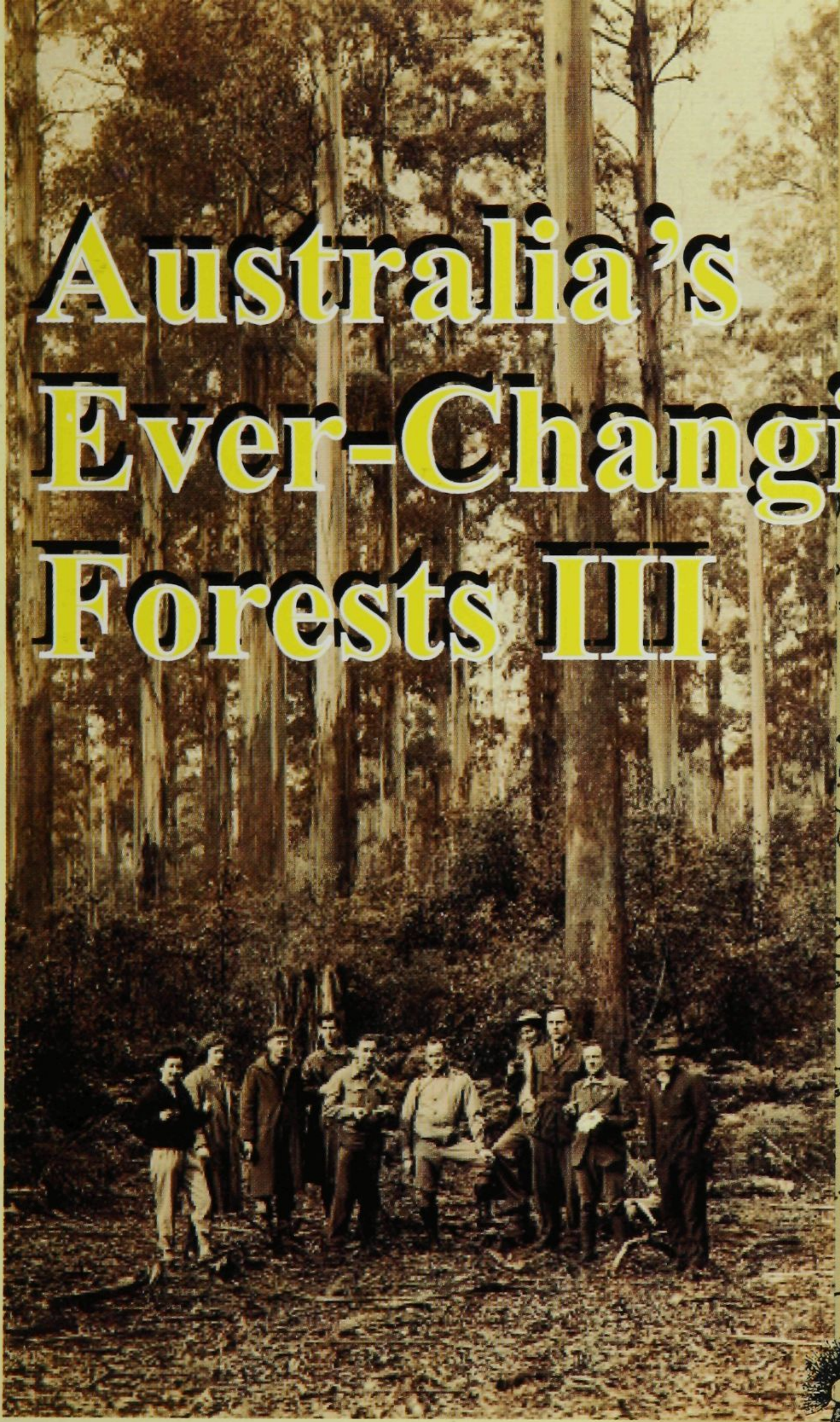
Australia's Ever-Changing Forests III



Proceedings of the Third National Conference on Australian Forest History

Edited by
John Dargavel

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Cover photo shows Melbourne University's Botany Part III class and postgraduate students in a mature mountain ash, *Eucalyptus regnans*, stand at Wallaby Creek, Yan Yean Catchment in the Victorian Central Highlands in 1947. The stand resulted from a fire c.1730 (see Chapter 13). From left to right: Fiona MacLennan, Jean Mathieson, John Fitzpatrick, Norman Endacott, Professor J.S. Turner, Jack Newey, Bob Oldham, John Brookes, Jim Willis, and an unidentified foreman from the Melbourne and Metropolitan Board of Works. *Photo*: late Professor E.J. Hartung.

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Preface

Forest history has grown steadily in Australia since the first two national conferences were held in 1988 and 1992—in Canberra and Creswick respectively—and since their papers were published.[1] The first conference concentrated on papers reviewing major aspects of Australia's forest history, but also contained individual research papers. The second conference concentrated on research papers. Both reported the historical work being undertaken by public agencies. The subsequent growth in forest history occurred as a result of increased individual interest over a wide range of topics and as a result of greatly increased interest and funding by public agencies. The latter was largely due to the comprehensive regional assessments being conducted co-operatively by the Commonwealth and some State governments since 1991. The delineation of 'old-growth' forests became an important part of these assessments following the signing of the *National forest policy statement* in 1992.[2]

The third national conference, *Australia's Ever-Changing Forests III*, which was convened by the Australian Forest History Society at Jervis Bay, 24-27 November 1996, reflected these increasing interests, as can be seen from the papers to the conference which are presented in this volume. The selection of the theme of forest age, to which the first part of the conference was devoted, was stimulated by the attention being given to old-growth forests in the public arena. The very word 'old' commanded the attention of forest historians, as did 'growth' as capturing passing time, while the great but different values attached to such forests called for an examination of how their meanings evolved, all of which raised intriguing and more general questions. What are the various concepts of forest age? What do they mean in different sorts of forest? Is there a difference between the values attributed to forests and those attributed to trees? What values do Australians place on various ages and types of forest? How do they vary between people? How did forest age come to be so important?

A happy coincidence of interest between the Australian Heritage Commission, the Australian National University and the Australian Forest History Society enabled such questions to be explored widely. Six of the papers presented to the conference—Chapters 3,4,6,7,8 and 9 of this volume—formed part of a report prepared by the University for the Commission which has been published under the title of *The coming of age: forest age and heritage values.*[3] We are most grateful to the Commission for allowing versions of these papers to be included in this volume.

The first section of this volume explores concepts of forest age ranging from those expressed in the Greek and Latin classics of the ancient world to scientific measurements of tree age today. The second section examines aspects of forest age in Victoria, Queensland, New South Wales and Western Australia from the colonial period to the present. The question of the values placed on various ages and types of forest is considered in the third section. A variety of individual research papers have been placed in the following sections concerned with 'Using the forests' and 'Transforming the forest ecology'. Papers reporting the work of public agencies have been placed in the final section of the collection, 'Public history and methods'.

The conference was organised by Terry Birtles, John Dargavel and Sue Feary. It was held in the Commonwealth Territory of Jervis Bay with forest excursions to the National Botanic Gardens and to surrounding national parks and state forests in New South Wales. The Australian Forest History Society is most grateful to Mike Patrick of the Australian National Parks and Wildlife Service at Jervis Bay for making the Park Headquarters venue available for the conference, to Fred Howe for enabling the conference to visit the National Botanic Gardens and to Bruce Angus for guiding an excursion to Beecroft Peninsular. The conference and this publication was assisted by The Australian National University through the Urban Research Program in the Research School of Social Sciences, the Department of Forestry and the Centre for Resource and Environmental Studies.

I am most grateful to Sue Feary and Penny Handley for their assistance with editing the papers for publication, to Michael MacLellan Tracey for transforming the illustrations into digital images for publication and for designing the cover, and to McComas Taylor for his ready, cheerful advice.

John Dargavel
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[1] Frawley, K. J. and Semple, N. M. 1989. *Australia's Ever Changing Forests: Proceedings of the First National Conference on Australian Forest History*. Campbell, ACT: Department of Geography and Oceanography, Australian Defence Force Academy.

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Concepts of forest age

Among all the varied productions with
which Nature has adorned the surface of the earth,
none awakens our sympathies, or interests, or imagination,
so powerfully as those venerable trees which have stood the
lapse of ages, silent witnesses of the successive generations of
man, whose destiny they bear so touching a resemblance,
alike in their budding, their prime and their decay.

Jacob George Strutt,
Sylva Britannica,
1826

1

Ancient forests: the idea of forest age in the Greek and Latin classics

J. Donald Hughes

Introduction

I invite you to join me on a search through the surviving writings of the ancient Greeks and Romans, and some of the Jews, for ideas about forest age. In contemporary modern discussions of forest management there are many mentions of 'old-growth forests','ancient forests', and what the US Forest Service calls 'late successional' forests.[1] Are these terms relatively new, or are there classical antecedents for the concepts they attempt to express, if not for the words themselves? At the outset, we must warn ourselves that, as in so many scientific endeavours, the result may be largely negative, and the path we will have to follow somewhat circuitous.

Our attempt, first of all, must be to discover what early writers said on the subject, and to postpone for the most part our critical tendency to ask whether they were right or wrong in their opinions. I would like to investigate just how many ancient forests there were, and where, and what happened to them in history. On another occasion, I hope to do so. But that is not my assignment for today. All scholarly essays must accept certain limitations, and mine is to deal with literary sources as a preface to the wider historical inquiry.

Age a characteristic of trees

The first observation we will make in our search is that in classical literature as in so many other places, it is hard to see the forest for the trees. Comments on the age of trees are much more prevalent than mentions of forest age. But we will begin with these comments, and proceed from the individual to the community.

A quality of trees that struck the minds of ancient writers was their longevity. When a prophet called Isaiah wants to emphasize the permanence of the future occupation of the holy city by the children of Israel, he says, 'Like the days of a tree shall the days of my people be.'[2] The Greeks and Romans were also amazed by how long some trees had lived. Pliny the Elder, first-century collector of natural history lore, notes that a wild olive tree in the marketplace at Megara had grown over the pieces of armor that brave warriors of the past had hung on it, so that the men who cut it down found greaves and helmets inside.[3]

Old trees

Several writers remark upon individual trees of great age. A search for the oldest tree mentioned in ancient literature might begin with the best documented examples and move backwards to trees of legendary antiquity. Theophrastus, the peripatetic student of Aristotle, wants the most dependable evidence he can find, most of the time. He opines that the plane trees which Dionysius the Elder had planted at Rhegium, although much thought of, had not attained great size in his own day. Since Dionysius died in 367 BCE, and Theophrastus wrote within about a decade of 300, those trees were about 70 or 80 years old, hardly record holders.[4]

Pliny, however, gives a list of trees of progressively greater age. An olive and myrtle planted by Scipio Africanus would have been about 260 years old.[5] A lotus tree existed in the sacred grove of Lucina, which was consecrated in 375 BCE, i.e. 445 years before Pliny's time, but the tree itself, he thinks, must be at least 500.[6] Seeking even more venerable examples, Pliny recalls a cypress as old as Rome itself that fell in Nero's day, 815 years after the founding of the city, and a nettle tree of Vulcan, planted by the founder Romulus and still growing in Pliny's day, 15 years after Nero.[7] But an oak[8] flourishing on the Vatican Hill was even older than the city.[9]

A plane tree at Delphi was reputedly planted by Agamemnon. That must have been before the Trojan War, since he was murdered as soon as he returned from it, more than 1200 years before Pliny.[10] Three oaks at Tivoli were as much as a generation older than the Trojan War.[11] Outdoing these examples is another mentioned both by Theophrastus and Pliny: the oaks on the tomb of Ilus, the hero who gave his name to Ilium (Troy), were reputed to have been planted there at the founding of that city, a date lost in antiquity.[12]

One might think that would end it, but the Jewish historian Josephus takes us even further back, recounting the story of the oak under which Abraham sat, called Ogyges. The Greek word *Ogygen* is a synonym for 'primeval,' or 'antediluvian.'[13] Near Hebron, he continues, is a terebinth that has been standing there 'from the Creation of the world until now.'[14] That obviously outdoes them all. The rings in such a tree would have settled the controversy concerning the date of Creation, perhaps, but there is no mention of annual rings in ancient literature. Theophrastus describes the rings but does not correlate them with yearly cycles. Even if the ancients had known about annual rings, however, they lacked increment borers and would have had to cut them down to count them.

Age and sacredness

For Greeks and Romans, age was linked with holiness. The older a tree, the more sacred it was likely to be. Theophrastus' list of famous long-lived trees is composed of trees linked with gods and heroes, including the olive Athena created on the Athenian Acropolis, Zeus' wild olive at Olympia from which the victors' crowns were cut, and the palm of the twins Apollo and Artemis on Delos, which had been grasped by Leto during her labour pangs at their birth.[15] In Rome, the Vestal Virgins hung their severed hair as offerings to the goddess in an ancient nettle tree.[16] Nero's stepfather, Caius Sallustius Passienus Crispus, fell in love with a beech tree that had been sacred to Diana 'from early times,'[17] and was observed not only to lie under it and pour wine on it, but to hug and kiss it as well.[18]

The image of a deity was often of wood, plain or carved[19] taken from a venerable tree sacred to the god or goddess. This was undoubtedly the case with the olive wood statue of Athena that the weavers of Athens provided with an embroidered robe every four years in the Panathenaic Festival. Jason's Argonauts, we are told, found 'a vine that grew in the forest, a tree exceeding old,'[20] so they cut it to be the sacred image of the mountain goddess.[21] It is clear that wood from an old tree was more appropriate than younger wood for this purpose.

Tree nymphs were 'of an age equal to their trees.'[22] Much longer-lived than mortals, they were not immortal, since they were born with their trees and died with them, too.[23] Woodmen had to be wary of lopping dryad-haunted trees with the axe, because nymphs often had friends among the gods who might work terrible vengeance on their killers. Not every tree dies when it is cut down, of course. Shoots can come from the stump, so that the tree grows anew.[24] Pliny knows of an oak ten metres around that had given birth, as it seemed, to a circle of ten daughter trees.[25] But 'is the shoot the same tree or a new one?' Theophrastus ponders.[26]

How does age affect trees?

Questions such as 'How does age affect trees?' and related ones are the subject of two portions of Theophrastus' writings on botany. In his descriptive work, *An Investigation Concerning Plants,* [27] he devotes a moderately long chapter[28] to longevity in trees; and in his physiological study, *Causal Phenomena in Plants,*[29] he provides another chapter[30] relating longevity to the bearing of fruit by trees. His comments on age in trees are, however, not limited to these passages. Pliny repeats a number of Theophrastus' observations and adds others he has collected.

Among Theophrastus' ideas are that older trees bear earlier in the year than younger ones, and mature all of their fruit;[31] however, that non-bearers live longer than bearers.[32] Pliny adds that almond trees and pears have their heaviest crops in old age, and, voicing a principle that may have some application among mature scholars as well, that older vines make better wine.[33] On the other hand, he adds that in all trees the bark becomes more wrinkled in old age.[34] Theophrastus quotes Democritus as saying that crooked trees live longer than straight ones, but adds, 'He is wrong.'[35]

Old trees shed leaves earlier than young ones, says Theophrastus, and leaves change their shape as a tree grows older.[36] Young trees sprout more.[37] The wood of older trees is inferior to that of younger ones as fuel. That of really old trees is especially bad, because it is dry and sputters as it burns; wood for charcoal should contain sap.[38] Pliny maintains that to be most useful for timber, trees should be neither very young nor very old.[39]

About roots there was a difference of opinion; Theophrastus says, 'Young plants root deeper and have longer roots than old ones.'[40] This is strange, because he also holds that older trees draw their food from a distance.[41] Pliny differs, noting that the roots of old trees can be very long.[42]

Firs produce pitch only when they are older, observes Theophrastus.[43] Among his ideas are that older trees hold out against sunscorch, but are liable to get grubby.[44]

A commonplace of many writers links age with size; in Arcadia, Pausanias tells us, he saw 'a grove of plane trees, most of which are hollow through age, and so huge that they actually picnic in the holes, and those who have a mind to do so sleep there as well.'[45]

Rapidity of ageing

So far we have been looking at the idea of age in individual trees. We come somewhat closer to our main subject, age in forests, when we examine our ancient natural historians' comments on longevity generally, and the rapidity of ageing, since these are considered to be characteristics that vary with types of trees. There is agreement that forest trees age very slowly,[46] and Theophrastus quotes woodmen as his authority for saying that wild trees are longer-lived than cultivated.[47] Fruit trees are held to be especially short-lived.[48] Trees growing in water are believed shorter-lived than those on dry land.[49]

Pliny asserts that the following trees 'do not experience decay and age: cypress, cedar, ebony, nettle-tree (lotus), box, yew, juniper, wild olive, cultivated olive; and of the remainder the slowest to age are the larch, oak, cork, chestnut, and walnut.' Palm, maple, and poplar age slowly.[50] Anyone with experience of trees would undoubtedly differ from the placement of some of these species on this list, particularly poplar, along with several others of the opinions quoted above, but our purpose here is to portray ancient opinion, not to correct it.

Human origins in forests

One of the most widely held beliefs about forests of the distant past connected them with the origin of human society. Forests existed even before people,[51] and constituted the supreme gift[52] bestowed by Earth on humankind.[53] Humans first lived in groves and woods.[54] Oaks first produced food for mortals and were the foster-mothers of the earliest folk in their 'destitute and savage state.'[55] In addition, forests were the teachers of humankind as they moved from one stage of culture to the next. Lucretius imagines that acorns dropping from oaks taught humans how to plant seeds,[56] and that the discovery of metallurgy happened when people discovered metals after forest fires had melted them from rocks.[57]

Old groves

One kind of forest often distinguished for its antiquity by ancient writers is the sacred grove, which could vary in size from a few trees to a wood several square miles in extent. These were protected because they were believed to be the residences of gods and spirits, and therefore had grown undisturbed for many years. Some authors believe that the age of trees in a grove was one of the factors that caused people to set it apart from ordinary land in the first place. 'Groves were the primordial temples of the gods,' maintains Pliny, 'By an ancient[58] religious ceremony, simple rural folk even today dedicate an outstanding tree to a deity; and we do not worship images gleaming with gold and ivory more than we do forests,[59] within their own silence.'[60] Seneca remarks, 'If you come upon a grove of old trees that have lifted up their crowns above the common height... you feel that there is a spirit in the place.'[61]

Sometimes an author will establish that a grove is very old by referring to archaeological evidence found within it. Diodorus of Sicily does this several times. He thinks a cypress grove at Cnossus on Crete is old because it contains the foundations of a house of Rhea 'which has been consecrated to her from ancient times.'[62] A forest near Panara with 'trees of every kind' he connects with a sanctuary of Zeus 'admired for its antiquity.'[63] The age of a palm forest in Arabia is shown by the fact that it contains an altar 'very old in years, bearing an inscription in ancient letters of unknown tongue.'

