder has been incorporated into the nearby Royal Canberra Golf Club, as described in Rout and Eldridge (1983).

*P. roxburghii, P. torreyana a*nd *P. pinaster* in Adelaide's Botanic Gardens arboretum in the 1870s.[4] The Woods and Forests Department established arboreta at Roseworthy Agricultural College just north of Adelaide, and at Bundaleer, in the 1880s, as well as many other trial plantings throughout the State.

Trial plantings of *Pinus pinaster* were made in Western Australia in 1896 and in plantations on the northern Swan Coastal Plain in 1923, using seed from France (Butcher 2007).

Pilot Hill arboretum near Tumut in NSW was planted in 1924 with *Pinus contorta, P. ponderosa, P. lambertiana* and *Pseudotsuga menziesii*, and several other arboreta occur in plantations managed by Forests New South Wales.

In 1875 the South Australian Government established a Forest Board which, charged with the responsibility of demonstrating the

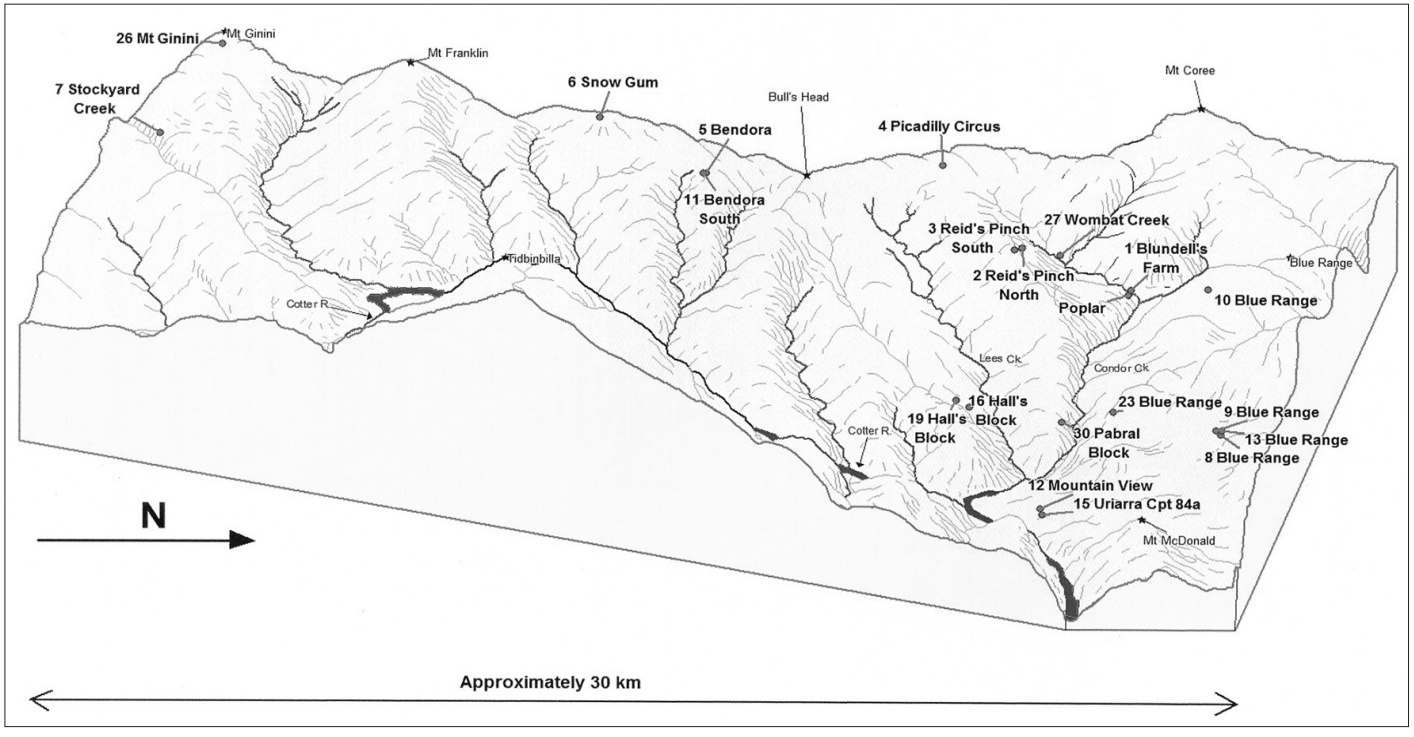


Figure 1: Arboretum Locations west of Canberra
This diagram has appeared in a number of publications without attribution. The original linework was by C.D. Hamilton, who lectured at the AFS from 1948 to 1965 and at the Australian National University's (ANU) Department of Forestry from 1966 to 1971. The viewpoint is approximately above the confluence of the Cotter and Murrumbidgee Rivers. Arboretum locations are approximate only.

'practicability' of forestry, first established pine and eucalypt plantations in 1876 from seedlings, including '*Pinus insignis*',[5] grown in nurseries at Wirrabara, Mount Gambier and Bundaleer.

In Victoria *Pinus insignis* was being planted by 1895, but it wasn't until 1907 that the *Forests Act* created a State Forests Department with responsibility for development of State-owned coniferous plantations. The legislation was strengthened by a new *Forests Act* in 1918.

In NSW, trials of coniferous species for plantation development had begun under Ednie Brown[6] in the late 1890s, and by 1926 the annual planting programme had risen to about 1,000 ha/yr, with mixed success. Brown dispatched A. D. Helms[7] in 1920 to procure suitable seed in North America and Europe (Carron 1985).

In Western Australia, Lane Poole, as Conservator of Forests, advocated the development of pine plantations in his Forests Bill of 1918, and in 1921 a Royal Commission on Forestry recommended that funds be made available for development of *Pinus pinaster* plantations.

Early plantation development in Tasmania commenced on a small scale in 1922 on 'wasteland' nutritionally unsuited to coniferous species, and it was largely unsuccessful.