Its longevity may be contagious, since he remarks that the inhabitants are long-lived, too.[64] Animals were also protected in sacred groves and, it was said, achieved great age there: 'At the foot of the Atlas Mountain ... there are marvelous ... forests of the deepest, with the dense foliage of groves all shady and over-arched. And that ... is where elephants are said to resort in old age when heavy with years ... and they are regarded as sacred, under the care of ... the gods of the woods.'[65]

Anthropological evidence is offered by Procopius, who records that the Tzanoi, neighbours of the Armenians, worshipped groves as gods at a time when they lived as hunter-gatherers. Their forests remained impenetrable until Justinian conquered and Christianized them, felling trees to make space for roads, churches and fortresses.[66] More often an author will assert that a grove is very old because it has a mythological origin or association. Pindar refers to 'The most ancient grove[67] of the lords Aiakidai,' which would be at least as old as the Trojan War.[68] Pausanias reports that people say that a huge grove of planes on Mount Pontinus was dedicated by the daughters of Danaus, traditionally dated about 1425 BCE.[69] The grove of Colonus, described at length in Sophocles' play, *Oedipus at Colonus*, has many even earlier associations.[70] There are other instances of such claims of antiquity, too numerous to mention and of course impossible to verify.[71]

In many other cases, various words for 'old' and 'ancient' are used for groves without any specific association or indication of how long they might have been thought to exist. For example, Pausanias reports, 'On the Phliasian citadel is a grove of cypress trees and a sanctuary which from ancient times has been held to be particularly holy.'[72] Again, there are innumerable other examples.[73]

Occasionally one finds the idea that the sanctity of trees in a sacred grove preserves them from the effects of age. Speaking of the Grove of Aphrodite at Knidos, Lucian remarks that though the myrtle trees 'were old in years they were not withered or faded but, still in their youthful prime, swelled with fresh sprays.'[74]

The officials of Greek city-states and Roman municipalities promulgated laws to protect sacred groves and stationed guards to enforce them; inscriptions give ample evidence of this. As a result, the groves often contained old trees of remarkable size. They may not have been completely safe, since trees from groves were sometimes cut to make beams for use in temples. Regulations on the leasing of groves usually included replanting when trees were cut, but such requirements are closer to those governing sustainable yield rather than those intended to keep old-growth intact. Still, preservation was undoubtedly regarded as the rule and use as the exception.

Forest growth and succession

Theophrastus mentions the behavior of trees in association with each other in forests. 'Trees which are close together,' he says, 'grow and increase more in height, and so become unbranched, straight, and erect.'[75] Various tree species are 'good and bad neighbors' to each other, depending mainly on root structure.[76] He also notes that a forest may reestablish itself after a disaster: 'Where forests have been swept away by flood, the same trees grow afterwards.' And also, 'River floods encourage forest growth, as do heavy rains.'[77] These phenomena would of course depend on the forest species; he has failed to observe ecological succession.

Vanished forests

The idea that forests had existed in times gone by, but had been destroyed, is found in several of the classical authors. Lucretius recalls the clearing of forests for agriculture, saying that humans 'made the woods climb higher up the mountains, yielding the lowlands to be tilled and tended.'[78]

Others deduce that there must have been forests in places which were in contemporary times occupied by urban structures. 'There was a laurel grove[79] on the Aventine in Rome,' Pliny remembers.[80] Referring to Cyrene in Libya, Theophrastus says, 'There was a lot of sandarac[81] where now the city stands; roofs in ancient times[82] were made of it.'[83]

Strabo deplores the process of deforestation that he observed in his own day. 'Pisa [had]... timber for ship-building; in ancient times[84]... they utilized [it]... to meet perils... on the sea... but at the present time most of it is being used up on buildings at Rome, and also on the villas, now that people are devising palaces of Persian magnificence,' he laments.[85]

Primeval forests

Finally, there was a feeling of awe before what today might be called 'old-growth,' or 'ancient forests.' Virgil connects their antiquity with the mountain gods, singing of 'Old Father Apennine himself, with his roaring of quivering oaks.'[86] He also extols virgin forests, whose trees are 'unsown by mortal hand,' exclaiming, 'How fair the sight of ... fir trees, mountain born, and beauteous lands that owe no debt or wage to implement of man!'[87]

The age and extent of primeval forests on the edge of the known world genuinely excited admiration. 'If one thinks of the remote regions of the world and their inaccessible forests,' Pliny reflects, 'it is possible to believe that some trees have an immeasurable span of life.'[88] Not limiting himself to this generalization, he gives an example: 'In the northern region [of Germany] is the vast expanse of the Hercynian oak forest, untouched through the ages and coeval with the world, which surpasses all marvels by its nearly immortal destiny.'[89]

Conclusion

In a search through classical Greek and Latin texts, we have found references to age and ageing in individual trees, and in forests as well. The authors who gave the most attention to the subject knew that trees may change in appearance, configuration, and size as they get older. What they did not achieve is the concept of ecological succession; that is, that in ageing, the species composition and structure of a forest may change in characteristic ways. In seeking the roots of modern attitudes to late successional forests among the expressions of ancient minds, therefore, we must confess our failure to find much forest science worthy of the name. But we certainly find psychological antecedents. The admiration of venerable trees, the worship of antique god-filled groves, and the wonderment at endless, undying forests primeval that we find in the poets and philosophers have not disappeared. Expressed in other ways, they are among the motives for preservation of the remaining old-growth and opposition to logging of ancient forests that are still active today.

Notes

[1] United States Department of Agriculture, Forest Service, and US Department of the Interior, Bureau of Land Management. 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl and Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. US Government Printing Office (1994 - 589-111 / 00003 Region No. 10).
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[3] Pliny. Natural History 16.76, 199. Quotations throughout this paper are based on the Latin text and translation by H. Rackham. 1968. Pliny, Natural History. Loeb Classical Library, Cambridge and London: Harvard-Heinemann.
[4] Theophrastus. Enquiry into Plants (HP) 4.5.6. Quotations throughout this paper are based on the Greek text and translation by Arthur Hort. 1916. Theophrastus, Enquiry into Plants. Loeb Classical Library, Cambridge and London: Harvard-Heinemann. Cf. Pliny 12.3, 7.
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[6] Pliny 16.85, 235
[7] Pliny 16.86, 236
[8] Ilex.
[9] Pliny 16.87, 237.
[10] Pliny 16.88, 238.
[11] Pliny 16.87, 237.
[12] Theophrastus HP 4.13.2; Pliny 16.88, 238.
[13] Josephus. Antiquities 1.10.4.
[14] Josephus. Wars 4.9.7, 533
[15] Theophrastus HP 4.13.2.
[16] Pliny 16.85, 235.
[17] Antiqua.
[18] Pliny 16.91, 242.
[19] xoanon.
[20] gerandryon.
[21] daimonos oureiês; Apollonius Rhodius. Argonautica 1.1117-23.
[22] Nonnos Dionysiaca 14.210-212.
[23] Homeric Hymn to Aphrodite 5.260-272.
[24] Theophrastus HP 2.7.2,3.
[25] Pliny 16.91, 242.
[26] Theophrastus HP 4.13.3
[27] Peri Phyton Historias.
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[31] Theophrastus CP 5.9.2.
[32] Theophrastus CP 2.11.1
[33] Pliny 16.51, 117.
[34] Pliny 16.55, 126, cf. Theophrastus HP 3.12.9.
[35] Theophrastus CP 2.11.7-9.
[36] Theophrastus HP 1.9.7; 1.10.1.
[37] Theophrastus CP 1.13.8.
[38] Theophrastus HP 5.9.1.
[39] Pliny 16.74, 192.

[40] Theophrastus HP 1.7.2.
[41] Theophrastus CP 5.9.2.
[42] Pliny 16.56, 130.
[43] Theophrastus HP 9.2.8.
[44] Theophrastus CP 5.9.2-3.
[45] Pausanias. Description of Greece 7.22.1. Quotations throughout this paper are based on the Greek text and translation by W.H.S. Jones. 1918. Pausanias, Description of Greece. Loeb Classical Library, Cambridge and London: Harvard-Heinemann.
[46] Pliny 16.51, 119.
[47] Theophrastus HP 4.13.1.
[48] Theophrastus HP 4.13.2; Pliny 16.90, 241
[49] Theophrastus HP 4.13.1, CP 2.11.1; Pliny 16.90, 241.
[50] Pliny 16.51, 119; 16.78, 212.
[51] Philostratus. Life of Apollonius, 8.18.
[52] Summumque munus.
[53] Pliny 12.1, 1.
[54] Lucretius. On the Nature of Things 5.955.
[55] Inopis ac ferae sortis, Pliny 16.1, 1.
[56] Lucretius 5.1360-62.
[57] Lucretius 5.1242.
[58] Priscoque.
[59] Lucos, groves.
[60] Pliny 12.2, 3.
[61] Seneca. Letters 4.12.3.
[62] Diodorus Siculus. Library 5.66.1.
[63] Diodorus Siculus 5.42.6–43.3, 5.44.5.
[64] Diodorus Siculus 3.42.2-5.
[65] Aelian. On Animals 7.2.
[66] Procopius. Buildings of Justinian 3.6.2.
[67] alsei palaitatô.
[68] Pindar. Nemean Odes 7.44-7.
[69] Pausanias 2.36.8-37.2.
[70] Sophocles. Oedipus at Colonus 11.54-61, 1593-7.
[71] Pausanias 4.1.6; 5.10.1; 8.11; 8.23.6; 8.38.5; 8.41.4; Strabo. Geography 14.1.27. etc.
[72] Pausanias 2.13.3–4.
[73] Pausanias 2.29.8; 3.22.8; Virgil. Aeneid 8.597 ff., etc.
[74] Lucian. Amores 12.
[75] Theophrastus HP 4.1.4.
[76] Theophrastus CP 3.10.3-8.
[77] Theophrastus HP 3.1.2,5,6.
[78] Lucretius 5.1370-71.
[79] Loretum.
[80] Pliny 15.40, 138.
[81] thyon.
[82] archaiôn.
[83] Theophrastus HP 5.3.7.
[84] palaion.
[85] Strabo. Geography5.2.5
[86] Virgil. Aeneid 12.701
[87] Virgil. Georgics 1.21-22; 2.437–42.
[88] Pliny 16.85, 234.
[89] Pliny 16.2, 6.

2

European ideas of the age of forests

Oliver Rackham

Europe is a glaciated continent. Even where it has not been covered with ice, most of it has been converted to tundra, or to steppe in southern Europe, several times over the last two million years. Forests can therefore seldom be more than 12,000 years old. No Holocene forest is exactly equivalent to the primeval forest of previous interglacial periods, because palaeolithic men had already altered the ecological balance.

Trees, of course, are living beings, not environment, and their history is not environmental history. Each species has its own agenda in life, and European trees have different agendas from Australian ones. Many of them are deciduous, shedding their leaves in the winter half of the year. In north Europe most trees are evergreen conifers. In middle latitudes (including England) most are deciduous broadleaves. In the Mediterranean south—in a climate resembling that of south-west Australia—most trees are evergreen broadleaves, but there are also winter-deciduous broadleaves and evergreen conifers.

European trees in general have more or less horizontal leaves, casting a denser shade than do eucalypts; they do not, however, produce chemicals which inhibit the vegetation under them. Adaptations to fire vary widely. Middle Europe, including England, is far less combustible than Australia, and most forests will not burn at all. Although Pyne (1991) claims that the importance of fire in England has been underestimated; nearly all his examples relate to non-forest fires. England has some fire-adapted plants (bracken, heather), but they are not trees, and forest fires are almost unknown. In the north fire is a major factor owing to the abundance of *Pinus sylvestris*, a fire-adapted tree; for example, many of the pinewoods of Scotland are a mosaic of different ages since fire. In the Mediterranean basin, where most of the vegetation, especially pines, is fire-adapted, fires are almost as important as in Australia.

When felled, many European trees sprout, to much the same degree as do most eucalypts (Rackham 1986). Most conifers lack this property. Browsing seems to be more important than in Australia. European trees are palatable to wild herbivores, especially deer, and to domestic livestock; this varies both with the tree and with the animal. Palatable trees in savanna, and often in forest, have their foliage ending at a sharply-defined browse-line at the height to which the particular animal can reach above ground (this is often seen with introduced trees in Australia). Some Mediterranean trees are highly adapted to coexist with browsing, much as Australian trees coexist with fire; these can persist for centuries in a bitten-down state (Rackham & Moody 1996).

Most European trees have better seed-dispersal mechanisms (by wind or birds) than most eucalypts. New forests readily spring up on abandoned farmland, as in North America. This property, too, varies from species to species, and some trees are poorly dispersed. Although a new forest may arise within decades, it may take centuries to acquire all the characteristic species. Most European trees have well-defined annual rings and are thus easy to date.

European cultural history

Europe has long been a continent of settled population and agriculture, extending back in the Mediterranean for half the Holocene. There is no defined date of discovery or settlement (except for islands such as Crete and Iceland), and usually no verifiable distinction between 'Aborigines' and 'settlers'. Some countries, such as England and Ireland, have had dense populations (by modern Australian standards) for at least 3000 years.

Europeans have devoted their landscape to agriculture, gardening, pasturage or woodcutting. They spent thousands of years cutting down trees with stone or metal tools, and digging up trees to create farmland. They have had less opportunity to influence the landscape by altering the fire regime, except in the far north and the Mediterranean basin where trees will burn and are fire-adapted.

In the early Holocene nearly all of Europe, except at high altitudes and in the driest areas, was covered with 'primeval' forest known as wildwood. Most non-forest land is the result of human activity. The present proportion of forest can vary from over half the land area, as in Finland, to less than two per cent, as in Ireland. Why some countries have more forest and others less is not well understood. In general the difference goes back before the earliest written records. The major deforestation of England, Scotland and Ireland took place more than 2000 years ago. The distinction between Italy, where forests were common, and Spain and Greece, where forests were rare, was as clear to Pliny (the ancient Roman naturalist) as it is today (Grove & Rackham 1998). England in 1086 A.D. had more forest than it has today, but less forest (in relation to its area) than France or Germany have now. Most European trees, except for most conifers, survive being cut down and sprout. This is the basis of <u>woodland</u> management by coppicing, which goes back at least 5000 years. Nearly all forests or <u>woodland</u> are 'umpteenth-growth', having been felled many times in their history.

By 1788 the English had long been used to trees and forests as a settled and permanent part of their cultural landscape (Rackham 1990). When describing the very different landscapes of Australia they used existing words but gave them new meanings. Their English meanings are summarised in Table 1. Most of the Australianisms seem to date from early in the colony's history, and are independent of American terminology. In this paper words like <u>woodland</u> are underlined to indicate that they are being used in the English, not Australian, sense.

Besides reducing the area of forest, and promoting woodcutting-adapted species in those forests that remained, human activities created new habitats for trees. Pasturage has greatly extended the area of savanna—cattle and sheep, to some extent, making up for the lack of wild beasts. There are also free-standing trees in hedges, parks, around settlements, and along roads.

The conversion of forest to non-forest is not a one-way process. Farmland, grassland and savanna have reverted to forest on many occasions. Most of the big wooded areas of medieval England contain archaeological evidence of settlement in earlier periods (e.g. Rackham 1989).

Table 1. Terms used in England which are different or unfamiliar to those in Australia

Term used in England	Meaning
Wildwood	Forest before human intervention
forest (small 'F')	Modern (not historic) term for land with continuous trees
Forest (capital 'F')	Historic term for a place of deer (often savanna with few trees or heath with none)
Woodland	Forest (in modern sense) as part of a cultural landscape
Wood-pasture (English) or savanna (American)	Scattered trees among non-forest vegetation
Coppice, copse	Forest which is frequently logged and grows again from sprouts
Scrub	Woodland in a young stage of development
Pollard	A tree (usually non-forest) which has its top repeatedly cut off (as can happen from natural causes or municipal engineers in Australia)
Grove	Small area of forest
Bush	Individual shrub or undershrub (not used for an area of land)
Wood (1)	Area of woodland surrounded by non-forest
Wood (2) (or equivalent in other European languages)	Stems less than 20 cm in diameter
Timber (or equivalent in other European languages)	Stems more than 20 cm in diameter
Maquis (French)	Trees reduced to the stature of shrubs
Phrygana (Greek) or *garrigue* (French)	Vegetation composed of undershrubs (which are not potential trees)

Wildwood and old-growth forest

Europeans know about the wildwood of the early Holocene chiefly from pollen analysis. It may not have been strictly wildwood. Palaeolithic men could have altered it in at least two ways. The elephants and other great tree-breaking beasts of previous interglacials were absent, probably because they had been exterminated. It is possible that the ability to sprout is an adaptation to browsing by great herbivores and not necessarily only an adaptation to fire, for many fireproof trees, such as *Tilia, Ulmus* and *Corylus*, are sprouters. The fire regime would probably have been altered in areas where fire was possible.