After Federation in 1901 the Australian states retained sovereign control of their lands and forests. However, the heads of the various state forestry agencies held a number of conferences, the first in Sydney in 1911, in which common issues of national significance were discussed, among them the management and conservation of natural forests as well as the need for coniferous plantations.

In 1914–15, D. E. (later Sir David) Hutchins, an eminent British Empire forester, was highly critical of Australian forest management. Lane Poole was also very critical of the lack of professional forest management in the state forestry agencies, and by 1919 was strongly advocating a role for Federal Government in the development and implementation of a national forest policy, and a Federal research, management and training function.

At the sixth interstate forestry conference in Brisbane, in 1922, the heads of the state forestry services discussed extension of the area of plantations with the objective of national self-sufficiency in timber. The interstate conference in 1925 discussed a mechanism to involve the Federal government in plantation development whereby the states would provide land and management, with the Commonwealth

providing finance, the parties to split the net proceeds, with the states' share being used to repay Commonwealth debt.[8]

In 1925 the Federal Capital Commission began an afforestation programme in the Federal Capital Territory,[9] headed by G. J. Rodger.[10] By 1936 a total of 4,000 ha of conifer plantations, primarily of radiata and ponderosa pines, had been established in the ACT.

Over the whole of this period there was considerable, and at times acrimonious, debate over state versus Federal control and management of Australia's forest resources.

Lane Poole was appointed Commonwealth Forestry Advisor in 1924 and began development of an Australian forestry policy, which included the formation of a Federal Forestry Bureau consisting of five branches dealing with forestry matters in the Commonwealth's territories;[11] management of State-Federal financial affairs; education for professional foresters; forest research; and a forest products laboratory.

In 1925 the Federal Government announced its intention to establish an Australian Forestry School to train professional foresters, and a Commonwealth Forestry Bureau to advise on development and utilisation of Australia's timber resources, both to be situated in Canberra. The AFS was established in Canberra by 1927, but legislation empowering the Forestry Bureau, in the Department of Home Affairs, was not passed until 1930.[12]

The significance of the legislation to the arboretum programme was the mandate it gave to the Bureau to establish experimental stations to study silviculture, forest management and forest protection. In its early years, however, the research effort of the Bureau was severely constrained by a lack of funds.[13] Much of its research was carried out by staff and students of the AFS, and restricted mainly to the ACT.

Prior to this time, although exotic conifer species had been introduced in an attempt to assess their suitability across a range of environments, the approach was piecemeal. The environment of the Federal Capital Territory, with sites ranging from dry grassland to high-altitude wet-sclerophyll forest sites, provided an ideal experimental ground to systematically explore the performance of newly introduced species, as well as exotic species that were already known in Australia, for possible use in south-eastern Australian plantations.

It was against this backdrop that the arboretum programme was begun.

Movers and Shakers

Charles Lane Poole (1885–1970)

As Conservator in Western Australia, Lane Poole was responsible for the establishment of several arboreta, but he resigned as Conservator after strong disagreements with the state's Premier over forest policy (Dargavel 2008). In 1928–29, as Acting Principal AFS at Yarralumla, he dispatched Jacobs to Oxford to study forestry in Western Europe, Lindsay to the USA, and Byles to Oxford to study forestry in the Mediterranean forest region. They returned with seeds, which were probably used in the early arboreta. When Lane Poole retired from the Bureau in February 1945, a total of eight arboreta had been established under his guidance. Several of the seedlots planted in Bendora, Stockyard Creek and 13 Blue Range arboreta between 1940 and 1947 are attributed to Lane Poole and also to his daughter, Miss Charlotte Lane Poole.

Charles Carter (1885–1976)

In 1926, Carter was appointed senior lecturer at the AFS where he variously taught classes in silviculture, forest dendrology/botany, plant pathology, and soil science, using the arboreta as a teaching resource for the students. Several of the early seedlots planted in the arboreta are recorded as 'CEC', for Charles Ernest Carter.

Andy Wood (1900–1988)

In 1937, Wood took charge of the FTB's Outdoor Gang, which established several arboreta under his leadership, and he also became keeper of the arboretum records. He was appointed 'Assistant to the Principal' when Jacobs was appointed AFS principal in 1944. Carron (1985) described him as the school's 'major-domo' for the next twenty years. The Institute of Foresters of Australia elected Wood as an Honorary Member in 1985.

Max Jacobs (1905–1979)

Jacobs was employed as Research Officer with the newly formed CFB from 1934 until 1939, and lectured at the AFS while pioneering the use of radiata pine cuttings as a means of propagation. He established

some small clonal trials and progeny tests of radiata pine which demonstrated clearly the significant effect of genetic variation on the growth and form of the species. As Director-General of the FTB, Jacobs had control of the arboreta. The FTB's annual reports written by him contain accounts of the progress of their development. It is interesting to note how tree-breeding assumes an increasing importance in the Bureau's activities under the stewardship of Jacobs.

Jack Fielding (1910–1995)

After war service, Fielding became Research Officer at the FTB in charge of the arboreta, and held the position until 1968. Fielding appreciated the significance of genetic variation to tree improvement, and was keen to see as wide a provenance range as possible for a genus or species represented in the arboreta, in order to fully assess its performance and to identify superior strains. He significantly expanded the arboreta in the Brindabella Range (Blundells, Reids Pinch, Bendora, Mt Ginini) and established new arboreta at Boboyan, Jervis Bay and Jerilderie, to provide a wider range of test conditions and to accommodate a wider genetic base for a tree improvement programme. In 1954, Fielding and Nicholson presented 'The growth of conifers in forest arboreta in the Australian Capital Territory' (Fielding and Nicholson 1954), the first article describing the performance of various species in the arboreta, at the inaugural Institute of Foresters of Australia's conference in Canberra.

Lindsay Pryor (1915–1998)

As a student, Pryor visited the arboreta with Carter and undertook exercises in species recognition, plot establishment, and selection of sample trees for measurement of height and diameter. Later, while working for Lane Poole, Pryor supervised the axe-felling and burning of the native vegetation at Stockyard Creek, which had been selected as an arboretum site by Lane Poole. The arboreta at Blue Range (8, 9 and 10) were established by Andy Wood at Pryor's direction. Pryor had a keen sense of the purpose of the arboreta as proving grounds for species which might have had potential for south-eastern Australia's plantations, particularly in the event of catastrophic failure of radiata pine.

Tony Franklin (1916–1993)

Franklin led the outdoor field crew from about 1957 until 1981, directed by Eldridge and others. He also managed the FTB's Yarralumla nursery during the final stages of his career. During this period, the outdoor field crew undertook significant maintenance activities in the arboreta, such as thinning, pruning, burning to remove debris, development of recreational facilities, and weed control, as well as labelling the trees in several arboreta.

Alan Brown (1931–)

As a Commonwealth Forestry Scholarship student at Sydney University in 1948–49, Brown participated in the maintenance and measurement of the arboreta at Blundells and Reids Pinch, from a summer camp supervised by Andy Wood. Brown also attended the AFS at Yarralumla in 1950 and 1951, and visited the arboreta on student field trips. In 1955 he joined Fielding's silvicultural research group at the FTB, and he considerably improved the arboretum records by producing maps of each arboretum, accompanied by comprehensive notes of the species and provenance in each plot. Brown's M.Sc. dissertation (Brown 1966) entitled 'Isolating barriers between closed-cone pines' drew on genetic material established in Blundells, Reids Pinch South and Halls Block arboreta.

Ken Eldridge (1934–)

Eldridge's introduction to the arboreta was at Westbourne Woods as an AFS student in 1957. He was head of the FTB's Genetics Subsection from 1969 to 1987 with responsibility for the care and maintenance of the arboreta. By 1974 it was clear that the arboreta had fulfilled their initial purpose of determining species suitability. Five arboreta (Blundells, Reids Pinch South, Bendora, Picadilly Circus and 8 Blue Range) were identified as worthy of thinning to ensure continued health and stability, and an extensive labelling programme was completed for these arboreta. A series of leaflets about each of these arboreta was also prepared for public information. Eldridge had a seminal role in instituting, in 1981, public walks in Westbourne Woods at Yarralumla, which still occur each month, hosted by the Friends of the ACT Arboreta (FACTA).

Tony Fearnside (1934–)

Fearnside and Lea's 1991 report 'Management Proposals for Arboreta in the ACT' rekindled interest in the arboreta, and Fearnside prepared nominations for ACT heritage listing of five arboreta. After the 2003 fires, Fearnside, assisted by Kim Wells, formed the Friends of the ACT Arboreta (FACTA), which continued to be active in the management of the ACT's tree landscape.

John Turnbull (1940–)

Turnbull's primary role at FRI, from 1965 to 1969, was management of the arboreta, supervised by Fielding. The search for species suitable for dry-land afforestation saw Fielding and Turnbull establish an arboretum at Jerilderie in 1968. Many species from the Mediterranean and drier parts of North Africa were planted there under Turnbull's supervision, and he was instrumental in extending the representation of species of *Pseudotsuga* in the arboreta, under Fielding's guidance. Turnbull was also involved in the extension of Blundells, Bendora and Mt Ginini arboreta, the establishment of the 'Hole in the Wall' arboreta at Jervis Bay, and at the Boboyan arboretum, as well as the white pine (*P. strobus*) provenance trial planted in Bendora and Boboyan arboreta.

Tony Rout and John Doran

In 1972–73, Tony Rout and John Doran re-measured about[14] 630 plots. By that time, twenty-five of the thirty-six arboreta were still being maintained, covering an area of about 39 ha, and containing over 770 plots. In addition, 5.3 ha of replicated provenances[15] of species showing promise for south-eastern Australia (*Pinus attenuata*, *P. strobus*, *P. monticola*, *P. pinaster*, *P. halepensis*, *P. brutia* and *Pseudotsuga menziesii*) had been established. The measurement report (Rout and Doran 1974) contains the measurement results, comments describing the general condition of the arboreta, and notes on individual plots.[16]

Arboretum Establishment and Management

The Early Seed Collections

The earliest seeds for the arboreta were probably obtained by Lane Poole through his extensive network of contacts around the world, but the precise provenance of these seedlots, or even their country of origin, is sometimes unknown. Lindsay and Jacobs brought back seed from their sojourns in America and Western Europe in the early 1930s, but again the precise geographical location of the sources was often not recorded. Seed was also often purchased in bulk from seed merchants such as Herbst Brothers in New York, J. Rafn and Sons in Denmark, Vivario et Vezzani in Corsica, and Vilmorin et Cie in Paris, with no record of provenance.

By 1939, however, when Jacobs visited California, the importance of provenance was becoming recognised, and the geographical locations of his 1940 collections of radiata pine seedlots in coastal California were recorded, as were those collected by Fielding from California in 1949.