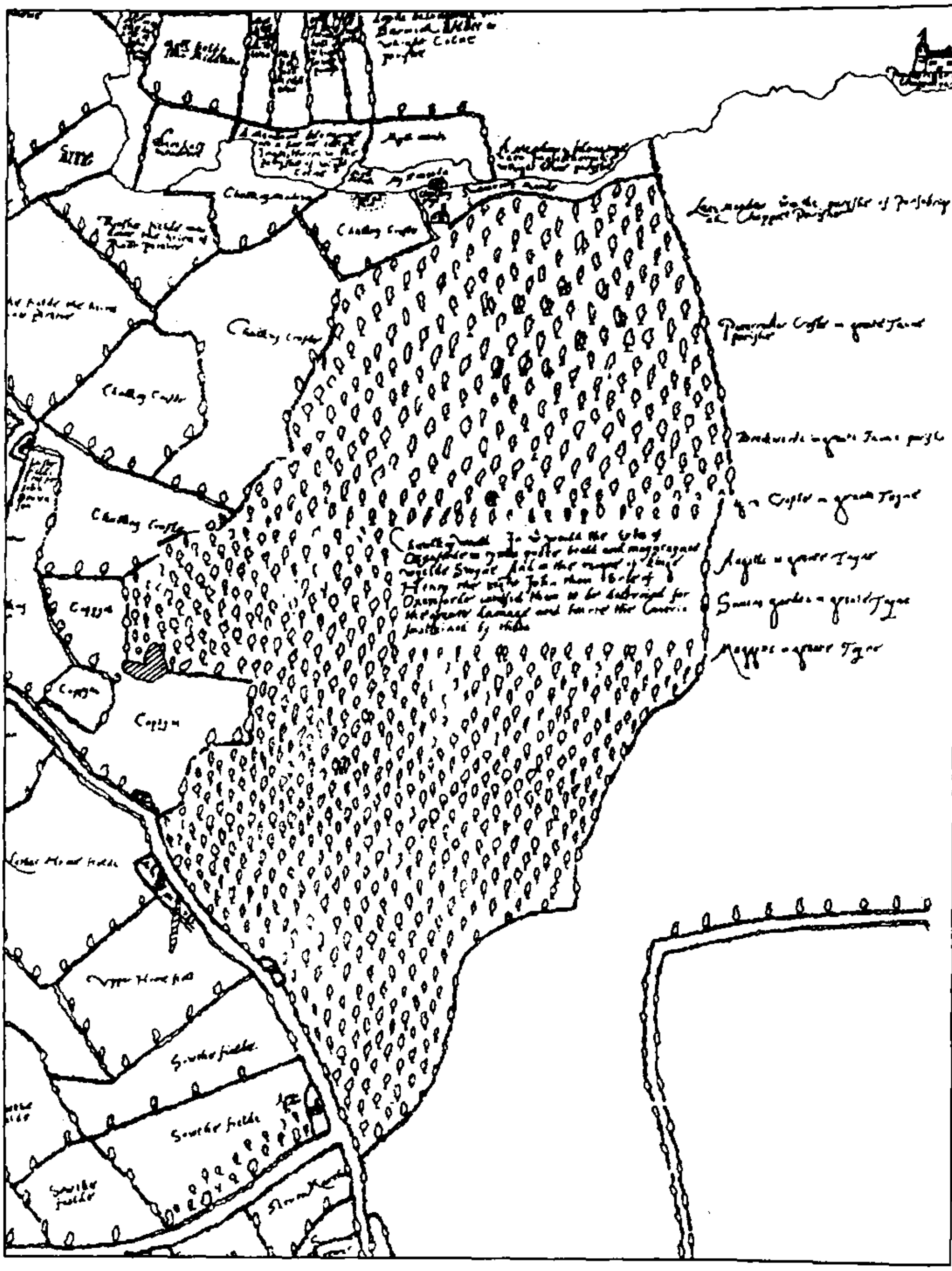

Figure 1A. Chalkney Wood, Earl's Colne, Essex, as mapped by Israel Amyce in 1598. The wood is about 2 kilometres long. A great earthwork runs all round the perimeter. *Source*: Traced from original in Essex Record Office

Figure 1B. Chalkney Wood, Earl's Colne, Essex, as photographed by a pilot of the German Air Force in 1940. Note the mosaic of different areas of regrowth since felling. *Source*:United States National Archives, Group 373, GX 10373F/1054/SK38.

Figure 2. Logging in the Bradfield Woods, west Suffolk. This scene has been repeated on this spot at intervals of about 10 years for at least seven centuries. The picture is of the variant known to academic writers as 'coppice-with-standards', in which the wood-producing trees have been felled but some trees have been left to grow on to timber size. *January 1980*

In a continent where civilisation has been pervasive for 6000 years, wildwood is most unlikely still to exist, and its existence is difficult to prove. Archaeological surveys often reveal signs of early settlement and agriculture even in areas which later were to be great forests. This is particularly true of areas where early civilisations produced monuments which are easily found even in forest, for example, the thousands of Iron Age forts (*nuraghes*) in Sardinia, or in countries such as England where archaeological study has been thorough. Elsewhere the apparent lack of archaeology in present forests may be merely because the dense vegetation hides all but the most conspicuous evidence. Even if people did not live in an area, they could have affected it at a distance by altering the browsing and fire regimes.

'Old-growth' is an American term not much used in Europe. In some European countries there are areas, usually of old trees, which are regarded as 'primæval forest' or 'virgin forest' and thought of as the equivalent of old-growth forest in other continents. Peterken (1996) gives a map of such areas. They are often not in remote or well-protected places, and their designation seldom depends on detailed knowlege of their history. Out of 264 sites, 112 are in Czechoslovakia, and none are in Britain, which suggests that the British have a narrower standard of designation than the Czechs or Slovaks. As Peterken points out, such 'old-growth forests' tend to have been designated by foresters, not ecologists. They are forests that for some reason have escaped the last 200 years or so of modern forestry. Many of them have been altered by activities other than forestry within the last two centuries, and what activities shaped them in the previous 5000 years is anyone's guess. As Peterken puts it, 'in most current usage the term ["virgin forest"] means little more than "old-growth unmanaged for at least several decades"'.

Figure 3. Scene in the Bradfield Woods (Figure 2) one year after felling. Among the regrowth is a dense stand of the herb *Euphorbia amygdaloides,* grown up from seed buried since the previous logging. *May 1987*

Pockets of wildwood, often too small to have attracted attention, may be expected to survive in particularly inaccessible places, even in densely-populated countries. Trees on cliffs and gorges escape browsing and burning, although woodcutting has often extended even here (Rackham & Moody 1996). Trees which are sensitive to browsing but not logging such as *Tilia,* or to burning but not logging such as *Cupressus,* may find refugia in such places.

Woodland in the cultural landscape

Looking for wildwood in Europe is chasing a might-have-been. Forests in reality are part of a cultural landscape, in which trees have come to terms with human behaviour. Europeans are settlers in other continents but Aborigines in their own. There is a history of centuries or millennia of conservation and management, especially in countries such as England where forest was rare.

Hayley Wood near Cambridge is a wood of 50 hectares surrounded by farmland. It is first described in A.D. 1252 in a survey of the Bishop of Ely's estates as *boscus de Heyle,* and its history can be traced in documents down the centuries to its present ownership by Cambridgeshire Wildlife Trust. A survey of 1356 says that it was supposed to be logged every seven years (Rackham 1975). Hayley is an example of Ancient Woodland. There are thousands of woods, typically of 5 to 100 hectares in extent, each with its own name, islanded among farmland, having permanent boundaries, and managed sustainably down the centuries (Figure 1). Although intensively logged (on a sustainable basis), they remain recognisable as natural vegetation; they are not plantations. Their plants and animals have come to terms with a management regime that has been relatively stable and has come to form part of the environment (Figures 2, 3).

Ancient woods are to be distinguished from the recent woodland which has sprung up on former farmland, heath, industrial sites, etc. It may take many centuries for such secondary woods to become assimilated to Ancient Woodland, although the latter often contains evidence of cultivation in the remote past. In England, Ancient Woodland is an official conservation designation, and English Nature has compiled a register of sites. Ancient woods can be identified not only from written records. The boundaries are fixed typically by banks and ditches, which defined the perimeter and made it easier to fence against browsing livestock. Other earthworks may subdivide the interior, marking former divisions of ownership; the labour invested in them demonstrates the importance then attached to woodland conservation. Changes of banks and ditches may mark areas added to or subtracted from the wood. Written records never tell the whole story: Gamlingay Wood, three kilometres from Hayley, is perhaps the best-documented wood in England, yet its archaeology reveals a complex history of which the documents know nothing.

Figure 4. Ancient coppice stool of *Cupressus sempervirens*, Eligias Gorge, Crete. This tree is one of the few conifers that sprout after felling. *July 1989*

The trees in ancient woods were expected to renew themselves by sprouting. This is mentioned several times in the Bible: 'And there shall come forth a rod out of the stock of Jesse, and a Branch shall grow out of his roots' (*Isaiah* **11** 1, 8th century B.C.). It is also alluded to in Roman and less often Greek authors (Rackham 1996).

Over the centuries these trees have developed massive permanent bases, up to five metres in diameter, recalling the ancient lignotubers of mallee eucalypts (Figure 4).

Many plants and animals are characteristic of Ancient Woodland. Some have poor powers of dispersal or establishment on new sites, such as lime, *Tilia cordata.* Others are adapted to the cycle of light shade and dense shade resulting from felling and regrowth, such as *Primula elatior* and *Euphorbia amygdaloides* (Figure 3) (Rackham 1990).

A source of evidence for woodland (and non-forest trees) in past centuries is the timber and wood contained in ancient buildings. These indicate the sizes, environments, and management of trees up to 800 years ago. Excavation of timber and wood in waterlogged sites indicates that woodland management in England goes back at least 5000 years.

Intermediates between forest and non-forest: hedges, savanna, maquis

Trees do not occur only in forests. Europe has trees in hedges, standing in fields, or scattered over the landscape in the form of savanna (roughly equivalent to Australian woodland).

Hedges
Rows of trees or shrubs along boundaries go back at least 2000 years; some individual hedges are more than a thousand years old. Boundaries in Australia seem not to turn into hedges as do those in Europe and North America. This may be because many European and American trees, unlike Australian, are dispersed by birds sitting on fences and excreting the seeds. (Hedges are less infrequent in West Australia.)

Maquis
Maquis consists of trees reduced to the form of shrubs by browsing, burning or woodcutting. Many Mediterranean oaks (*Quercus*) and other trees are adapted to living indefinitely as shrubs when circumstances require: they are roughly equivalent to the mallee species of *Eucalyptus.* Maquis is widespread in the less arid parts of southern Europe. It is often regarded as an artefact, as forest 'degraded' by human activity, but is really a long-standing ecosystem important in its own right.

Savanna
Savanna occurs in many European countries. It is now most widespread in southern Europe (Figure 5): the existence of savanna and maquis, as intermediates between forest and non-forest, makes measurements of forest area untrustworthy. Savanna has been overlooked by ecologists in the belief that it, too, is no more than 'degraded forest' unworthy of serious study. The story, however, is more complex than this. Much historic forest, and even wildwood, appears to have been in the nature of savanna, with non-shade-bearing herbaceous plants. In Europe, as in Australia, many present forests (including even some 'old-growth' forests) have the character of infilled savanna, with an old generation of big spreading trees now embedded in a crowded mass of younger trees.

Savanna was part of the medieval and earlier practice of wood-pasture, combining trees and browsing animals (Moreno 1990). Domestic livestock would eat the regrowth of felled trees and kill the palatable species. To prevent this, either logged areas were fenced to exclude animals until the new shoots were big enough not to be harmed, or it was the practice to pollard the trees, cutting them 2-4 metres above ground level so that the new shoots would be out of reach (Figure 5). Pollarding was used to provide successive crops of wood, or in some countries to yield leaves on which to feed cattle and sheep.

Figure 5. Savanna in the mountains of Fonni, Sardinia. The trees are ancient pollards of deciduous oak. Note the hollow trunks. *April 1992*

Areas of pollard trees usually took the form of savanna. Until the nineteenth century this was widespread in Europe. In the Age of Enlightenment it fell into decline, because of the fashion for disapproving of common-land and other multiple land-uses. Modern European forestry has almost always separated the growing of trees from pasturage, and has been particularly hostile to savanna. Savanna now survives mainly in countries such as England, Spain, Sardinia (Figures 5,6) and Greece, where modern forestry was late in developing and many areas escaped its influence.

Ancient trees

Many European trees are capable of living to several times the age at which they are 'mature' in the foresters' sense. Ancient trees have been venerated since Biblical times as picturesque objects and for their historical associations. Like deer, they play a part in native rites and ceremonies. They have been preserved as venerable features of later designed landscapes. They have names, and artists paint their portraits. If they are pollards (as most of them are) they are evidence of the history and use of the lands around them.

Recently it has been recognised that ancient trees are of unique value as habitats. A single ancient tree has rot-holes, red-rotted heartwood, dead limbs of various sizes, a hollow interior, old dry bark—a series of miniature ecosystems, each with its peculiar animals and plants, for which no amount of middle-aged trees are any use at all (e.g.

Harding & Rose 1986). Some of these habitats are enhanced by a history of pollarding (Figures 5,6).

Figure 6. Wood-pasture savanna, Staverton Park, Suffolk. The site was set up as a deer-farm in the twelfth century, and has kept its ancient trees. The middle tree, called the King's Oak, is probably at least 800 years old. *May 1979*

The occurrence of ancient forests is different from that of ancient trees. Ancient Woodland seldom contains old upstanding trees, but it does have the centuries-old permanent bases of trees that have been repeatedly felled. Old upstanding trees are normally in savanna and non-woodland situations, although infilling may have converted their sites to forest today. They are seldom relicts of former forests; indeed they often grew up as farmland trees, and may stand on archaeological features such as terrace-walls or stone-piles. Most trees live longest in adverse environments where their growth is slowed by infertile soils, pollarding, cold, or drought. They are not usually the biggest of their kind; very large trees are often comparatively young, having grown fast in a favourable environment.

In England wood-pasture was given a new lease of life in the eleventh century A.D. by the addition of deer to conventional livestock. Deer were kept as semi-domestic animals in parks (Figure 6) and Forests. These did not always contain trees, but where they did they were treated as savanna or wood-pasture. This began the characteristic English love of ancient trees, which continues in various forms until this day.

The fate of ancient trees is bound up with that of savanna. They are most numerous in England and Greece, where modern forestry was a late and incomplete development.

Conclusions

As in Australia, the age of a forest, the ages of the trees in it, and its age since last logging are three different things. The age of the forest as an ecosystem—the length of time since the site was something other than forest—may be much older than the oldest tree. Conversely, if the forest has grown out of savanna, it is possible for some of the trees to be older than the forest.

With trees that sprout, the age of the tree may be much older than the last time it was felled or burnt. Coppice stools and pollards, like lignotubers in Australia, may have outlived many cycles of felling or regrowth.

Centuries of woodcutting have produced stable ecosystems, of the greatest value both as cultural artefacts and as habitats for plants and animals. Felling is an integral part of these ecosystems, to the extent that lack of felling becomes a conservation problem. Many English woods for the last 70 years have suffered from too little logging; they are often in an excessively shady state.

This might be thought to give countenance to the theory that logging is beneficial to Australian forests and the creatures that dwell in them. There are, however, three important differences. First, European coppice-woods have come to terms with logging over scores of felling cycles and hundreds of years. Logging is a novelty in Australian forests, which are mostly in their second and third cycles and are unlikely to become fully adapted in the humanly foreseeable future. Second, in Europe, coppicing was preceded by drastic upheavals during the glaciations, which will have eliminated all the wildlife sensitive to disturbance. In Australia the effects of glaciation seem to have been less, so that disturbance-sensitive plants and animals, liable to be eliminated by logging, can be expected to survive to a greater extent than in Europe. Third, the effects of the logging cycle on shade are different. Australian trees tend to cast less shade than European trees in summer, and lack of felling does not normally result in excessive shade. However, the crowded sprout-growth of some eucalypts in the decades after logging produces a degree of shade seldom encountered in natural forests. This artificially dark, dense coppice phase may well be highly detrimental to ecosystems not adapted to it.

The importance of ancient trees in Europe has its parallels in Australia: here too it is important to prevent them from being tidied away in logging operations or 'stand improvement'. It is my impression, however, that there are some differences. In Europe ancient trees are usually protected from fire; in Australia they get burnt from time to time, which may affect their longevity and the habitats contained within them (e.g. rotten wood). Whether some eucalypts, like some oaks, can live for three or four times the average life-span of the species seems not to be known.

Savanna in Europe has declined through destruction by encroachment of farmland or forestry, and by infilling. Both of these have happened in Australia, although new savannas have been created by partial destruction of forest. In Australia as in Europe, there has been concern over decline of savanna trees and lack of replacement. To a European, a regrettable feature of many Australian savannas is the disappearance of the original grassland component. The trees may remain, but the ecosystem has lost its integrity where native grassland has been replaced by European grasses and weeds.

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3

Primeval forests in Australia

Tim Bonyhady

Sometimes they called it 'aboriginal'. Sometimes they called it 'old'. Sometimes they called it 'virgin'. More often than not they called it 'primeval'. That was how colonists generally characterized the forest which had survived European settlement more or less intact—and how Australians continued to characterize it through into the twentieth century. When this forest was felled, it became *A Primeval Clearing* as Arthur Streeton titled one of his paintings executed around 1888 at Gembrook in the Dandenong Ranges which shows a few dead trees in the foreground, a primitive hut in the middleground, then a wall of forest behind. The opening in the forest is manifestly new; a man holding an axe stands at the base of the biggest tree in the foreground; the clearing is only 'primeval' because of what is behind it.

What did colonists make of this forest? Most of them wanted it cleared 'entirely away'. They delighted, as Captain James Wallis's *Historical Account of New South Wales* put it in 1821, in how the 'primeval forest' could be 'changed from a mournful and desolate wilderness, into the cheerful village, the busy town, and the crowded city'.[1] Streeton's *Primeval Clearing* can be read as similarly celebratory. There is nothing to suggest that he was troubled by the destruction of the giant forest of the Dandenongs when he began painting in the 1880s. Rather his concern at the despoilation of Australia's forests developed only in the 1920s when, for example, he attacked the Victorian Forests Commission's plans to 'thin' the Cumberland Valley near Marysville because of how it would destroy the forest canopy, open the valley floor to 'strong sunlight and drying winds' and leave 'countless tons' of 'inflammable rubbish' littered through the 'once primeval forest'.[2]

Yet from at least the 1830s some colonists began looking very differently on Australia's old trees on account of their age. Although their work has long been forgotten – as early as 1920 the New South Wales Government Botanist, J.H. Maiden, claimed that there was only a 'scanty Australian literature' dealing with the rate of growth of eucalypts – some of Australia's leading colonial scientists began trying to determine the age of gum trees.[3] Insofar as they concluded that some species of eucalypts were very fast growing, colonists were delighted because of the 'industrial' implications for the eucalypt as a source of timber. When they concluded that the biggest eucalypts were hundreds, if not thousands, of years old, colonists began to argue that at least small stands of these trees should be protected. At least once, in 1889-90, the Victorian government was forced to abandon its plans to grant a timber concession near the Black Spur north-east of Melbourne partly because of the value colonists attached to this 'irreplaceable' forest.[4]

The age of the patriarchs

In the Old World everyone knew that each ring on a tree trunk indicated a year's growth and, to begin with, Australian colonists assumed that they could apply the same rule. Typical was the Tasmanian Governor Sir William Denison who in 1849 visited a shipbuilding yard at Oyster Cove where he saw two blue gums felled. One of these 'ordinary-sized' trees was 172 feet [52.4m] to its first branch; the other was 135 feet [41.1m]. According to Denison, both of these trees 'were from 270 to 300 years old, judging from the annual rings'. A decade later, when specimens of blue gum were exhibited at the Crystal Palace in London in 1859, the catalogue noted that 'from observations made on the annual rings of growth, it would appear to attain its full magnitude in about 300 years'.[5]

This view was probably orthodoxy among most colonists in 1875 when a Select Committee of the Tasmanian Legislative Assembly examined whether the export of native timber should be regulated so that foreign buyers could be confident of its quality. As if all eucalypts grew at the same rate, John Watson, an experienced timber merchant who had been in Tasmania for 43 years, testified that 'in Gum timber each year's growth has a ring for itself'. Watson declared that 'A gum tree takes three hundred years for its growth'. He had 'counted 280 rings in the timber'.[6]

The same view was maintained by the photographer Nicholas Caire who from the late 1870s through to the early 1900s did more than anyone to record Victoria's giant trees. One reason was their size: Caire took nationalist pride in the fact that the mountain ash were probably the tallest trees in the world eclipsing the sequoias of California. But the age of these trees was at least as important to him because he thought that they were probably the 'oldest inhabitants of the land'.[7] Caire's strongest reason for thinking Victoria's giant trees were of great age came from a mountain ash on the Black Spur north-east of Melbourne which was felled so that a section from it could be sent to the Paris Universal Exhibition of 1878. When a friend of his took 'the trouble of counting the rings from the core to the outer edge of the bark' of the stump of the tree, he found 1,200. Because he applied the standard old world rule of one ring for each year of growth, Caire concluded it was 'at least 1,200 years old' and that the mountain ash reached 1,200, if not 1,500 years, before decay and shrinkage set in.[8] Yet Caire at least occasionally imagined that the mountain ash were even older, influenced most likely by reports that the giant redwoods of the Sierra Nevada were up to 3,000 years old. Because the higher mountain ash were even taller than the biggest sequoias, Caire presumed that the 'patriarchs' of Victoria's 'older forests' must be even older. When an amateur naturalist David Boyle discovered a tree near Sassafras in the Dandenongs which he measured in 1888 at 466 feet (but which on remeasurement proved to be only 220 feet), Caire suggested in 1889 that this 'monster tree' might have withstood 'the shocks of time' for 3,500 years.[9]

The applicability of the European science of tree-dating to the eucalypts was questioned, however, already in 1853 by Governor Denison in a paper submitted to *Hooker's Journal of Botany* in which he provided detailed measurements of several big trees near Hobart including two which had been felled and proved to have 189 rings each. Denison explained that because 'the Gum-trees evidently make two shoots in the year, one in the autumn and another in the spring, the summer being an apparently dead time for them as regards growth', he suspected 'there might be a growth of two rings in the course of one year'. But after considering 'the size of these trees, and the rate of increase shown by dividing the number of rings by the radius in inches', Denison rejected this hypothesis. If the trees put on two rings a year, they would have grown quicker than Denison thought possible.[10]

This issue was taken up again in 1867 by the Reverend William Woolls, an Anglican clergyman-scientist, who concluded that tree rings provided little evidence of the age of Australian trees. One of his reasons was that, while these rings were 'clear enough in some of the younger trees of our forests', they were 'frequently obliterated and confused' in older trees and often did not exist at all because the trees became hollow. Woolls also drew on work done in Madras by Edward Green Balfour who had recognized that, while tree rings allowed for age to be calculated:

> with tolerable correctness in trees of temperate and cold climates, where during the winter there is a marked interruption to growth, and thus a line of demarcation is formed between the circles; ... in trees of warm climates, this mode of calculating age may lead to error.

Because of the irregularity of the seasons in Australia, particularly the occurrence of long droughts, Woolls declared it 'unlikely that calculations formed on the concentric circles of trees would lead to any solution of the problem regarding their longevity, even if other circumstances were favourable for such an investigation'.[11]

How then could the gum trees be dated? Woolls suggested that one possibility was to measure the rate at which different species put on girth and then extrapolate how long it would then take them to reach a given size. So he suggested that if:

> in some of the quickly-growing species, the diameter of the tree should be found to measure a foot [0.3m] in twenty years, then the same tree would require four hundred years to attain a diameter of twenty feet [6.1m] ... Or, again, if in some of the very hard and slowly growing species, 50 years should be required for the diameter of a foot, 300 years would be necessary to produce even the diameter of six feet [1.8m].

When Woolls applied this reasoning to ironbarks, he concluded that a tree just three feet [1.8m] in diameter could be 200 years old as an ironbark planted by Elizabeth Macarthur at Parramatta over 50 years before still had a diameter of only 1 foot [0.3m]. But Woolls also warned that his methodology was only useful while trees were growing. It applied to their youth and prime but not their old age and there was 'great obscurity in making any estimate of the period they may endure after they have passed the time of their perfect development'.[12]

For all this acute observation, Woolls was one of many colonists who could not stop himself assuming that the biggest trees had to be very old. Already in 1859 the catalogue accompanying the Tasmanian exhibits at the Crystal Palace had declared with no apparent justification that there was 'little doubt that trees of the Blue Gum now exist in Tasmanian forests which have witnessed the revolution of more than a thousand years'. Woolls did not go as far. But excited by reports from the Victorian Government Botanist, Ferdinand von Mueller, of giant mountain ash up to 480 feet [146.3m] high on the Black Spur, Woolls declared it 'impossible to believe that any trees could attain the astonishing height of 300 or 400 feet [91.4-146.3m] in less than several centuries'.[13]

Woolls was similarly unscientific a decade later when he delivered a paper on the 'Wonders of Australian Vegetation' to the Horticultural Society of New South Wales. So great was Woolls's enthusiasm for the eucalypts that he forgot his own earlier observations on the growth rates of different species of eucalypt which should have led him not to extrapolate from one species to another. Instead he proceeded to take the ironbarks at Parramatta as the basis for estimating the age of the mountain ash reported by Ferdinand von Mueller. Because he calculated that the ironbarks 'would not exceed a diameter of 6 feet [1.8m] in less than 200 or 300 years', he declared that a mountain ash 480 feet high [146.3m] or over 50 feet in girth [15.2m or 4.8m diameter] 'must be 1000 or 2000 years old'.[14]

Woolls's views about the great age of the eucalypts were implicitly supported by Mueller himself, although the great Victorian botanist was unusually unforthcoming with precise estimates of the age of these trees. Mueller seems to have first addressed this issue in a lecture at Melbourne's Industrial and Technological Museum in 1870s. Having described the 'marvellous' longevity of certain types of tree such as the cedars of Lebanon which he put at 2,500 years, British oaks which he thought reached 2,000 years and the giant redwoods which he believed attained only 1,100 years, Mueller declared: 'Here, in Victoria, the Native Beech and several Eucalyptus are veritable patriarchs of the forests, and of a far more venerable age than is generally supposed.'[15]

When Mueller returned to this issue a year later in another lecture at Melbourne's Industrial Museum, he declared that he had 'endeavoured to arrive at some idea of the real age of the larger trees'. But all he had to say was that 'a period of a quarter or even half a century must elapse before a solid plank, hardened by age', could be 'obtained from even a rapid growing eucalyptus tree'. So far as Victoria's oldest trees were concerned, he simply speculated that they might have 'stood already in youthful elegance, while yet the diprotodon—one of the megafauna which Mueller described as 'a wombat of the size of a buffalo'—was roaming over the forest ridges encircling Port Phillip Bay'.[16]

The Jesuit clergyman-scientist, Julian Tenison-Woods, put a radically different view of the gum tree's age in June 1878 in one of his most influential papers on 'Tasmanian Forests: Their Botany and Economical Value'. Within six months of delivering this paper to the Royal Society of New South Wales, Tenison-Woods was recording with suprise that it had attracted 'general attention' not just in Australia but in Europe and America. In April 1880 a reduced version of his paper dealing with the question of forest age was published in the English journal *Nature*.[17]

Tenison-Woods commenced his discussion by acknowledging that because of the size of Tasmania's eucalypts, one was 'inclined to attribute to them great antiquity'. But he announced that after trying to gather reliable information about the age of Tasmania's forests during almost three years on a 'missionary tour' of the colony, he had found no evidence to support this conclusion. His repeated questions had simply elicited 'mere guesses; from 200 to 300 years was the general reply'. In all he had found only two informants with useful empirical evidence about the rate at which trees put on rings and their observations suggested that Tasmania's eucalypts were of 'very rapid growth' and that even the largest were 'not of great age'.[18]

One of Tenison-Woods's informants was the owner of a big sawmill on the Huon, who felled a blue gum which his brother had planted 18 years before and found that it had 36 rings. His other informant was a farmer who cleared a paddock which had last had a crop on it 16 years before and reported that the biggest saplings had 33 rings.

Hence Tenison-Woods concluded that gum trees put on two rings of growth for each year. Because the sawmiller also seems to have reported that not one of the thousands of trees which had gone through his sawmill had more than 150 rings, while a 'very large proportion of ... serviceable timber' had just 100 rings, Tenison-Woods concluded 'the tallest trees of the forest, the giant timber of Tasmania, range from fifty to seventy five years old'.[19]

Tenison-Woods returned to this issue early in 1879 in one of his many scientific essays for the weekly *Australasian* in which he brought his work before a general audience. Rather than simply popularize what he had already told the Royal Society, Tenison-Woods both refined and generalized his conclusion. Unlike in his earlier paper, Tenison-Woods drew on a recent article in London's *Quarterly Review*, which suggested that lack of climatic extremes meant that tree rings in tropical countries were 'apt to be but faintly marked', while a 'cold snap' during the summer could 'divide the annual layer in two, and therefore be accounted as two years' growth'. Probably encouraged by these findings, Tenison-Woods announced that he was 'meeting with proof every day that two, and even three rings of growth are produced in the eucalypts in certain seasons, and that in times of extreme drought not even one is formed'.[20]

The problem with this new conclusion was that it implicitly cast doubt on Tenison-Woods's own earlier finding that Tasmania's tallest trees were just 75 years old. If trees sometimes formed no rings at all—and perhaps sometimes formed only one ring—there was no basis for dividing the number of rings by two. Moreover, as William Woolls had already recognized and Ferdinand von Mueller similarly noted in 1880 in his *Eucalyptographia*, identification of tree rings was itself not straightforward because 'the less regular intermediate rings between the annual layers of wood apt to be formed in the trees of the zone of evergreen vegetation, are easily mistaken for the results of a year's growth'.[21]

Tenison-Woods's conclusion that the biggest trees were just 75 years old was also too great a generalization as Woolls was quick to point out. In his *Lectures on the Vegetable Kingdom* published in 1879 and then in a paper to the Linnean Society of New South Wales in 1880, Woolls acknowledged that blue gums were particularly fast growing. He even accepted that one tree had 'attained 115 feet [35.0m] in seven years' and that in Tasmania they might assume 'gigantic proportions in less than a century'. But he insisted that such rapid growth did 'not apply to the species generally' and that 'the harder woods in the county of Cumberland' which he had observed for almost 50 years were 'slow in growth, and ...†centuries elapse before they reach their full proportions'.[22]

Nature and mammon

These very different views of the eucalypts' age of Australia's were not just a matter of arcane, scientific debate. They also underpinned very different views of what colonists should do with Australia's primeval forests. Those colonists who, like Tenison-Woods, believed that even the biggest, oldest trees were 75 years old at most, were inclined to see no reason to protect them from timber-getters. Those who, like Woolls, thought them the product of centuries of growth were much more inclined to argue that some of these forests should be preserved because, once they were destroyed, they could not be re-created.

Possibly the first colonist to suggest that Australia's big, old trees should be preserved was another Anglican clergyman-scientist, the Reverend W.B. Clarke, who arrived in Sydney in 1839 when much of the original native flora around the harbour had been cleared. The Austrian traveller Baron von Hugel recorded in 1834 how settlers in Sydney often removed 'every last trees round their homes'. This destruction made other settlers look more favourably on the trees which survived. In his first letter to his mother, written the day after he arrived in Sydney, Clarke observed of the few that remained around the harbour: 'These are old trees and I would not cut them down.'[23]

By 1870 Ferdinand von Mueller was calling for protection of some of Australia's old forests. In his lecture at Melbourne's Industrial Museum, Mueller declared 'Some feelings of veneration and reverence should also be evinced towards the native vegetation, where it displays its rarest and grandest forms'. According to Mueller, it was 'lamentable that in all Australia scarcely a single spot' had 'been secured for preserving some relics of its most ancient trees to convey to posterity an idea of the original features of our primeval forests'. While implicitly attaching most blame to government, Mueller also lambasted individual landholders for their 'vandalism' which he contrasted with the 'respect' for nature shown by the 'uncivilised inhabitants of many a tropical country'.[24]

When Mueller lectured at the Museum again a year later, he returned to this theme, contrasting his own success in 'saving many a venerable tree' under his control at Melbourne's Botanic Gardens with the fate of many old trees throughout the rest of Victoria which were 'sinking daily under our axes, often sacrificed unnecessarily'. Again the age of the eucalypts was a key part of Mueller's preservationist arguments as he asked, 'why should even the life of a plant be expended cruelly and wastefully, especially if, perhaps this very plant stood already in youthful elegance' when the diprotodon existed. Although he did not identify specific areas for protection, Mueller clearly wanted Victoria's 'primeval forests' preserved unless good reasons could be given for their destruction.[25]

John Smith, the foundation professor of chemistry at the University of Sydney, came to the same conclusion in 1871 after visiting the Mariposa Grove of giant sequoias in California which the United States government had protected seven years before. In his account of his travels, Smith recalled how on a visit to the Clarence River in northern New South Wales he had once measured a fig tree which 2 feet [0.6m] from the ground was 180 feet [54.9m] in girth and 6 feet [1.8m] from the ground had a girth of 118 feet [36.0m]. This tree had been felled soon after Smith measured it along with the rest of the Big Scrub along the Clarence. The contrast between what Americans had protected and Australians had destroyed led Smith to observe:

> In California, the Mariposa big-tree grove was made an inalienable reserve for public resort and recreation. Had our Government made a similar reserve of say a square mile on the Clarence, they might have preserved for the enjoyment of future generations some of the most wonderful productions of the vegetable kingdom, now hopelessly lost. It is still possible to secure a specimen of a forest of a very similar character ... in the district of Illawarra. I am not aware, however, that any such forest remains the property of the Government; but ... it is worth serious consideration whether some of it should not be bought back and carefully preserved for the common good. Once these aboriginal forests disappear no art can restore them.[26]

Yet when Australia's colonial governments began to enact laws to limit the cutting of native forests, they always sought to protect new growth by setting minimum size limits and ignored the old. For example, from 1870 regulations in Victoria prohibited the felling of all trees less than 18 inches in diameter but otherwise allowed splitters to fell an unlimited quantity of timber of any size and age in return for an annual licence fee of £5 and a royalty for sawmillers of 1 shilling for every thousand feet cut [$2.4m^3$]. The comparable regulations made in 1885 governing State Forests in New South Wales set different minimum girths for different species. While forest oak, *Casuarina*, had to be 2 feet 3 inches [0.7m], the minimum for red cedar was 9 feet [2.7m].[27]

Australia's first foresters supported this legislation because their overriding concern was to maximize timber production so that State Forests would yield the greatest possible financial return to the Crown. Typical was George Perrin who after working as Conservator for six years in South Australia, where organized forestry began in Australia, became Tasmania's first Conservator of Forests in 1886 and two years later assumed the position in Victoria. Time and again, Perrin emphasized that colonists needed all 'the old timber out'. He had 'no intention of keeping a single matured tree from the saw-miller'. When he first outlined his plans for reforming Victoria's State Forests in 1889, Perrin hoped to induce the sawmiller 'to take away old rejected trees and cut them up, by a reduction of the royalty charges on such trees'. But a year later he was arguing that sawmillers 'should be compelled to clear off every matured tree' from their concessions because 'every year it stands the tree is deteriorating through decay' and 'is simply occupying the ground to the detriment of its successors'.[28]

What did it mean for a tree to be 'mature'? Perhaps influenced by Julian Tenison-Woods's estimate that even the biggest trees were only 75 years old, Perrin generally identified a mature tree as between 30 and 35 years, although in evidence to Victoria's Royal Commission on Gold Mining in 1890, he declared 'the general life of the eucalyptus is from 30 to 35 years. But Perrin then made clear that he was equating 'life' with 'maturity'. According to the Conservator

> ... a eucalyptus planted now, in 30 to 35 years would become fit for the sawmill. If it is not cut down, every month it stands it is either rotting or deteriorating in some other way, and the sooner that tree is cut down the better. So we can arange for a rotation, and keep a large forest at from 30 to 35 years old.

Perrin's goal was to clear forest blocks of all such 'mature' trees and then close these areas 'for a rotation of years, say, 5, 10, 15 or 20, according to the growth of saplings upon the area at the time of abandonment'. his goal was to ensure that 'crops of trees' of uniform age and size were always coming on for the sawmillers.[29]

This approach to forest management finally became the stuff of politics in 1889 when the *Argus* revealed that Perrin had negotiated what he regarded as a model timber agreement – granting the Yea River Company exclusive rights over 5,000 acres [2023ha] of State Forest and 14,000 acres [5666ha] of adjoining land close to the Black Spur for 21 years with a right of renewal for another 21 years. Because the new company not only undertook to spend £100,000 on sawmills and tramways but also agreed to pay 2s 6d for every 1,000 superficial feet [$3.0m^3$] of timber which it felled, Perrin saw this agreement as a first step towards introducing a more general timber royalty. Perrin also believed that if logging were done by a single company it would be easier for his department 'to fix the responsibility of destroying saplings and immature timber'. The result would be both a proper financial return to the State and an end to indiscriminate logging by 'paling men' who left two-thirds of what they felled in the bush, often taking just one length of timber from trees 250 to 300 feet [76.2-91.4m] high. With manifest pride, Perrin informed his Minister that the new agreement marked 'an important epoch in the history of forest management in Victoria ... likely to result in a permanent revenue, conserve the forest and put a stop to the fearful and careless destruction going on everywhere'.[30]

When the Melbourne *Argus* revealed in November 1889 that Perrin had negotiated this agreement, there was 'an immediate explosion in Parliament'. Over the next two days it was debated twice in the Legislative Assembly. It was also the subject of a parliamentary inquiry and then another parliamentary debate in October 1890. In addition the agreement provoked a stream of editorials and articles in the press. As a result, the agreement did not proceed. The forests of the Black Spur were preserved from at least this threat but at the same time, Perrin's attempts to secure a better economic return from the forests were also stymied. When Victoria finally introduced a royalty on timber in the early 1900s, 'after strenuous opposition to change was experienced at every turn', it was the last jurisdiction to do so.[31]

Why was the Yea River Company agreement so controversial? One reason was that it was almost certainly illegal because the Victorian Crown Lands Act prohibited the Crown from granting a lease over a State Forest. But the agreement also offended both sides of politics on deeper philosophical grounds. The radical *Age* attacked the creation of monopolies in Victoria's forests as anti-democratic. The conservative *Argus*, which was the most influential advocate of environmental protection in Victoria in the late nineteenth century, argued that Perrin was wrong to try to turn the colony's forests into a source of profit to the Crown. It declared:

> The state does not wish to make a direct profit out of its timber. It is willing to dispose of trees as it disposes of coal or gold – in such manner as to promote general prosperity. The only reasonable stipulation should be that there must be a sufficient revenue from licenses to enable such a staff of inspectors and rangers to be maintained as is necessary to protect the forests and prevent spoliation ... the imposition of a royalty would not only be unnecessary for purposes of conservation, but would directly tend to increase the price of timber.[32]

The agreement was, however, most controversial on environmental grounds. A minor issue was that the government did not intend to require the Yea River Company to replant what it felled. The major ground of attack was that the mountain ash should not be logged at all. As the *Argus* put it in November 1889,

> The Black Spur forest is one of the beauty spots of the colony. Its magnificent timber, its sassafras and myrtle gullies, are only now beginning to be appreciated. Travellers who come ten thousand miles are charmed with the fairy spectacle which we have too much neglected. It would be nothing short of a crime now to hand over to the destroyer giant eucalypts and natural fern bowers, which could never be replaced.