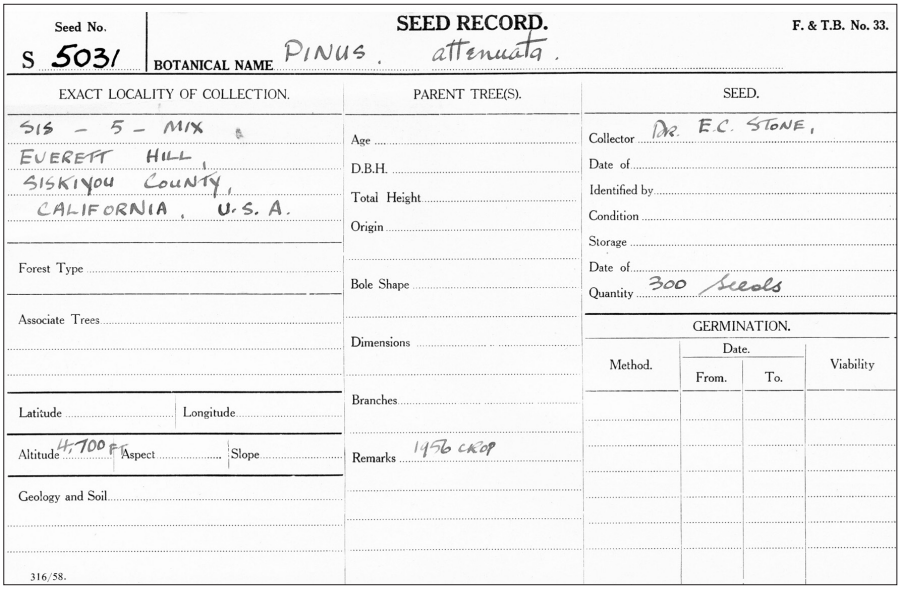
The 'Imperial Preferences' agreement between the British and colonial governments required that first preference for seed purchases be given to British Commonwealth countries. As a consequence, much of the ponderosa seed imported from Canada was of inferior strains compared to that which might have been imported from more southern provenances in the USA.

Seed Source Records

Most seedlots received into the seed store by the CFB and its successors were allocated unique seed numbers. The number was recorded on a 'Seed Card' along with a description of the provenance and characteristics of the seed. A typical seed card is shown in Figure 2.

About 470 unique seedlot numbers were recorded for the 1,128 'plots' planted. About 370 plots have no seedlot recorded. For the remainder, the name of the person who provided the seed (e.g. 'CEC', 'CLP') or the nursery (e.g. 'Y.NURS.')[17] from which the plants were supplied is recorded as the 'seedlot', or there is no record.

The country of seed origin can be determined from notes recorded against each planting on the seed cards for about 70 per cent of the plots. The seed origins of the remaining plots are unknown or they represent crosses or special trials of one sort or another. The plots whose seed



Seed No. S 5031 | SEED RECORD. | F. & T.B. No. 33.

BOTANICAL NAME PINUS. attenuata.

EXACT LOCALITY OF COLLECTION.
SIS - 5 - MIX
EVERETT HILL,
SISKIYOU COUNTY,
CALIFORNIA, U.S.A.

Forest Type

Associate Trees

Latitude | Longitude

Altitude 4,700 FT | Aspect | Slope

Geology and Soil

316/58.

PARENT TREE(S).
Age
D.B.H.
Total Height
Origin
Bole Shape
Dimensions
Branches
Remarks 1956 CROP

SEED.
Collector DR. E.C. STONE,
Date of
Identified by
Condition
Storage
Date of
Quantity 300 Seeds

GERMINATION.

Method.	Date. From.	Date. To.	Viability

Figure 2: Typical Seed Record

origin can be traced represent 39 countries as illustrated in Figure 3. Fifty per cent of the seed originated from just five countries: USA (28 per cent), Australia (9 per cent), Mexico (7 per cent), France (3 per cent) and Denmark (3 per cent). Seed sources in the USA were predominantly from the western seaboard, extending from Washington to Arizona and New Mexico, with few collections from the eastern states.

The Planting Years

Planting at the first arboretum site, Laurel Camp, began in 1928 along with two others in the vicinity, but both those were destroyed by fire. Only six arboreta had been established by 1938. Between 1939 and 1968, however, establishment of a further thirty new arboreta brought the total to thirty-six, including the arboretum at Jerilderie in NSW. The last planting in the ACT arboreta occurred in 1970 at Bendora. Figure 4 illustrates the planting activity from 1928 to 1970.

Genera and Species

A total of 242 species, varieties and crosses in 39 genera were represented in the arboreta. Nearly seventy percent of the plantings were of *Pinus* spp., predominantly *ponderosa*, *radiata*, *attenuata*, *nigra*, *sylvestris*, *contorta*, *patula* and *muricata*.

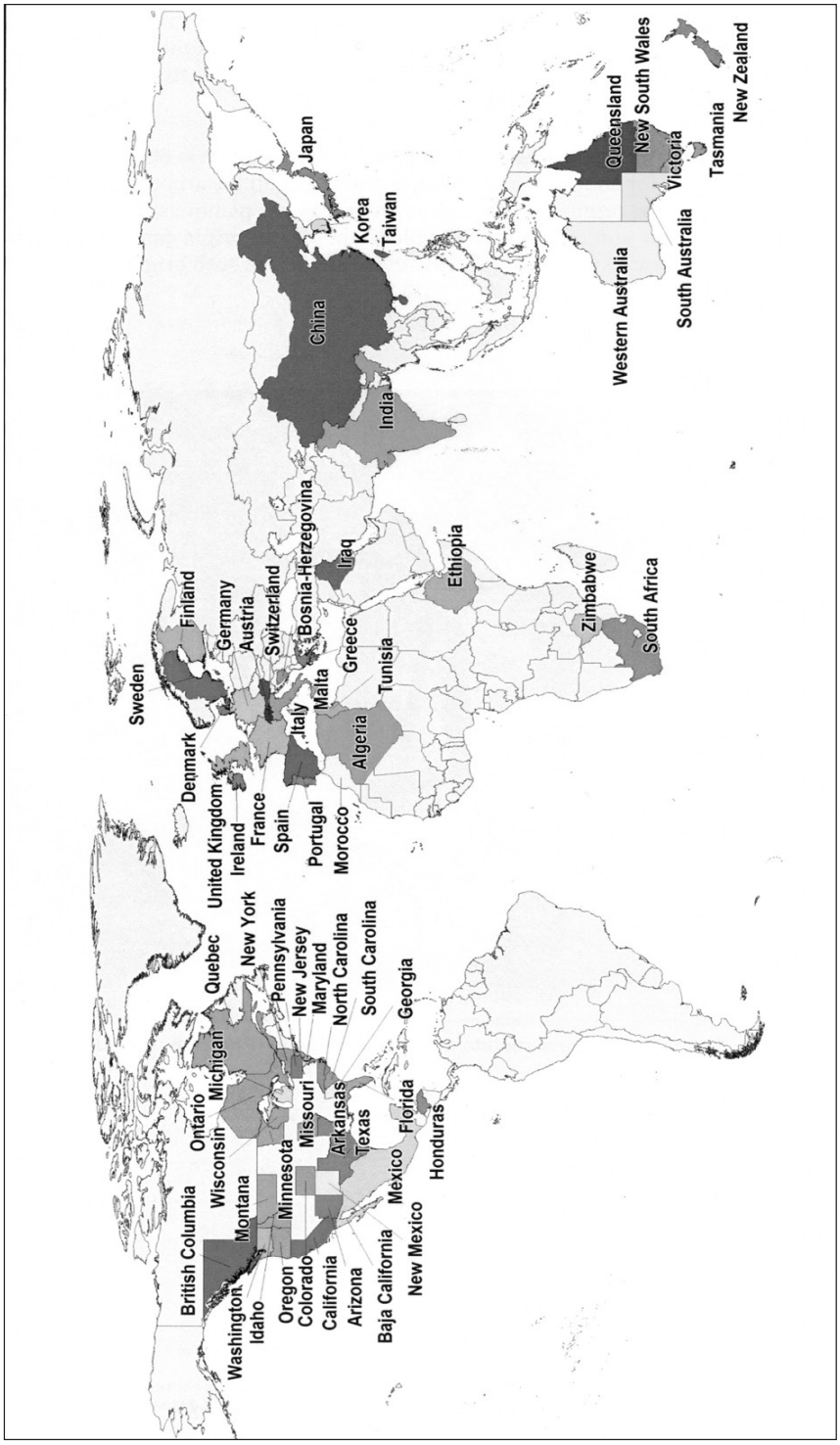


Figure 3: Seed Origins

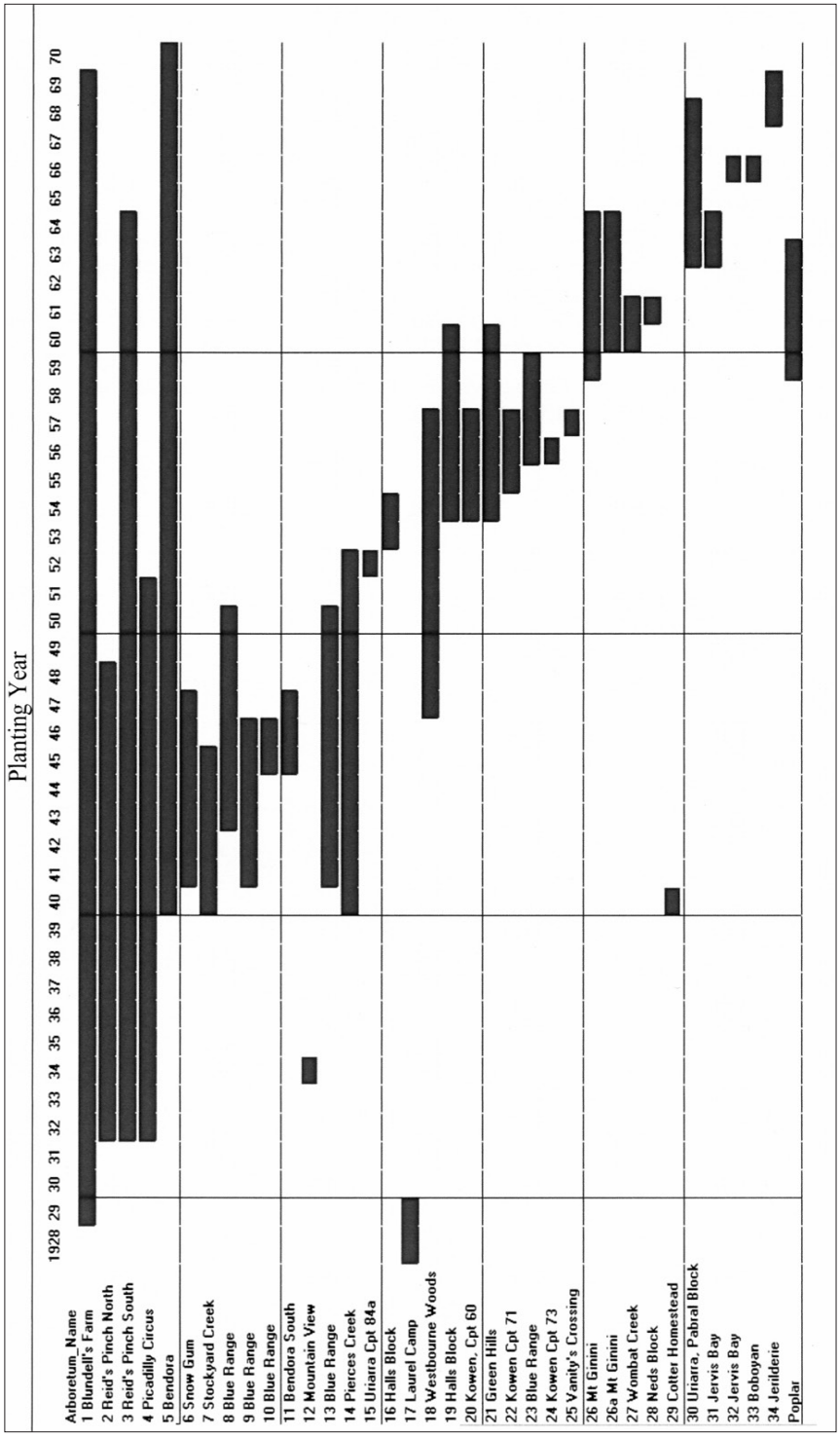


Figure 4: Span of Planting Years

Western yellow pine (*P. ponderosa),* radiata pine (*P. radiata)* and *Pinus attenuata* together made up about 30 per cent of the plantings, but about 45 per cent consisted of a wide range of other species. Despite its promise as an alternative to radiata pine at high altitudes, *Pinus muricata* was represented by only about 3 per cent of plantings, probably because the 'green' strain, which did not perform well, predominated.[18]