This type of argument for protection of the forest was largely aesthetic. For example, the leader of the opposition James Munro declared it 'disgraceful to talk of destroying such a beautiful forest' which was 'one of the finest spots on the face of God's earth'. When the Minister for Lands John Dow interrupted and declared that the colony was 'not going to keep a forest for the sake of ornament', Munro responded by asking, 'Were they not? Were they going to destroy that forest ... surely they were not going to destroy every beauty spot in Victoria. Surely they would leave some parts of the colony for ornament'. According to Munro, the Black Spur 'ought to be reserved by Act of Parliament so that no-one should destroy it'.[33]

Not least, the *Argus* published 'A Plea for Beauty' by one of its occasional essayists, Edwin J. Hart, who identified Victoria's mountain forests as 'one of the few things of beauty' which colonists could point to with pride. While Hart acknowledged that it would be possible to turn the Black Spur into 'a perennial source of revenue' by replanting it with trees, he argued that 'deprived of its kings', the Black Spur 'would lose all distinctive feature and descend to a commonplace tree grown waste'. Not least, he questioned the type of civilisation which would engage in such destruction—reminding his readers that even the Goths and Vandals had revered the forest and would never have thought of clearing the Black Spur. As Hart put it, the barbarian had

> regarded the forest with a half affectionate, half superstitious veneration, and held his despoiling hand from its beauties. He deified the power of Nature, and enthroned his deities in the tree, the fountain, and the running stream ... In such woods as clothe the slopes and long ravines of the Black Spur, and plume the steep sides of high-crested Juliet, the barbarian would have seen a living temple, where we, or those who are supposed to represent us, see naught but an unproductive waste.[34]

The state of the forest was also a major issue as government argued that the area to be granted to the Yea River Company had already been worked over and hence was 'not really virgin forest, as had been stated'. To begin with, the Victorian Premier Duncan Gillies declared it 'had really been in the hands of the splitters ever since 1881' – a claim immediately disputed by James Munro who responded that 'only a small portion' had been worked in his way. In 1890 Perrin went further, claiming that 'the bulk of the land' proposed to be granted had 'been culled of its splitting timber over and over again for the past 30 years'.[35]

The age of the forest was even more of an issue as the government and its supporters argued that the mountain ash in the area were less than 40 years old because all the trees in the area had been killed by the bushfires of Black Thursday in 1851 and that, if they were not felled soon, all their timber would be wasted. Most notably, Jonas Levien, the prominent Geelong businessman who represented the seat of Barwon, ridiculed Munro's suggestion that 'the forests should be preserved as if they were something very sacred' when 'if they were locked up they would very quickly go to ruin'. While mountain ash grow rapidly, sometimes reaching 130 feet [39.6m] in 20 years, Levien claimed that they were of 'mushroom growth', reaching 300 feet [91.4m] within 35 years and then decaying just as rapidly. In similar fashion to Perrin, he declared that 'after 45 or 50 years' growth the timber would not improve.'[36]

Could Levien be correct? The *Argus* reckoned that even if the mountain ash grew as fast as he claimed and could be replaced in a generation, 35 years was too long 'for a beauty spot to remain as an object-lesson of greed and carelessness'. Hence it declared that even if mountain ash were as 'wonderfully recuperative' as Levien claimed, the Black Spur should not be subject to unrestricted logging and that any felling there 'should be done not for profit but to assist nature in her process of renewal'.[37] In any event Levien's argument was promptly rejected by several members of the Assembly who ridiculed the idea that a tree could grow 200 feet [60m] in 30 years. The *Argus* similarly declared it 'difficult to believe that the Black Spur giants, 75 feet in circumference [22.9m or 7.3m diameter] and hundreds of feet in height, could have attained their enormous proportions during the life of men ... still young'. Because it was sure that these trees were 'not likely to be replaced either in one generation or two', it argued that 'they should be preserved in common with the whole district'. According to the paper, the Black Spur was Victoria's 'wonderland—a spot to be held semi-sacred, inasmuch as it is nature's temple'. Neither the splitter nor the syndicate was to be considered for it was one place where colonists could not 'serve nature and mammon'.[38]

Notes

[1] James Wallis 1821. *An Historical Account of New South Wales*. London: Ackerman: 1; James Atkinson 1826. *An Account of the State of Agriculture and Grazing in New South Wales*. London: 90.

[2] *Argus*, 3 May 1929, p. 11. Tim Bonyhady 1993. A Different Streeton, *Art Monthly Australia* 61: 8-12. Compare Geoffrey Smith 1995. *Arthur Streeton 1867-1943*. Melbourne: National Gallery of Victoria: 24.

[3] J.H. Maiden 1922. *A Critical Revision of the Genus Eucalyptus*. Sydney: Spence, v.5: 244.

[4] *Argus*, 17 October 1890: 4.

[5] *Industrial Products of Tasmania exhibited at the Crystal Palace* 1859. Hobart: Bent: 10-11; Jospeh Milligan 1860. The Timber of Tasmania - Blue Gum. *The Technologist*, November: 101; William Denison 1870. *Varieties of Vice-Regal Life*. London: Longmans Green, v. 1: 114.

[6] Indigenous Timber: Report of the Select Committee 1875. *Journals of the House of Assembly*, v. 29: 6.

[7] N.J. Caire, Notes on the Giant Trees of Victoria, *Victorian Naturalist*, v. 21, 1904-5, p. 127.

[8] *Australasian*, 8 February 1908, p. 334; Caire, pp. 122-3.

[9] *Argus*, 30 January 1889, p. 8; 22 May 1889, p. 6; 6 June 1889, p. 8. See further Tim Bonyhady, The Giant Killers, *Sydney Morning Herald*, 3 February 1996, Spectrum p. 9.

[10] William Denison, Gum Trees of Van Diemen's Land, *Hooker's Journal of Botany*, v. 5, 1853, pp. 343-4.

[11] Woolls, *A*. 1867. *Contribution to the Flora of Australia*. Sydney: White: 221.

[12] Woolls, *A*. 1867. *Contribution to the Flora of Australia*: 220-2.

[13] *Industrial Products of Tasmania exhibited at the Crystal Palace*. 1859. Hobart: Bent: 10-11; Milligan: 101; William Woolls. *A Contribution to the Flora of Australia*: 220.

[14] William Woolls 1879. *Lectures on the Vegetable Kingdom*. Sydney: Fuller: 92.

[15] Ferdinand von Mueller 1870. *On the Application of Phytology to the Industrial Purposes of Life*. Melbourne: 7-8.

[16] Ferdinand von Mueller 1871. *Forest Culture in its Relation to Industrial Pursuits*. Melbourne: 18, 50.

[17] Julian Tenison-Woods 1878. Tasmanian Forests: Their Botany and Economical Value. *Journal of the Royal Society of New South Wales* 12: 17-28; *Australasian*, 28 December 1878, p. 806; *Nature* 1880. 21: 573-4.

[18] Tenison-Woods: 17, 21-2.

[19] Tenison-Woods: 22.

[20] *Quarterly Review*, v. 142, July 1876, esp. p. 79; *Australasian*, 22 February 1879, p. 230..

[21] Ferdinand von Mueller 1879-84. Eucalyptus Globulus. *Eucalyptographia*. Melbourne: Ferres.

[22] William Woolls. *Lectures on the Vegetable Kingdom*: 116; William Woolls 1880. Species of Eucalyptus of the County of Cumberland: Their Habitat and Uses. *Proceedings of the Linnean Society of New South Wales*. 5: 507-8.

[23] Elena Grainger 1982. *The Remarkable Reverend Clarke*. Melbourne: Oxford University Press: 76; Charles von Hugel (Trans. D. Clark) 1994. *New Holland Journal November 1833-October 1834*, Melbourne University Press: 275.

[24] Mueller. *On the Application of Phytology to the Industrial Purposes of Life:* 10-11.

[25] Mueller. *Forest Culture in its Relation to Industrial Pursuits*: 7, 15, 18, 50.

[26] John Smith 1872. *Wayfaring Notes (Second Series): A Holiday Tour Around the World.* Aberdeen: Brown: 302.

[27] State Forest and Timber Regulations 1885. *New South Wales Government Gazette*. 1: 166.

[28] *Argus*, 26 January 1889: 13, 28 January 1889:. 13; Woods and Forests of Tasmania: Report of the Conservator of Forests 1886-7. *Journals and Printed Papers of the Parliament of Tasmania*. 12: 9; Conservator of Forests for the Year ending 30th June 1890. *Victorian Parliamentary Papers* 4: 17-18; Report of the Royal Commission on Gold Mining. *Victorian Parliamentary Papers*. 5: 641, 643.

[29] Conservator of Forests for the Year ending 30th June 1890. *Victorian Parliamentary Papers* 4: 17-18; Report of the Royal Commission on Gold Mining 1890. *Victorian Parliamentary Papers*. 5: 641, 643.

[30] *Argus*, 21 November 1889, p. 7; 22 November 1889, pp. 6-7; *Age*, 21 November 1889, p. 4; *Victorian Parliamentary Debates*, v. 62, 1889, pp. 2443, 2483; v. 65, 1890, pp. 2114, 2120-1; Report from the Select Committee upon the Yea River Company, *Victorian Parliamentary Papers*, v. 1; Report of the Royal Commission on Gold Mining, *VPP*, 1890, v. 5, p. 643.

[31] *Argus*, 17 October 1890: 4; *VPD* 1889. 62: 2441-4, 2482-6; 1890 . 64: 1654-5, 1719; 1890. 65: 2110-32; Forests Commission of Victoria 1928. *Empire Forestry Conference Australia and New Zealand 1928: Handbook of Forestry in Victoria*. Melbourne: Green, Melbourne: 43-4; Sandra Bardwell 1974. The National Park Movement in Victoria. PhD thesis, Monash University: 324.

[32] *Age*, 21 November 1889: 4; *Argus*, 22 October 1890: 4.

[33] *Age*, 21 November 1889: 4; *VPD* 1889. 62: 2443-4, 2482; 1890. 65: 2113-16.

[34] *Argus*, 7 December 1889: 4.

[35] *VPD* 1889. 62: 2484; 1890. 65: 2121.

[36] *VPD* 1890. 65: 2114. See also *VPD* 1890. 65: 2115-16, 2128.

[37] *Argus*, 17 October 1890: 4.

[38] *VPD* 1890. 65: 2114, 2116-7; *Argus*, 17 October 1890: 4.

4

Tree ages and ageing in yellow box

J.C.G. Banks

Introduction

Yellow box, *Eucalyptus melliodora* (Cunn. ex Schauer), is a one of the most widely distributed of the woodland eucalypts in south-eastern Australia, its principle occurrence in New South Wales on the tablelands and adjacent slopes west of the Great Dividing Range extends into adjacent lands in Victoria and Queensland where it is a common component of the *E. melliodora-E. blakelyi* alliance. These woodlands have been utilised for agriculture from the earliest days of settlement which began in the 1820s when squatters, following in the footsteps of the explorers Blaxland, Lawson and Wentworth, and Evans who had blazed the first access trail over the Blue Mountains in 1813 (McEwan 1979), began to move their flocks westward from the confines of the coastal plain to the tablelands near Bathurst. They soon spread west, south and north to occupy the extensive woodlands that lay before them. In selecting land, graziers were quick to recognise the value of yellow box as a reliable indicator of 'sweet country', the land carrying good native pasture (Lea-Scarlett 1968). Indeed, it was often the best land available consisting of undulating and easily accessible country with permanent water. It was well-treed and often referred to as park-like, providing shade and shelter from the hot summer sun for the expanding flocks of sheep and cattle herds. The soils were fertile although often shallow over-lying heavy clays.

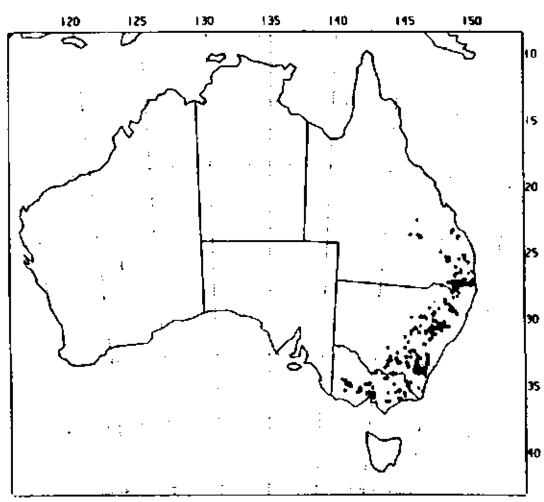

Figure 1. Distribution of yellow box (adapted from Boland and others 1990)

Most of the woodlands carrying yellow box have been utilised for grazing and to a lesser extent cropping for up to 175 years undergoing major ecological changes in the process so that today few stands resemble the original ones. The most profound changes have been the species composition of the native plant communities, the loss of top soil, and the extensive reduction of tree cover through the thinning out, usually by ring-barking, of the original trees to create open woodlands with scattered shade trees, and the loss of all or most trees in croplands. Grazing has suppressed tree seedlings while repeated cultivation has effectively eliminated regeneration. Often the last of the original stands are to be found along road easements and even these are at risk when roads are upgraded, widened and re-aligned. The result, inevitably, has been the fragmentation and 'thinning' of the woodlands with little or no tree regeneration. Tree populations have become smaller and are getting smaller still due to natural attrition as the trees get older, the death of weaker individuals and the absence of regeneration.

In order to rectify these losses, tree planting in rural Australia has taken on a new sense of urgency, particularly since the 'One billion tree' statement by the Commonwealth Government in 1990, and tree planting assistance programs through Greening Australia, Landcare and other organisations. Many of the trees being planted are native species. In New South Wales significant plantings are being made in the yellow box - red gum woodlands. Strategic plantings of yellow box and associated species will in time ameliorate deteriorating ecosystems by reducing salination and soil erosion, preserving and improving native ecosystems, enlarging wildlife habitats, adding to relict stands, preserving native ecosystems, and maintaining and enhancing landscape values. This comes at a critical time as many of the original trees, often left as isolated shade trees in the grazing lands, are slowly dying out, changing the landscapes for ever. This paper seeks to answer two questions: first, how old are yellow box woodlands trees, and second, what is the time frame for new plantings to resemble the mature trees?

Materials and methods

The Australian Capital Territory provided an ideal study site on the Southern Tablelands to answer these questions as it is located in the middle of typical yellow box-red gum woodlands which today are in various states of disturbance and periodic decline after some 170 years of settlement in the region. The sacrifice of woodland trees for new suburban developments in Canberra and Queanbeyan provided the opportunity to obtain bole cross-sections for tree age analyses. Yellow box trees which have been planted in Canberra over a long period provided a source of trees of known ages for non-destructive physiognomic study.

Tree ageing study

Bole cross-sections were salvaged in 1994 from trees being sacrificed in new housing developments in Jerrabomberra and Gungahlin with two samples coming from residential Garran and Theodore. From these trees, five samples with sound centres were sub-sampled to provide radial cross-sections for tree ring analysis and sound centre wood for radiocarbon dating. In addition a bole cross-section was collected from a 29 year old street tree in Garran which blew down in a windstorm in September 1996.

Tree physiognomic study

Four classes of trees representing a size/age series were sampled in spring 1996 to provide tree height, crown width and bole girth (measured at breast height over bark) data. The six youngest trees were saplings from 1990 plantings at the Namadgi National Park headquarters; 30 trees from 1967 plantings were sampled from the street and parkland trees in the suburbs of Garran, Hughes, Lyons and Chifley in the Woden Valley; and 30 trees from the 1932 planting in the median strip along Melbourne Avenue, Forrest were the oldest suitable trees of known age. The fourth category consisted of 31 mature and old-growth trees of unknown ages representative of the local pre-city woodland. These came from Australian National University campus in Acton (3), Uriarra Road (3), Melbourne Ave. in Forrest (2), Woden valley (8), Lanyon Station (5), Namadgi National Park headquarters (4), and Campbell, near the Pistol Club (6).

Results

Tree ages

Tree No. 65 provided a useful check as to the reliability of equating rings to years as its age was known independently, the tree was planted in 1967 as a street tree. A tree ring count on a basal cross-section matched the tree age of 29 years. False rings were sometimes difficult to identify and therefore tree ageing in this species using tree rings would not be precise. Tree ages were then estimated from tree ring counts for six of the mature trees (Table 1). For each tree sample tree rings were identified and counted to provide an estimated tree age. Mature tree ages ranged from 112 to 180 years.

Table 1 Tree ring counts (years) for mature yellow box trees

Tree no.	Cutting date	Locality	Latitude	Longitude	Girth (m)	Number of growth rings
31	10/1994	Theodore	35° 26′	149° 00′	4.50	170
32	10/1994	Garran	35° 20′	149° 08′	3.14	160
55	11/1994	Gungahlin	35° 12′	149° 08′	3.07	143
56	11/1994	Jerrabomberra	35° 27′	149° 11′	3.40	180
59	11/1994	Jerrabomberra	35° 27′	149° 11′	2.95	130
62	11/1994	Jerrabomberra	35° 27′	149° 11′	2.70	112
63	11/1994	Gungahlin	35° 13′	149° 08′	2.80	132
64	9/1996	Garran	35° 20′	149° 08′	1.10	29

Notes: Tree no. 31 - estimate of tree bole age in years; tree nos. 31-63 were sacrifice trees in new suburbs; tree No. 64 was a street tree planted in 1967

Ring widths were measured, but difficulties arose as to where the boundaries lay between some of the rings as they often displayed a sharp break between the early/latewood and a diffuse boundary between the late/earlywood raising the question of where the new seasons spring growth began. Ring widths were estimated and plotted (Figure 2). Ring widths did not appear to relate to seasonal conditions with respect to rainfall. For example, the ring for the drought year 1982/3 ring was one of the widest in the series. This suggested errors in defining the seasonal ring or other factors such as insect defoliation and supplementary garden watering may have influenced growth.

From the results of ring identification in tree no.65, the rings in six mature trees were assessed to provide age estimates and growth rates (Table 1). Ring counts were taken as estimates of tree bole ages since the tree rings were not always clear and distinct in the mature tree samples. These analyses provided ages from 112 to 180 years. These were taken as minimum tree ages as doubtful rings were assumed to be false rings and missing rings were an unknown quantity. For example, tree no.32 was much older than the ring count of 160 as cross-sections were incomplete and the outer 1.5 cm consisted of narrow indistinct rings which were not included in the age estimate. Ring widths were plotted as multiples of 10 rings, thus minimising errors from estimating each ring width (Figure 3). These data showed similar and uninterrupted growth rates in all trees, indicating that these mature trees had fully developed and undamaged crowns at time of sampling.

Table 2. Radiocarbon dates for centre wood from three mature yellow box trees.

Tree no.	ANU lab. code	Conventional age BP (years)	Tree age in 1994 and range	Inner ring date
31	9470	Modern, ie. post 1850	144 ± 30	1820 to 1880
32	9471	310	354 ± 40	1600 to 1680
59	10367	Modern, ie. post 1850	144 ± 30	1820 to 1880

Source: Data from Quaternary Dating Research Centre, ANU, Canberra

As a means of confirming the tree ages obtained from the ring counts, samples from the innermost solid wood from trees nos.31, 32 and 59 were submitted to the Quaternary Dating Research Centre, Australian National University, for radiocarbon dating. The results gave the inner rings of trees nos.31 and 59 a modern age of 1850 ±30 years. The estimates of age of 116-176 years old from this method may be compared to the estimates of 160 and 130 years from ring counts. The radiocarbon age for tree no. 32 of 354 ± 30 years was double the estimated ring count age estimate of 160. This large discrepancy could be explained in part by four narrow zones of decay which would account for a small number of rings. The major part of the discrepancy was accounted for by the numerous and extremely narrow and indistinct rings in the outer 1.5 cm of growth which were not included in the ring count assessment. The result confirmed that radial growth had been minimal over the last 100+ years.

Physiognomy of yellow box trees

Tree height, crown width, and bole girth data were analysed statistically and graphically to assess relationships of these characteristics between trees of known ages and with mature trees from the natural stands. All four tree classes were significantly different from each other for tree girth, height, crown width, crown silhouette (tree height x crown width), bole radius and crown radius, Table 3. The 1967 and 1932 cohorts were, as expected, the most similar. The mature trees were most dissimilar in girth and crown width, reflecting the continued increase in these attributes over time.

Graphically tree height vs bole girth (Figure 4) revealed a curvilinear relationship indicating that tree height reaches a 'ceiling' while the bole continues to expand in girth as the tree ages, although at a diminishing rate. The graph also shows that at least some of the planted trees had attained the mean height of mature trees. These mature trees had a mean height of 19.4 metres (range of 15-25 m) attained when trees had a girth of around 2.0 metres. Seventeen per cent of the 1932 trees and seven per cent of the 1967 trees had achieved a top height by 1996. The tree height data suggested that half mature tree height (10 m) could be achieved by age 20 years and the mean mature tree height (ie. 20 m) by 60-80 years. Early height growth can be quite rapid when trees are given favourable conditions. The heights of many of the 1967 trees overlapped those of the 1932 because most of the 1967 planting were street trees receiving some supplementary water and nutrients from residents gardens while the 1932 trees were from a medium strip planting and had no similar advantage.

Table 3. Mean and standard errors for yellow box trees in the different age/maturity classes. All tree categories were significantly different for all attributes.

Tree attribute Mean and (Standard Error)	Tree category 1990	1967	1932	Mature
Girth (m)	0.30	1.22	1.63	2.86
	(0.06)	(0.05)	(0.05)	(0.12)
Height (m)	4.52	14.58	16.00	19.39
	(0.43)	(0.44)	(0.40)	(0.50)
Crown width (m)	2.60	9.20	11.48	19.78
	(0.39)	(0.45)	(0.34)	(0.65)
Crown silhouette =	12.29	133.88	185.21	384.37
height x width (m^2)	(2.49)	(9.50)	(8.62)	(17.03)
Bole radius squared	0.011	0.150	0.261	0.831
(m^2)	(0.039)	(0.011)	(0.015)	(0.080)
Crown radius squared	0.20	2.23	3.49	10.41
(m^2)	(0.058)	(0.241)	(0.026)	(0.0666)

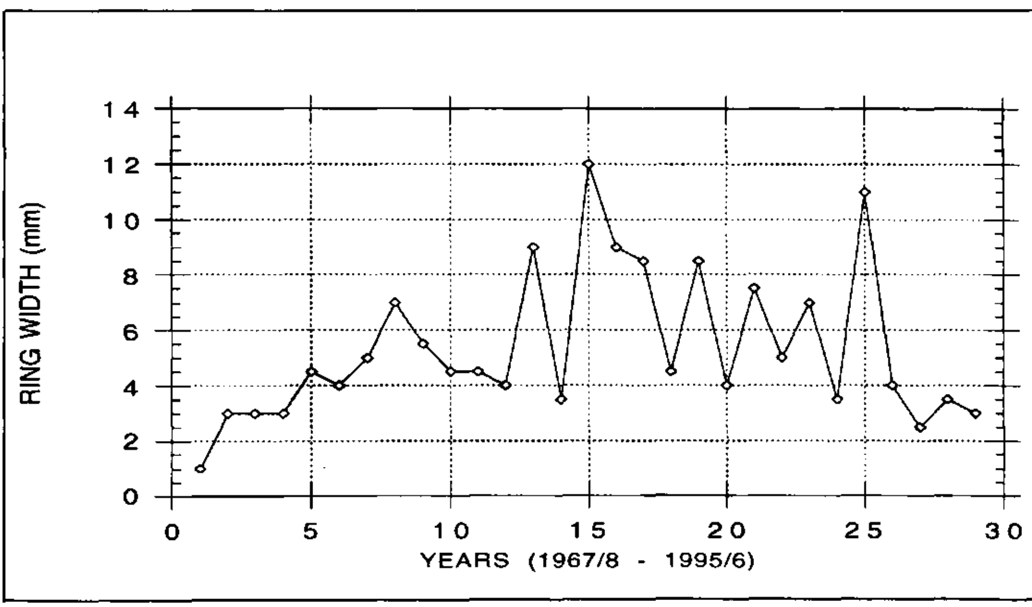

Figure 2. Plot of seasonal tree ring width for a yellow box tree planted in 1967 as a street tree in Garran ACT. The sample was cut from a windfall in September 1996.

Tree height vs crown width (Figure 4) revealed a similar relationship with crown width having the potential to continue to expand over time, doubling its size from around 15 to nearly 30 metres while tree height growth remained essentially stable. Some of the larger 1967 trees had crown widths larger than those of the 1932 trees. However, the mature trees were essentially distinct with wider crowns suggesting they were from a much older cohort of trees.

Tree height x crown width vs girth (Figure 6) showed a good relationship, with considerable overlap between age classes, in the planted trees but not in the mature trees suggesting that crown silhouette was not related to bole size in older trees. A similar pattern emerged with tree crown radius^2 vs bole radius^2 (Figure 5) indicating that cross-sectional area of the tree crown was not linked to basal area of the bole.

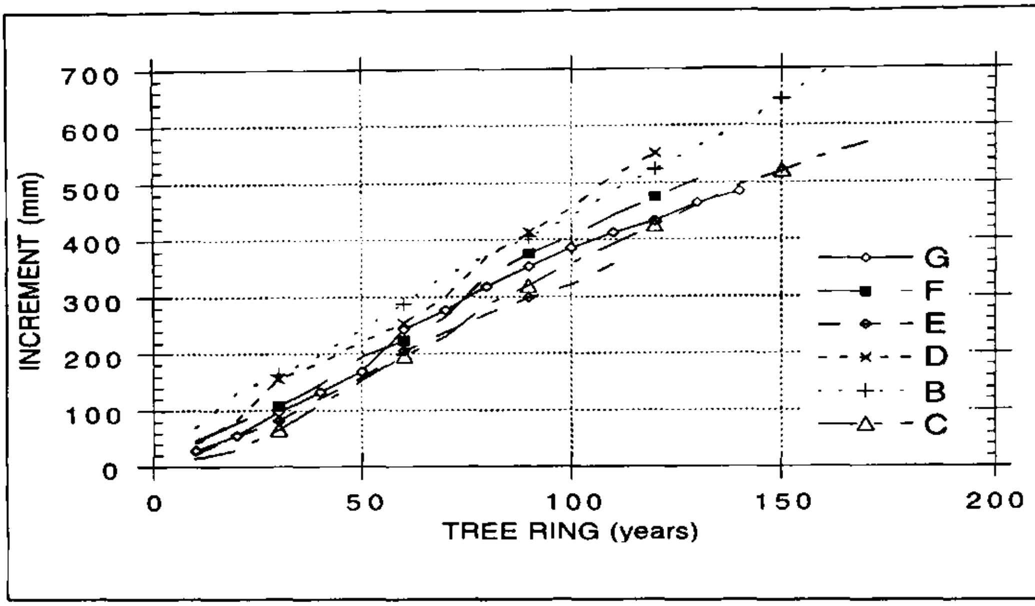

Figure 3. Graph of cumulative 10 tree ring increments in mature yellow box. Outermost increments not included as these were often indistinct.
(B = Tree 31, C = Tree 56, D = Tree 59, E = Tree 62, F = Tree 63, G = Tree 55)

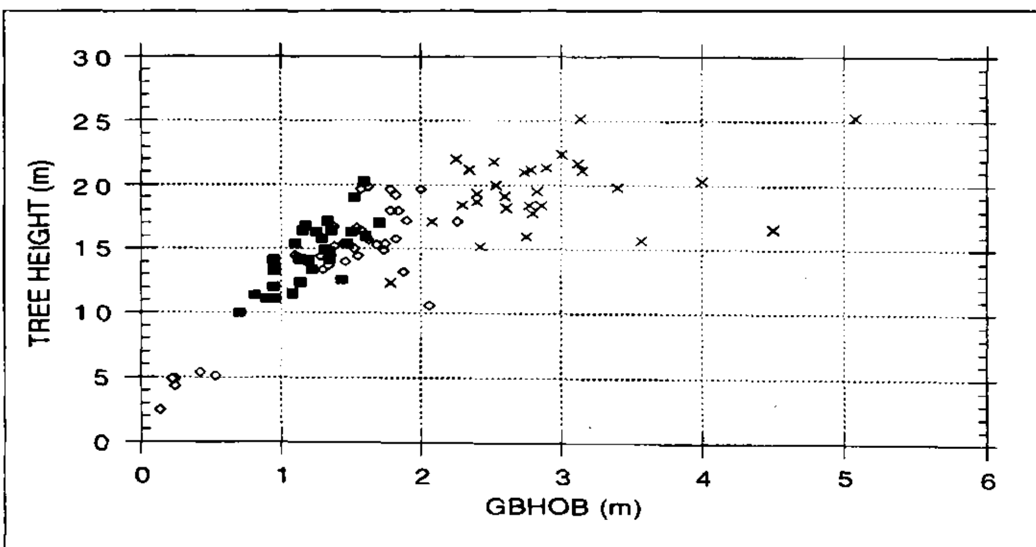

Figure 4. A scatter diagram illustrating the relationship of tree height to bole girth (GBHOB) for yellow box. Symbols represent (left to right) 6, 29, and 64 year old trees, and mature trees of unknown ages.

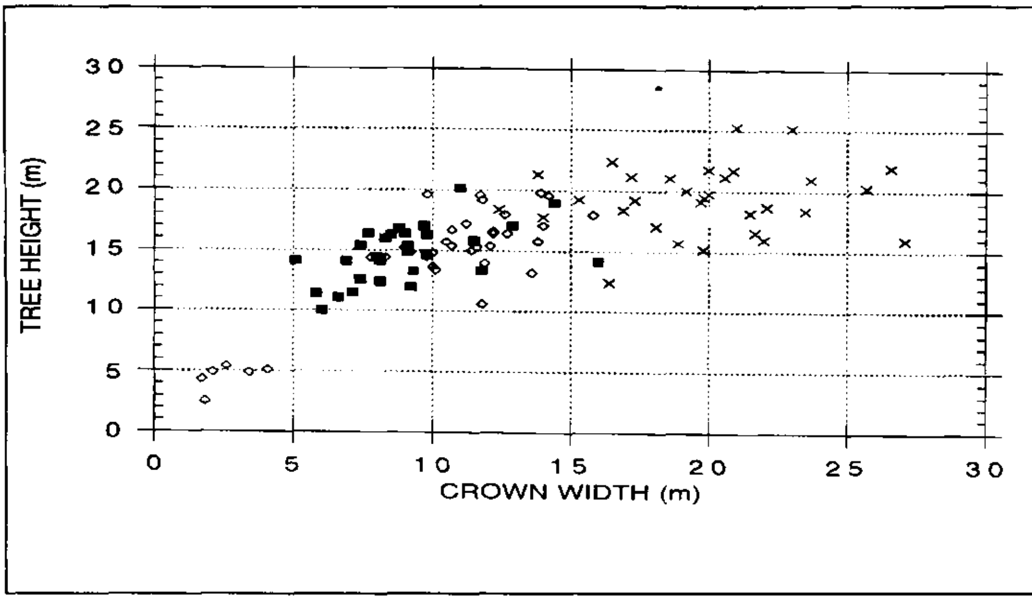

Figure 5. A scatter diagram illustrating the relationship of tree height to crown width (Symbols represent 6, 29, and 64 years old trees, and mature trees of unknown ages).

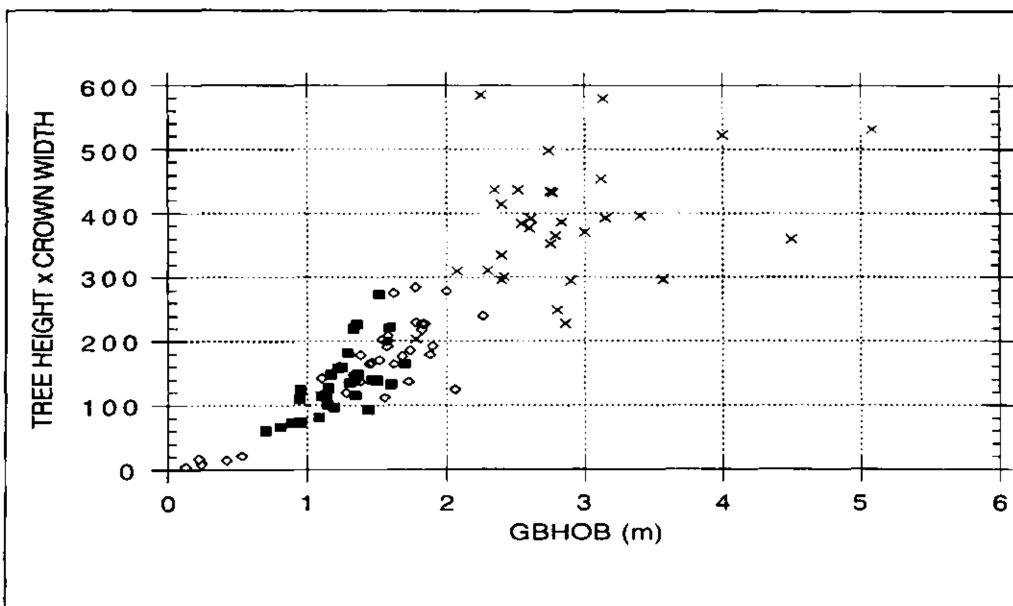

Figure 6. A scatter diagram illustrating the relationship between tree height x crown width vs bole girth (GBHOB). (Symbols represent 6, 29, and 64 years old trees and mature trees of unknown ages)

Discussion

Yellow box is an important component of the woodlands in south-eastern Australia and it is useful to comment on several aspects of ecosystem processes in these woodlands before considering the implications of the results.

The species and its environment

Yellow box is a rather majestic woodland tree, of medium-size to tall 15-30 metres in height and with a bole up to a 1.0 metre in diameter. It typically has a single trunk one third to one half tree height. The crown can be large and spreading and of medium to open density with pendulous branchlets. Its green or glaucous foliage is characteristically fine-textured, and bark persistence, colour and shedding pattern is variable. Indeed, trees in the same stand can appear to be from several different species with crowns varying from green to glaucous and the persistent bark from almost black to light-brown and extending from a short basal stocking to well above crown break. Nevertheless, flower and fruit characters are consistent for the species over its vast geographic range.