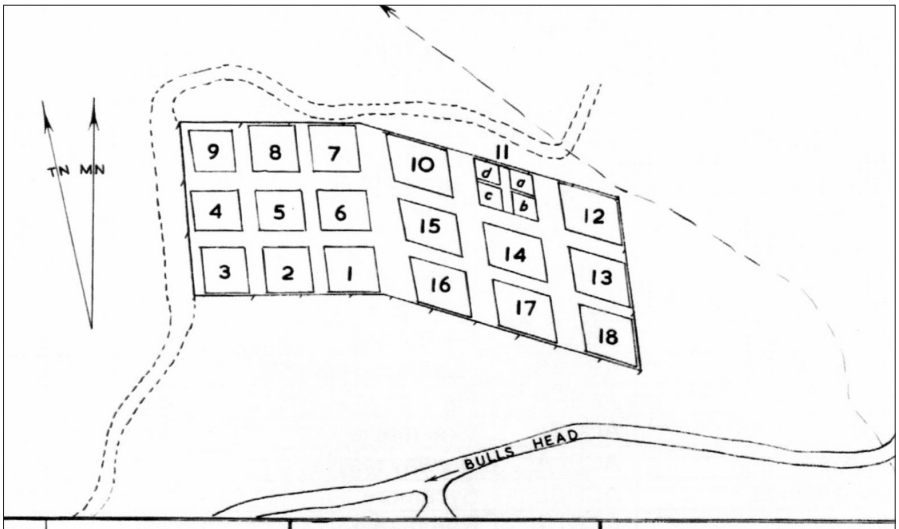
The rate of introductions of new species was relatively modest until about 1940. The initial interest was in *Pinus* species, but the first new introduction of a species outside the *Pinus* genus, *Cedrus atlantica,* occurred in 1932, and of the first hardwood (*Acer circinatum)* in 1933. From about 1939, the number of new *Pinus* species introduced was outstripped by introduction of new species from other softwood genera. The period 1940 to 1950 saw the most rapid increase in the rate of new species introductions, but they occurred at a fairly steady rate right up until planting ceased in 1970.

Establishment, Management and Measurement

Each arboretum typically consisted of a series of square plots each nominally of about 'one square chain' (405 m^2) in area and about 'one half chain' (10 m) apart (Anon. 1957). Triangular, rectangular and line plots were also employed to suit the natural features of the sites and the planting stock available. Sometimes a 'plot' consisted of a single tree. Figure 5 shows the plot layout for Reids Pinch North arboretum. Day-to-day management of the arboreta was carried out by a field crew attached to the FTB, commonly referred to as 'The Outdoor Gang'. It usually consisted of five to eight people (Figure 6).

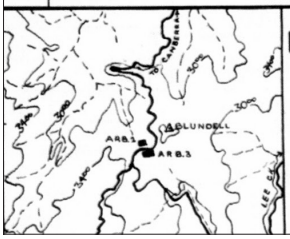
Preparation of the planting sites at the arboreta usually involved felling of the native vegetation and subsequent burning, with hand-planting between the stumps, often in quite stony soil. Post-planting maintenance required 'chipping' around the seedlings to reduce competition for light and moisture from surrounding vegetation. Some plantings suffered quite severely from weed competition, resulting in mortality, and many plots required 're-filling' up to three years after the initial planting. Drought also contributed to seedling mortality, and predation by wallabies, kangaroos, rabbits, and feral pigs often required the arboreta to be fenced.

Pruning treatments were applied in a sporadic fashion, primarily as



PLOT Nº	SPECIES	ORIGINAL PLANTING DATE 19—	SEED Nº	SEED ORIGIN & NOTES	REFILLING DATE 19—	SEED, ETC.
1	Pinus Flexilis	47		S1283, S1481 or S1509 WESTBOURNE WOODS BIDEE		
2	P. patula	38	802	3 PLTS.		
3	P. nigra var. calabrica	48	1636	NO RECORDS		
4	P. ponderosa	32	148	CANYON RA N.S.W.F.C.		
5	P. ponderosa	32	194	WESTBOURNE WOODS		
6	P. ponderosa	32	140	MONTANA, VIA U.S.F.S.		
7	P. radiata	32	—	N.Z. SEED.		
8	P. pinaster	32	38	VILMORIN & CIE, PARIS		
9	P. nigra var. cebennenis	32	65?	BESSEGES & GARNIERES; FRANCE		
10	P. torreyana	48	—	EX YARRA NURS.		
11a	Picea pungens	47	915	H.B.N.Y. 16		
b	Abies pinsapo	47	1252, or 1367, or 1165	BOTANIC GARDENS, HOBART " " " " R. JOHNS, S. AUST. 16	48	2 PLTS.
c	Picea rubens	47	641	H.B.N.Y. 16		
d	Pseudotsuga manziesii	47	9630 12282	BUENA VISTA, VIA COLORADO SEED CO. 16 MILES E. OF PLACERVILLE, U.S.A.		
12	P. ponderosa	47	1017	'Apacheca' SE. Arizona 7000'		
13	P. strobus	47 48	1220 1383	HERBST BROS, N.Y. 31 EXTRA PLANTS. H.B.N.Y. 81		
14	P. muricata	47	1057	H.B.N.Y. 81	48	12 PLTS.
15	P. monticola	47	1382	H.B.N.Y. 81	48	1 PLT.
16	P. contorta v. latifolia	47	862 or 868	ORIGIN UNKNOWN 81	48	1 PLT.
17	P. canariensis	47	1635	TREES IN FRONT OF MT BURR STNB	48	4 PLTS.
18	P. roxburghii	47	1478	DIV. FOR. OFFICE, CHAKRATA, INDIA	48	8 PLTS.