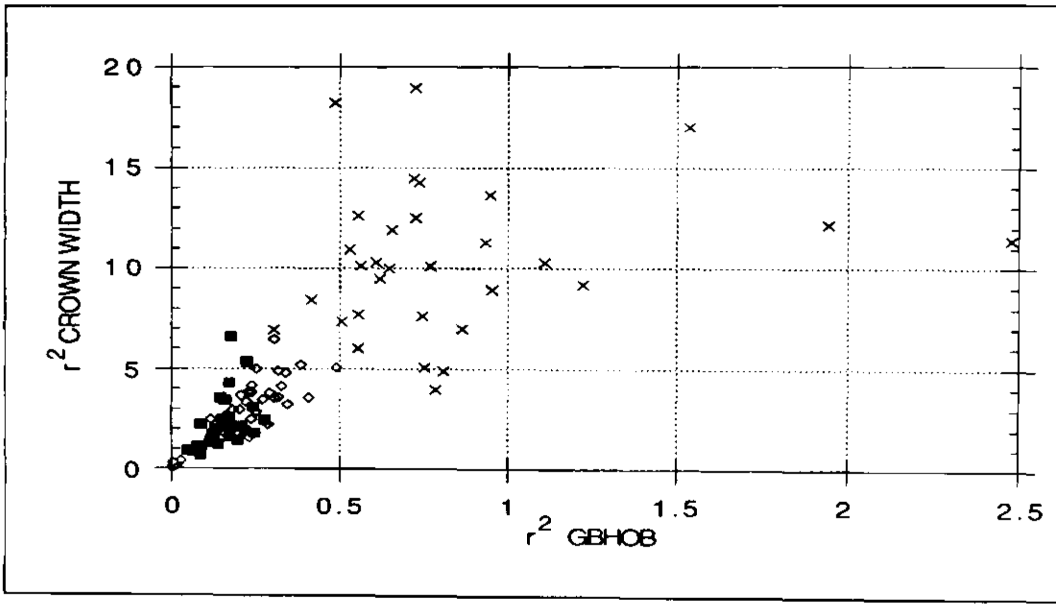

Figure 7. A scatter diagram illustrating the relationship of crown radius^2 vs bole radius^2. (Symbols represent 6, 29, and 64 years old trees, and mature trees of unknown ages)

Yellow box was described in 1843 by the botanist Allan Cunningham who travelled through much of its geographic range on the tablelands and western slopes in New South Wales and adjacent Queensland between 1817-27 (McEwan 1979; Figure 1). It is appropriately named (from the Latin 'melleus' of honey, and 'odora' sweet or pleasant smelling) as it produces copious quantities of fine honey nectar keenly sought by apiarists (Hall and Brooker 1979). Taxonomically, it is rather separate and distinct from other eucalypts and, unlike many species, hybridisation is rare with only one example known from Murrundi in NSW where it occasionally hybridises with *E. albens*. This was originally described as *E. melliodora* var. *murrurundi* (Blakely 1934). Pryor and Johnston (1971) placed *E. melliodora* with *E. leucoxylon* and *E. sideroxylon* in the Series Melliodorae in their classification of the genus, while Hill in the *Flora of New South Wales* (Harden 1991) has retained the species in its entirety emphasising its unity and uniqueness in the genus.

Yellow box occurs over a latitudinal range of 24-38°S and is commonly found over an altitudinal range of 150-600 metres extending to higher altitudes in northern parts of its range. The mean annual rainfall is between 500-900 mm grading from winter to summer maximum from south to north, (Boland 1990). It withstands light frosts only, and treeless frost hollows occur in cooler parts of its range. It is often locally abundant on gentle slopes and foothills occurring on most rock types, except basaltic types. In southern New South Wales it is characteristic of the warmer, sub-humid areas of the tableland and is notably absent from the colder central Monaro, (Costin 1954).

Ecologically yellow box occurs in mixed species stands and is a major component of the *E. melliodora-E. blakelyi* alliance, being present as a dominant species in 7 of the 15 associations recognised by Costin (1954). Many tree species associate with it over its wide geographic range including apple box (*E. bridgesiana*), bundy (*E. goniocalyx*), grey box (*E. pilligaensis*), red box (*E. polyanthemos*), ribbon gum (*E viminalis*), white box (*E. albens*), various red gums including Blakely's red gum (*E. blakelyi*), brown stringybark (*E. baxteri*), red stringybark (*E. macrorhyncha*), and black cypress pine (*Callitris endlicheri*). Floristically the alliance is a rich one. On the southern tablelands of New South Wales it contains a large flora of some 239 species and varieties dominated by Australian and cosmopolitan species. This flora, not unexpectedly, is transitional between that of the adjacent dry sclerophyll forest and grasslands. The mature woodland takes on a parkland appearance. Structurally the upper stratum consists of widely spaced trees with rounded crowns having greater depth than bole length. The ground cover stratum is a continuous herbaceous sward consisting mostly of grasses subdivided into three strata characterised respectively by tall grasses, smaller grasses and forbs, and dwarf forbs (Costin 1954).

The dynamics of the pre-European woodlands

No large intact areas of undisturbed woodland containing yellow box remain today, all have been disturbed to a greater or lesser extent. However, it is possible from field observations to consider the dynamics of the tree strata in terms of tree loss and replacement. The trees, yellow box and its associates, occur in multi-age stands. This can be ascertained from the fact that no one environmental stress—fire, drought, disease outbreak or insect attack—kills the woodland trees over large areas. Rather individual trees decline and die from the effects of a multitude of environmental stresses imposed at intervals over time. Extended drought and windstorms are the most likely 'final factors' to cause the demise of individual trees. Since these woodlands are multi-aged only a few of the extant trees are susceptible to collapse at any one time thus ensuring persistence of the multi-aged structure. Tree losses create 'holes' in the woodland which are 'repaired' by regeneration quickly filling the gaps. This is known as gap phase replacement.

Fire imposes little direct impact on these woodland trees, although it can have several important indirect effects. This is because grass fuel loads ensure that woodland fires are of low intensity and tree crown and bole damage is limited. Yellow box has a thick bark, 2-3 cm on mature trees, which insulates the tree against fire damage and fire scarring seldom occurs. Fire scarring will occur when additional heavy fuel accumulates about the tree butt ensuring a hotter and longer lasting fire. This typically happens in over-mature trees when large branches break off from the crown. Fire scarring is unlikely to lead to tree collapse as the wood readily chars and structural integrity of the bole is maintained. Fire can indirectly affect the overwood by providing ash nutrients which can benefit the tree if there are suitable weather conditions.

Tree establishment occurs periodically in these woodlands, but only when the necessary conditions are achieved and in the right sequence: seed, a sterilised mineral soil seed bed, moisture and freedom from competition. Periodic fire events provide suitable seed bed conditions and over time, seedlings can accumulate in large numbers both beneath the tree crown and beyond. These seedlings fail to develop into saplings in the intact woodland because of the intense competition for resources by the established overstory. As a result they persist as 'low shrubs' being repeatedly droughted, grazed and mechanically damaged. Resprouting from a reservoir of bud tissue in the woody lignotuber ensures the persistence of these seedlings. Over time the accumulated seedlings constitute a significant 'lignotuberous seedling pool' waiting, as it were in the wings, to repair gaps as they appear in the overstory. When a gap occurs the suppression factor, the overstory tree, is no longer active and the established seedlings quickly respond to fill the space. More seedlings than can survive as trees compete for the newly created space, but eventually the best adapted and presumably fastest growing individual will replace the previous tree.

European use of the woodlands

The *E. melliodora-E. blakelyi* alliance contains some of the most valuable native pastures for sheep and cattle on the tablelands and many areas have been settled for over 170 years. The most important anthropogenic practices have been animal and plant introduction, ringbarking and clearing, and changes to the fire regime. These practices have had major impacts on these ecosystems and in particular on yellow box trees. In many areas the biodiversity of the original flora has declined. Over-grazing, the invasion of exotic plants, and soil erosion on a large scale have accelerated this decline. Ringbarking and clearing, combined with the loss of tree seedlings by rabbits and sheep and cattle have reduced the density of trees. Many residual trees are in a mature to over-mature condition and over the years without seedling regeneration the woodland is progressively regressing to a disclimax grassland. This process is accelerated by the harvesting of yellow box for fencing and farm timber, and in recent years increasingly for urban wood fires.

Today, many trees display gradual crown decline which is believed to be due to senescence of the root systems, (Middleton 1978). This rural dieback is often prominent where the original tree cover has been reduced, creating a more hostile environment to the remnant vegetation largely due to increased exposure resulting in physical damage, salination and increased application of fertilisers (Peck 1978; Greig and Devonshire 1981). Also the loss of crucial top soil has reduced the buffer against environmental stresses. Thus trees are dying prematurely as a result of increased stresses, new stresses and a greater frequency of environmental stresses.

The persistence and longevity of yellow box

A tree is an ideal form of life to attain great age. Its living tissues are repeatedly regenerated at short intervals with most living parts typically less than three years old, (Jacobs 1955). Old dead tissues support the new living tissues and in some cases protect them from damage and predation. Tree death comes about when one or more of the following occurs: the connecting linkage between the crown and roots is broken, the mechanical strength of the bole and/or roots fails, or access to adequate water and nutrients is no longer possible. Typically a combination of biological and environmental stresses bring an individual into decline until a single event finally kills it. Longevity depends largely on the ability of a tree to develop mechanisms to minimise the effects of environmental and biological stresses and to exist in an environment where such stresses are minimal. For example, thick bark insulates living tissues from fire, durable wood resists decay, and rejuvenating crowns recover from storm damage and insect defoliation. The eucalypts have evolved many such strategies but are not in the league of the world's longest living trees.

Data on the longevity of eucalypts remains limited. Old trees of the wet sclerophyll forest (Helms 1945; Lindsay 1939; Rayner 1992; Woodgate and others 1993; Banks 1994), and subalpine forest (Banks 1982), have been estimated at 400 years old. Some dry sclerophyll forest species, are at least 250-300 years old (Semple 1993). Mallee eucalypts typically reach about 100 years before becoming unstable and/or being destroyed by wildfire (Holland 1969), although their rootstocks may survive for hundreds or even thousands of years.

There have been no previous studies on tree ages in the temperate woodland eucalypts. In this study the maximum age for yellow box was the radiocarbon age for tree no. 32 of 400 years. This tree was in good condition and could have lived on for perhaps another 100 years. If so, then it puts these woodland trees amongst the oldest of the eucalypts. Additional indirect evidence for yellow box reaching considerable ages comes from an examination of the scar overgrowth on aboriginal canoe trees. One such yellow box from Lanyon property in the ACT bears the scars of bark removal by Aboriginals dating from at least the first half of last century, possibly earlier. The small amount of growth since scarring shows this trees slow growth, estimated at 1.5-2.0 cm, over the last 150-200 years. Older trees almost certainly exist in these woodlands as there are many large trees of similar physiognomy still extant. The species owes its longevity to its fire tolerance, having a durable wood, lack of major insect predation and fungal disease, and the capacity to rejuvenate its crown from epicormic bud tissue, an important attribute when the crowns of old trees begin to break up with the loss of both major and minor branches.

The loss of these ancient trees from the remnant woodland continues in what is referred to as 'rural dieback'. The causes of this attrition are multiple and complex but new and enhanced factors are contributory: stands may be progressively thinned out so that indivudal trees are left fully exposed to the effects wind and sun; the already shallow topsoil may be lost; and insect defoliation may increase. The tree bole ages for most of the sample trees were unexpectedly young, between 112 and 180 years. This placed their regeneration at before and during the early period of settlement last century and concurs with the fact that locally extensive and heavy woodland clearing occurred later in the eighteenth century and in this century by which time trees such as those sampled must have been seen as young vigorous trees suitable for retention as shade trees. For example in tree no. 31 from Theodore displayed rapid and prolonged growth for 150+ years. This tree had a ring age of 170 and a modern radiocarbon age, ie. 1950±30. It had a vigorous and youthful crown suggesting it was still growing rapidly when it died in 1993, almost certainly in response to changed soil levels associated with urban development. These data confirm that the species can reach a large size in a relatively short time span when growing under favourable conditions.

Opportunities for woodland recovery:

The integrity and long term survival of the *E. melliodora-E. blakelyi* woodland depends on the persistence of key species in semi-natural conditions. At present its survival as a species is not in doubt, but its fragmentation and changes to its demography place the ecosystem of which it is part at risk.

This paper has shown that yellow box seedlings established on yellow box sites that have not been degraded to the point where they can no longer support the species, and when given appropriate silvicultural treatment—pre-planting site preparation and follow up treatments in the early years after planting—has the potential to reach half tree height by their third decade and at full tree height in 60-80 years. They will be mature trees in the second half of next century.

Conclusion

In undisturbed stands yellow box populations are multi-aged with regeneration by gap phase replacement. The longevity of individual trees is equal to that of other eucalypts, and may be considerably more than 400 years. Many of the mature trees in local woodlands are between 100-200 years old. Dendrochronology has only limited application in this species as the tree rings can be indistinct, however in moderately fast growing trees the tree rings can provide estimates of tree ages.

The growth data from the physiognomic study of planted trees in the Canberra region encourages the expectation that yellow box has a future in these woodlands. With appropriate silvicultural practices, trees planted today can make a real contribution to maintaining the parkland character of the agricultural landscape and contribute to conserving and enlarging remnant stands.

Acknowledgments

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5

Growth rates: debating pathways for New Zealand forestry

Michael Roche

Establishing a context

The success of *Pinus radiata* and plantation forestry generally has tended to obscure the highly contested place of forestry in New Zealand in the late 19th and early 20th centuries as well as the sequence of abrupt government oscillations between promoting exotic afforestation over favouring sustained yield management of natural forests. Understanding these sudden policy shifts and episodes of vacillation on the part of politicians, public servants and scientists is not a straightforward task. Donald Worster (1990), the American environmental historian provides a useful framework in this regard when he identifies 'ecology', 'production' and 'empirical' as three layers of analysis. The scientific literature concerned with New Zealand's forest ecology is now extensive, though for the purposes of this paper it is pertinent to note the impact of biogeographical isolation and attendant vulnerability to introduced browsing animals. Worster's 'production' category in the New Zealand context was played as a particularly imperial variant aptly termed 'dominion capitalism' (Armstrong 1978). The purpose of this paper is to explore Worster's 'empirical' category in order to understand something of the intellectual context of various ideas, some conflicting, some in harmony about early forestry in New Zealand with a particular emphasis upon the role of ideas about indigenous forest growth rates.

In New Zealand three distinct 'knowledges' about forestry collided in the late 19th century through to the 1920s. These represent three different constituents of Worster's 'empirical' level and represent contrasting views of the nature and possibilities of forestry and its appropriate directions in New Zealand. The three knowledges may be termed 'official', 'popular' and—drawing on J. M. Powell's extensive work in natural resource appraisal and management in Australia (eg. Powell 1970; 1995)—'scientific'. The 'official' view of forestry was the bundle of (mis)understandings held by public servants, particularly those in the Department of Lands and Survey whose major efforts were dedicated to land settlement. 'Popular' views were those ideas circulating in the community at large. These are difficult to precisely define because they are 'common knowledge' and not written down, but there are some sources of evidence amongst the early popular agricultural writing and in newspaper accounts. Finally it is possible to identify scientific appraisals as a third type of knowledge about forestry. Much of this latter work was inductively based and not subjected to rigorous experimental valuation until the 1920s, however, it does constitute a distinctive view of forests and forestry directions. The comparative smallness of the New Zealand population also highlights the manner in which individuals can move easily (contradictions not withstanding) between different forest knowledges, for example, Edward Phillips Turner (Director of Forests 1928-1931) was formerly a senior public servant in the Lands Department and trained as a surveyor, but had a strong amateur interest in botany and forestry and was a member of lobby groups such as the New Zealand Forestry League. Foresters themselves are sometimes peculiarly positioned as public servants and hence experiencing an 'official' perspective but simultaneously being 'scientists' concerned with generating quite a different sort of knowledge.

A fairly small number of issues gained recurrent attention in the official, popular and scientific knowledges of forestry in New Zealand from the mid 19th century to the 1920s. They included: the *displacement concept*—a belief that the indigenous flora and fauna were giving way to stronger invading species; the *forest influences concept*—this attributed climatic modification to deforestation and afforestation, and was subsequently modified to emphasise flood protection; a *timber famine*—this was a persistent concern from the 1870s in New Zealand; and a *forest growth rates debate*—indigenous forest species were generally regarded as slow growing, although visiting foresters disagreed with this assessment. Each provided a rationale for forest management, but collectively and separately they won only slow acceptance because they appeared to conflict with the ethos of land settlement and, equally significantly, its economic importance to the Dominion.

The displacement concept

A number of 'forest management' systems directed towards timber extraction were adopted in New Zealand. These ranged from regulated use through timber licensing and reserves (1850s) to afforestation activity (1870s) and plans for rotational indigenous forestry (1920s). The displacement idea and subsequently timber famine concerns had the greatest impact. The notion of displacement of the indigenous flora by superior invading species suggested that the indigenous forests were doomed. In consequence stock grazing in forests, wind and fire damage were not regarded as significant causes of forest retreat. Displacement ideas inhibited exploration of the full potential of indigenous forest species. Management strategies at the time consisted of regulating the exploitation of the forest. Any concern for timber supplies in the future tended to be expressed in terms of afforestation proposals. This was to be undertaken with exotic species which performed well when introduced into the New Zealand environment. Only a few independent observers continued to champion the indigenous forest species with regard to replenishing timber supplies.

The forest influence concept

The forest influence concept provided a rationale for another type of forest reserve initially dedicated to 'climatic improvement'. A belief—found also in Australia and North America—that forests had a marked impact on the climate caused them to be regarded as more than as a source of timber. An expansion of this concept suggested that afforestation could actually restore the climate of a district; 'climatic amelioration' was a favoured phrase, and contributed to one type of forestry activity. Empirical investigation by the overseas scientific community of the forest influence question also caused a revision of ideas in New Zealand in the early 20th century. Flood protection and water conservation now received emphasis over climatic modification, but although the reasoning had altered, a stronger case for protection forests now existed (McKelvey 1995).

A timber famine

Fears of a timber famine were voiced soon after the beginnings of organized settlement in New Zealand and gradually gained momentum in scientific and official circles as the land was progressively deforested. The popular response was afforestation, which was received official support in the 1870s via the *Forest Trees Planting Encouragement Act*, 1872. In 1898, direct state involvement in afforestation began through the activities of the Forestry Branch of the Department of Lands and Survey. Scientific state forestry, as undertaken in Europe and India, emphasised the natural regeneration and harvesting of indigenous forests and was virtually unknown in New Zealand. Efforts at its introduction had been severely hampered by a clash of interests with land settlement goals. Scientific state forestry was not successfully introduced until the first decade of the twentieth century, when concern about a timber famine peaked and land settlement demands were largely satisfied.

Various official, popular and scientific views of forests, particularly those centring upon displacement ideas, forest influences, growth rates and a timber famine, provide significant insights into the forest history of New Zealand. However, some aspects of the initiation and demise of State forestry in the nineteenth century were the product of wider structural concerns. The substance of the *Forests Act* of 1874 advocated by Sir Julius Vogel was drawn from his personal observations, the advocacy of others, and a perusal of forestry literature. But in the wider context it may be viewed as part of Vogel's public works and immigration strategy. The Act was the product of his expansive financial designs; its emasculation was a result of the rejection of Vogel's bold borrowing and development policies and their replacement by financial restraint under Premier Harry Atkinson. This sequence of events was replayed by Vogel and Atkinson with the *State Forests Act* 1885.