Latitude	35° 20'
Longitude	148°49'
Elevation	3225'
Aspect	N



LOCATION SKETCH
SCALE 1"=1 M
LOCATION REF 840348
BRINDABELLA EAST

ARBORETUM Nº 2 COREE
REIDS PINCH NORTH
SHOWING
LAYOUT OF PLOTS AND INDEX
REVISED 1965
SCALE 1"=2CHAINS
FOREST RESEARCH INSTITUTE
FORESTRY & TIMBER BUREAU
CANBERRA

Figure 5: Typical arboretum plot layout, Reids Pinch North

a fire protection measure, but also to improve access for measurement, and aesthetic appeal. Thinning occurred infrequently until the 1980s when several arboreta were thinned to reduce intra-tree competition, thus improving vigour, and reducing susceptibility to pathogenic attack.

Initially, measurements were carried out annually, but as the number of arboreta increased a three-year measurement interval was adopted, with one third of the arboreta measured each year. Observations of stem straightness, spiral grain, branch size, whorl spacing and branch frequency were made where there was a special interest. Measurements were recorded in various formats, by hand, using pencil and paper, and filed in loose-leaved fashion in Bureau files. No central comprehensive 'database' of measurements was created.

The 2003 Bushfires

In January 2003, widespread bushfires occurred throughout eastern Australia with loss of livestock and property. In the ACT, the fires were particularly devastating. On 8 January, electrical storms ignited five fires in the Brindabella Range, but these remained relatively small, burning about 70 km^2 in the eight days following their ignition. On 18 January, however, fires fanned by wind speeds of about 100 km/h and hot, dry conditions, burned about 1,650 km^2, affecting about 80 per cent of the ACT, with loss of life and destruction of residential property in Canberra. Although the intensity of the fires varied in different locations, all the arboreta in the Brindabella Range, except for Bendora, were destroyed.

Discussion

Selection of species for a plantation development programme in the 21st century is a complex task, requiring the weighing-up of a host of factors, including not just the rate of tree growth, but also factors such as susceptibility to disease, drought tolerance, nutrient requirements, ease of propagation, silvicultural requirements, intrinsic wood properties, market competitiveness of the potential final product range, and log shape and size.

The ACT arboretum programme, commencing as it did in the second decade of the 20th century, could not hope to address all these

Figure 6: The Outdoor Gang
The Forestry and Timber Bureau forest research field crew about 1980. Rear row: Unknown, Julie Harragan, Bill Madden; Front Row: Tony Franklin, Tony Rout, Bruno Monteleone, Sid Wolf, Unknown, Mike Reid, — Franklin, Domenec Pelle
Source: CSIRO

factors, and indeed, selection of radiata pine as the preferred species for large-scale afforestation in south-eastern Australia had already been made prior to commencement of the arboretum programme, although ponderosa pine was still being planted in the ACT until the 1950s. When the ACT's first arboretum was planted by Weston in 1913 there was little knowledge of how the growth and form of other species would compare across a range of sites with that of radiata pine, which by that time was being planted quite widely, especially in Victoria, NSW and South Australia.

The initial reaction of sawmillers to radiata pine was unfavourable. The relative immaturity of the first harvests,[19] and the concomitant high proportion of juvenile wood of low density and stiffness in the logs, caused problems in seasoning and machining, and in its use for structural purposes. It was not a foregone conclusion that radiata pine would retain its favoured status as south-eastern Australia's primary plantation species. North American species such as *Pinus lambertiana, P. monticola, P. strobus, P. ponderosa* and Douglas fir already had a reputation as superb softwood timbers, and were being imported to Australia. There was a real interest in determining how well these species, and others, would grow in south-eastern Australia.

Radiata pine was also known to be susceptible to snow damage and not well suited to higher elevations. Parts of the high-altitude country in southern NSW and north-eastern Victoria were perceived by some, at the time, as being candidates for conversion to exotics. *P. contorta, P. muricata* and *P. sylvestris* were of interest for this purpose, and planting under a eucalyptus canopy was attempted in the high-elevation arboreta at Mt Ginini and Bendora.

Fielding and Nicholson stated in 1954 that the main objectives of the arboretum programme were to identify species suitable for the south-eastern tablelands, provide material for a breeding programme, and identify species which could replace radiata pine in the event of biological catastrophe. There was also an implied objective, not clearly stated, to identify species which might be suited to afforestation on high-altitude sites, replacing native eucalypt forest.

With respect to the first objective, the essential final result of the arboretum programme was to confirm that no other species tested could consistently out-perform radiata pine on south-eastern Australian sites. That conclusion was effectively summed up by Pryor (in Higgins, 1995):

> …the most significant thing is that they've [i.e. the arboreta] given a negative answer absolutely clearly in deciding that many species of conifer are not as good as *Pinus radiata*…There was nothing tried that was a …challenger to *Pinus radiata*.

Eldridge (1998) summarises the major seed collections for Australia of radiata pine from California, noting that seed from the collections of Jacobs in 1940 from Aňo Nuevo, Monterey and Cambria, S. B. Benson in 1954 from Cedros Island, and Fielding in 1949, also from Aňo Nuevo, Monterey and Cambria, were represented in the arboreta at 3 Reids Pinch South, 19 Halls Block and 9 Blue Range.

Fielding, in about 1960 (as reported by Eldridge, 1998), was of the opinion that these plots demonstrated clearly that:

> Australian plantations already had the best provenances, a mixture of Aňo Nuevo and Monterey, with Monterey predominating.

The substantial investment in radiata pine plantations in Australia (about 700,000 ha by 2006 (Parsons, Frakes and Gavran 2007)) and the parallel programme of state and company-funded research on the genetics, breeding, nutrition, epidemiology, silvicultural management,

Figure 7: FACTA members at the Bendora Arboretum hut, 2008. L to R: Janice Fearnside, Alan Brown, Stan Goodhew, Nigel Morley, Helen and Ian Gordon.

and utilisation of the species, has cemented its place as the species of choice.

In the early phase of radiata pine plantation development, *Diplodea,*[20] *Chermes* and incipient *Sirex noctilio* were regarded as the main biological threats. In the event, the most serious pathogens of radiata pine to become established in southern Australia were *Sirex* and *Dothistroma pini.* Although present in Australian radiata pine plantations, *Sirex* and *Dothistroma* do not pose a serious threat.

Indeed, many of the species which were considered as alternatives, such as *Pinus ponderosa, P. attenuata* (and its hybrids), Douglas fir, *P. contorta* and *P. nigra*, have exhibited greater susceptibility to insects and diseases, paralleling New Zealand's experience where, with the exception of Douglas fir, many of the same species were tested, found to be susceptible to pathogens, notably *Dothistroma,* and discarded for large-scale afforestation.

By the 1970s, as noted in the FTB's 1970 annual report, and in Rout and Doran's 1974 report, the scientific life of the arboreta had about ended. The superiority of radiata pine had been confirmed and the FTB's research activity was focused on breeding to improve its

performance, although the Jerilderie arboretum, with its emphasis on dry-land species selection, remained of scientific interest.

In subsequent years, increasing acknowledgement was made of the aesthetic and recreational values of the arboreta. Eldridge, in a 1985 CSIRO file note, summed up the evolving sentiment:

> Sit down in one of the arboreta for half an hour, lean your back on a tree, look around, and see if you agree that it is a place for human enjoyment and spiritual reward.

During the ensuing 25 years, work in the arboreta was mainly confined to removal of species with potential to spread into surrounding native forest, including the felling of Stockyard Creek which was perceived to be of high risk from that perspective, access maintenance, and fire-protection activities in a selected few arboreta. Labelling of species in those arboreta was undertaken as well as the preparation of explanatory leaflets and other material for the general public, which came to increasingly value the arboreta for recreational purposes.

Planning, predominantly by FACTA (Figure 7), to ensure preservation of several arboreta for their historic, aesthetic, recreational and residual scientific values, through heritage listing, was abruptly curtailed by the 2003 fires, which destroyed all but Bendora arboretum. In 2004, however, in acknowledgement of the historic significance of Bendora, a proposal to include it on the ACT's Interim Heritage Places Register was prepared by the ACT Heritage Council (ACT Heritage Council 2004) and a conservation plan for its management was prepared by FACTA.

As the last remaining arboretum in the Brindabella Range, and containing magnificent examples of trees, which were typical of the arboretum program as a whole, it is worthy of preservation as an enduring, living monument to those who devoted much effort and dedication to furthering the very significant role of plantation forestry in the economy and landscape of south-eastern Australia.

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Notes

1 The original CFB has had several reincarnations over the years. In 1946 it became the Forestry and Timber Bureau (FTB) under the leadership of G. J. Rodger within the Department of the Interior, but in 1964 it was transferred to the Department of National Development. In 1963 the research functions of the Bureau were enhanced by the formation of a Forest Research Institute (FRI) within the Bureau, with headquarters at Yarralumla. The FRI subsumed the Bureau's Divisions of Silvicultural Research and Forest Management. In 1972 the Bureau, and FRI (including the management of the arboreta), were moved to the Department of Primary Industry, which was renamed the Department of Agriculture in mid-1973. In 1975 the Forest Research Institute and FTB's harvesting research group were transferred to CSIRO to create a Division of Forest Research.

2 Hereinafter the CFB and its successors are referred to as the Forestry and Timber Bureau (FTB).

3 Inaugural member of South Australia's 1875 forest board and director of Adelaide's Botanic Gardens.

4 http://www.environment.sa.gov.au/botanicgardens/pdfs/abg3_themes.pdf

5 Now *Pinus radiata*.

6 Ednie Brown, the first Conservator of Forests in South Australia, was appointed Director-General of Forests in NSW in 1889.

7 Helms was a Danish forester who had studied under Schlich at Oxford and later lectured at the AFS.

8 That arrangement was not to come to pass until enactment of the *Softwood Forestry Agreements Act* in 1967.

9 Now the Australian Capital Territory.

10 In 1945, Rodger succeeded Lane Poole as head of the Commonwealth Forestry Bureau.

11 Federal Capital Territory, Papua, New Guinea, Norfolk Island, Northern Territory.

12 The legislation also resulted in forest products research, which had until that time been undertaken in a forest products laboratory established by Lane Poole in Perth, being transferred to CSIRO and subsequently being relocated to Melbourne.

13 The Department of Home Affairs seems to have been disinterested in funding the Bureau's mandate until the legislation had been enacted (Carron 1985).

14 The number is approximate because sometimes a single measurement was reported where a single species occurred in multiple subplots.

15 Rout (1976) provides details of provenance tests of introduced conifers conducted from Canberra by CSIRO.

16 These measurements, together with measurements taken by FACTA after the 2003 fires, are available on a CD accompanying the full report (Shirley 2008).

17 CEC = Charles Edward Carter; CLP = Charles Lane Poole; and Y.NURS. = Yarralumla Nursery.

18 Of the 25 plantings of muricata, only 4 had the 'strain' recorded for the seedlot.

19 The first commercial sawmilling of radiata pine in Australia appears to have occurred in South Australia in 1903 when logs from Wirrabara plantation, east of Port Pirie, were sawn to make apple cases (Ajani 2007).

20 *Diplodea pini* is a fungus that infects elongating green shoots and leaders, causing dieback and stem malformation.

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