A forest growth rates debate

The widespread official, popular and scientific view that the indigenous forests were slow growing was held in spite of an absence of comprehensive data. The implications were significant for the future direction of forest policy and management. Concurrently, exotic forest trees, notably pines and eucalypts, were found to grow rapidly in their new environment. In conjunction the difficulties of propagating and regenerating indigenous species and the apparent advantages of exotics led to early official efforts being directed towards afforestation incentive schemes. The efforts of the visiting British forester David Hutchins from 1915 to 1920 helped reverse official thinking and create conditions for implementing a scientific forestry programme. But L. MacIntosh Ellis, the Director of Forests (1920-28), calculated that demand would exceed the supply of available indigenous forest stocks by 1965 and took the bold step of embarking on 300,000 acre [121,000 ha] afforestation programme in 1925.

Growth rates in focus, 1880s-1920

The interest and enthusiasm for exotic afforestation stemmed from a positive factor: the encouraging results obtained from experimentation with exotic species, and a negative dimension: a belief that the indigenous forest flora, particularly kauri, was slow growing. The difficulties encountered in propagating indigenous forest species probably lent support to this view. Botanists, engineers, and foresters, each from a different perspective, and with diverse purposes, contributed to a debate over growth rates. In consequence, the 'scientific' view of the growth rates question altered, sometimes to extremes, with important implications for exotic afforestation and indigenous management strategies.

Initial opinion on the growth of indigenous forests stems from observations originally published in 1875 by Thomas Laslett, a Timber Inspector with the Admiralty, who made several visits to New Zealand in 1840-1843. Other contributions were made by Ferdinand Hochstetter (1867) and W N Blair (1876). Laslett judged the kauri to be, a 'slower growing tree than most firs and pines; it is slower even than the Pitch Pine of America, and makes only one inch [2.5 cm] of wood diameter in about six or seven years.' (Laslett, 1894, 389). He estimated that the 72 foot [23.6 m] circumference kauri at Mercury Bay to be 2000 years old. Hochstetter suggested that kauri of fifteen foot diameter was 700 to 800 years old and observed 10 to 12 annual growth rings to the inch [3.9-4.7 per cm]. Blair, an engineer, in a survey of the building materials of Otago, made estimates of the growth rates of indigenous forest trees in that region. Cedar, he believed, 'grows faster than most European timber trees' (Blair, 1876, 153). Miro, rimu and 'black birch', he also considered to be fast growing, while totara was described as a 'comparatively slow grower'. This survey was widely referred to and despite Blair's previously quoted observations was used to support the contention that the indigenous forest species were slow growing.

Toward the end of the 19th century, the view that indigenous forests were slow growing gained support. It is somewhat paradoxical that a prime contributor to this reappraisal was Thomas Kirk, the Chief Conservator of Forests (1886-89) and an eminent botanist who argued that 10 annual growth rings to the inch [3.9 per cm] was a 'fair average of a growing (kauri) timber' (Kirk, 1889, 144). He also referred to ring frequencies of up to 30 per inch [11.8 per cm] which led him to estimate the age of some specimens of kauri at 4000 years. Henry Matthews, the Chief Forester of the Lands and Survey Branch (ie. solely concerned with exotic afforestation), drawing on Kirk (1889), and Blair (1876) and some data from a plantation of native species in Thames for maturation times, posed the question:

> would the Forestry Department be justified in planting any ... (indigenous) trees with a view to providing for the wants of the future, when two or even three crops of exotic trees - such as oak, larch, spruce, Oregon Pine or eucalypt could be produced within the same period that one crop of native trees would take to reach maturity? (Matthews 1905: 78)

Not surprisingly Matthews saw only a limited role for indigenous afforestation.

The next contribution to the growth rates question was by Stewart (1905) who provided some statistics on indigenous trees known to have been planted in 1865, but more importantly by observation of ring counts of trees of known age, confirmed that kauri produced only one growth ring annually.

An investigation of major importance which overshadowed the previous studies appeared in 1913. Authored by Thomas Cheeseman, curator of the Auckland Museum, the paper entitled *The Age and Growth of Kauri* was specifically directed at the question of indigenous forest growth rates. He noted the tendency for exaggeration in human nature and concluded that this had happened in the case of the kauri where he suggested even 'careful writers' such as Kirk and Blair had assigned ages of over 4000 years and 3600 years respectively to large specimens, 'although neither gentleman appears to have counted the annual growth rings of even a single complete section' (Cheeseman 1913, 18). He ventured the opinion that a neglect of Laslett's work had produced 'from subsequent writers many rash and unsupported statements which otherwise would never have been made' (Cheeseman 1913: 10). Then he proceeded to attack Kirk's earlier work, claiming his assumptions were faulty and not supported by evidence. Specifically, Cheeseman argued that Kirk's two estimates of an average of 10 growth rings to the inch [3.9 per cm] for a five foot [1.6 m] diameter 300 year old tree and 30 growth rings to the inch [11.8 per cm] for a seven foot [2.3 m] diameter 1260 year old specimen were incompatible. Data collected by Cheeseman produced an average of 9.7 rings to the inch [3.8 per cm]. (In fact an arithmetical error occurred in the calculations and 8.5 rings to the inch [3.3 per cm] was more accurate). On this basis kauri trees dated by Kirk at 4320 and 3960 years were reassessed to be only 1398 and 1280 years respectively. That is to say, they grew more rapidly than Kirk believed.

In spite of demonstrating to his own satisfaction that kauri grew faster than had been previously thought, he still considered the species 'much slower than most trees of economic value' (Cheeseman 1913: 19) taking an average of 116 years to reach a two foot [0.6 m] diameter and 174 years for three feet [1 m]. 'Periods like these,' he concluded, 'are much too long to offer any hope of monetary returns from the planting of kauri, even if there were not other reasons to advance against such undertaking' (Cheeseman 1913: 19).

State exotic afforestation was thus apparently vindicated. But this view received a serious challenge from David Hutchins, who had extensive experience in South Africa and had only recently reported on Australian forestry. In an appendix to his Australian work he dealt with New Zealand (Hutchins 1916). As a consequence he was employed by the Government to report on the Dominion's forests. He argued that,

> Forestry in New Zealand has been entirely misjudged by the entirely erroneous idea that New Zealand native timber-trees grow more slowly than the ordinary timber-tree of other countries. (Hutchins 1916a: 301)

On these grounds, as well as using cost minimising arguments, Hutchins argued for indigenous management rather than afforestation as the solution to New Zealand's timber supply problems. In his subsequent report on New Zealand Forests, Hutchins (1919) expanded his arguments and lauded Cheeseman (1913) for dispelling the popular notion of the slow growth of kauri, dismissed Kirk (1889) as not understanding the true significance of his data, and insisted that Matthews (1905) had also misinterpreted his information. In Hutchins' opinion, the indigenous trees grew 'about twice as fast as European forest trees' (Hutchins 1919: 18).

Hutchins' views were not accepted unanimously. Ebenezer Maxwell (1919), a local afforestation advocate who established Taranaki Perpetual Forests Ltd in 1925 (see also Maxwell 1930), marshalled evidence in favour of faster growth of exotic species. The implication that Maxwell drew from his analysis was, 'that it would be an utterly hopeless undertaking to attempt to provide even a small portion of future needs in timber by growing native trees.' (Maxwell 1919: 372). Hutchins replied to Maxwell in 1920 claiming that he did not clearly distinguish between 'arborculture' (individual trees) and 'forestry' (mass trees). The former was concerned with unit growth per tree and the latter timber production per area. Hutchins did concede that there was a place for exotic plantations in New Zealand, because of the comparatively small area of forest and because some exotics showed 'an extraordinary rapid growth' (Hutchins

1920: 1) under local conditions. But he argued that Maxwell had compiled a diverse set of data, not all directly comparable because of variations in collection procedure. His major point, however, was that New Zealand forest trees *in situ* grew faster than European forestry trees in their own environment. In Hutchins' opinion the faster growth of some exotic species was not crucial:

> As long as there are no costs of planting plus interest on the native trees, it does not much matter if they do take considerably longer to produce their timber than costly and doubtful exotics. (Hutchins 1919: 4)

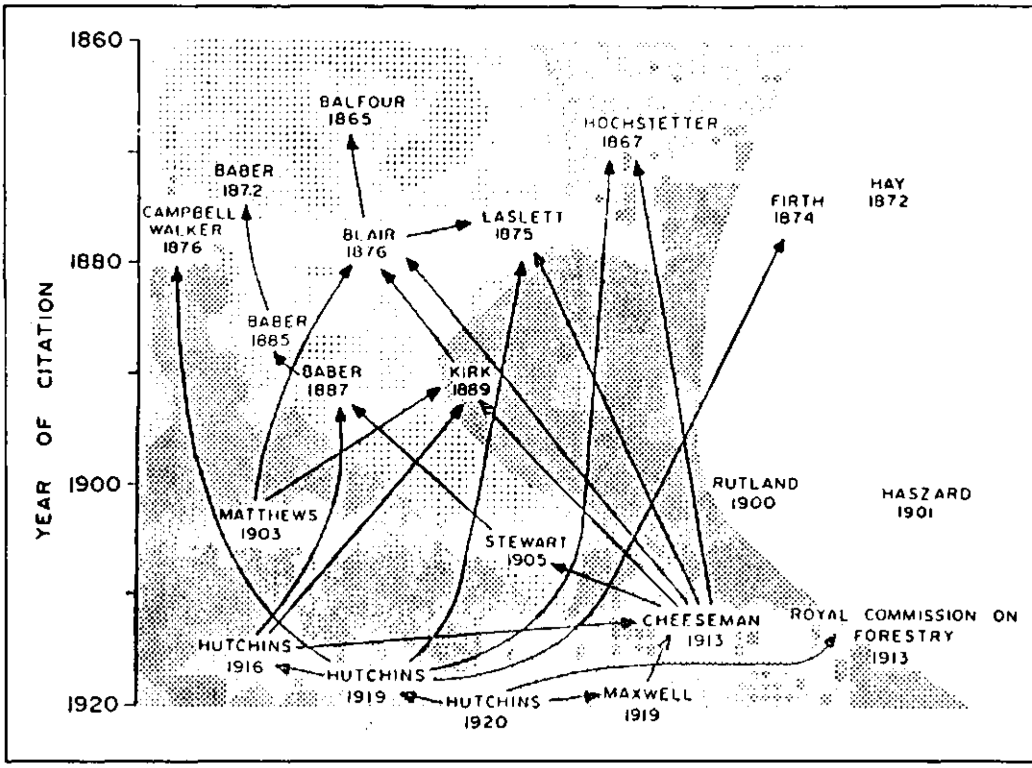

Figure 1. Citation network for the growth of indigeneous forests in New Zealand

Scientific opinion on the growth rates question vacillated over time and did not cease in 1920. The various contributions of foresters, engineers and botanists can to some extent be assessed through the use of a citation network. This is a diagram organised chronologically and indicating published papers cited subsequently. Garfield (1970) illustrated this approach with the example of Mendel's pioneering genetics paper and suggested that it helped to identify key individuals whose work had enduring impact in the field and helped to disprove myths about past influences. Usually cited publications dealing at least in part with the growth rates of native timber up to 1920 are depicted in Figure 1. Accepting that there are construction problems as nineteenth century citations were not streamlined and informal personal communication was frequent, some patterns still emerge.

The citation network clearly indicates that Laslett and Hochstetter's work was neglected in the nineteenth century. This oversight was perhaps the source of some of the confusion over indigenous growth raters. Laslett's volume was published in London and was probably not readily accessible in New Zealand. Instead, the standard reference was that by Blair (1876) who was less interested in growth rates than in the quality and attributes of the timber. Subsequent authors interpreted his data as showing that indigenous forest trees grow slowly. Cheeseman's (1913) paper emerges as a comprehensive review of the earlier published work and was in turn acknowledged as important by Hutchins (1916) and Maxwell (1919). The citation network also isolates engineers, botanists and foresters as three groups. The engineers in particular worked in isolation or cited work by others from their own field. In contrast, Cheeseman and Hutchins ventured more widely in their contributions. However, the foresters tone permeates Hutchins' writings; he favoured above all indigenous rotational forest management. Hutchins played a key part in subsequent developments leading to the establishment of an autonomous forests department.

State Forest Service growth rates research, 1920-30

Although McIntosh Ellis regarded himself as a practical man of action, he was aware of the importance of longer term research and forestry training programmes. Thus he directed efforts towards initiating a contract research programme and departmental scientific investigations of the indigenous forests. He was also in favour of the establishment of a School of Forestry to provide a source of trained graduates for the State Forest Service. In this way knowledge of the forest environment and State Forest Service expertise could be increased simultaneously.

The National Forest Inventory of 1921-1923 provided a basic check list of forest resources. From the first Ellis sought to obtain more detailed scientific information on indigenous regeneration and growth rates as this was essential information or implementing any system of sustained yield rotational forestry. In 1921 he wrote to the Commissioner, [i.e. Minister] of State Forests, Sir Francis Bell, arguing that in the past 'instead of searching for the key to nature's workshop', afforestation had been substituted as the solution to timber supply difficulties. In Ellis's opinion:

> ... unless and till the foresters are in possession of a working knowledge of the phenomena of Nature as regards the basic laws of growth of the native forests, you will have no managed forests, no regeneration and no future supplies'. (Ellis to Bell, 7 Sept. 1921, F6/1/13/1)

He remained exasperated by the difficulties in funding this research when indigenous forestry was a 'practical policy' and 'one that will pay its own way instead of calling for £40 000 000 if the indigenous forests are thrown overboard and exotic trees planted' (Ellis to Rhodes 19 Oct 1922, F6/1/13/1). Under difficult financial conditions, Ellis instigated departmental studies on a range of topics. These included plantings on an experimental station in Westland, sand dune stabilization work at Rangitikei, indigenous and exotic growth rate studies on a number of sample plots and underplanting of conifers in native forests. Important work on indigenous growth rates and regeneration was undertaken on a contract basis at Auckland and Canterbury University Colleges by the irascible William McGregor and Charles Foweracker and Frank Hutchinson.

Foweracker's Westland research showed 'the rimu is dying out where silver-pine is densest (which) seems to suggest that silver-pine is a successional forest following on rimu' (AJHR 1924, C3:10-11). Hutchinson (1926, 1927) completed a report on the forests of the Canterbury region, but by far the most important contribution was made by Leonard Cockayne, who had undertaken several botanical surveys for the Lands

Department in earlier years (AJHR 1907, C8A; 1908, C11; 1908, C14; 1909, C12) and published an important monograph on the vegetation of New Zealand in 1921. He was in no doubt as to the value of scientific study to forest management: 'If an accurate knowledge of any branch of New Zealand plant-ecology is of more importance for forestry than any other it will come from the study of succession.' (Cockayne 1928: 249) The concepts of community, succession, and climax were also used by North American forest managers. Scientific investigations greatly increased the knowledge about the indigenous New Zealand forests, but many questions remained unanswered.

Cockayne's work on the beech (*Nothofagus* spp.) forests was intended to provide the information required to manage them on a commercial basis. He argued that the beech were a 'climax plant-formation' of long persistence and self-replacing. By his calculation an 80-120 year rotation would be required for their management. This, he observed, was comparable with those in European forests. Cockayne, as had Hutchinson and Ellis, also favoured indigenous regeneration as an economical solution. However, other aspects of Cockayne's work may have played some part in convincing Ellis to shift to exotic afforestation as a solution to the timber supplies problem (Cockayne 1921, 1923). This reorientation had already taken place by the time that Cockayne's deliberations on the beech forests were published in 1926.

The research of Cockayne and others produced a detailed understanding couched in scientific language of New Zealand's forest environment. Ellis regarded this work as essential for sustained yield indigenous forest management. The official scientific appraisal of the environment now reached new heights of importance. Scientists possessed greater knowledge of the workings of the natural environment yet, somewhat paradoxically, this was obtained at the expense of its communicability to the official and popular sectors. Political decision makers now had to accept the recommendations of the forest scientists without the ability to critically evaluate them. However, political elements of decision-making remained ascendent, as for instance when timber exports were reintroduced despite Ellis's opposition in 1928 (Roche 1987)

Discussion

Growth rates were only one of a number of highly contested ideas about forests in New Zealand. Indeed, the growth rates arguably were not the dominant arena of official and scientific debate over forestry in the 1880s to 1910s although it did assume greater real importance under Ellis in the 1920s. Possibly, it remained more important in the 'popular' arena through the period. Growth rates were, however, an essential part of any broader forestry programme. The ebb and flow of knowledge about growth rates redefine the future of forestry in New Zealand in contrary ways: a belief in very slow indigenous growth rates initially directed attention towards exotic afforestation, the recognition that the growth rates of some indigenous forest species were comparable with selected European timber species helped open discussion about sustained yield indigenous forestry in the 1920s and the spectacular growth of exotic tree species enabled state afforestation to be seen as a means of meeting anticipated timber demands and winning time to allow the mechanism of indigenous forest regeneration to be understood. In this sense the growth rates debate on the early years of this century was of real significance to the eventual course of state forestry in New Zealand.

The interplay of various forestry knowledges at the empirical level is only one of the insights that can be traced from discussion over forest growth rates. Another link is that between Worster's 'empirical' and 'production' levels, for in the foresters' discussions about growth rates some of the ideas expressed are grounded in professional practices and principles that are ultimately anchored in a particular notion of the role of forestry in a national economy and the sort of social and economic conditions in which it will be pursued.

The impact of growth rates thinking in official and scientific spheres also cuts across the relationship between forestry science and Worster's 'production' category. In a selected fashion some aspects of this interrelationship have already been addressed by Gould (1962) and Raup (1964) who trace the connections between the emergence of sustained yield forestry in Western Europe (especially late 18th century Germany) and the historically specific social and environmental circumstances on which it is based. Lee (1984) summarises the conventional critique of sustained yield suggesting that the social practices embodied in sustained yield have been generally overlooked. This leads him to pose five research questions associated with sustained yield: Who were the social agents responsible for the development sustained yield and for whom did they act? Where, when and by what social agencies are sustained yields developed? What social function was pursued by developing sustained yield? Did sustained yield serve as a model for social-continuity? and How was sustained yield related to the major intellectual and ideological movements of the period?

The growth rates debate amongst officials in New Zealand takes place against a backdrop, as in the US where the basic assumptions of sustained yield, scarcity, stability, certainty and a closed economy were at best problematic and almost certainly ill-fitting. New Zealand was fifty per cent forest covered at the time of large scale European settlement in 1840, although this was reduced to about twenty-three per cent in 1900. The colonial economy, not without hiccups was geared towards growth, the 19th century colonial world of wood increasingly gave way to metals (and later plastics) in the 20th century, even wood based pulp and paper was not seriously discussed in New Zealand until the 1930s. New Zealand was not naturally endowed with a full range of merchantable hardwood species so that from the late nineteenth century, Australia provided timber for railway sleepers, telegraph poles and bridge timbers. The conventional criticism of sustained yield tends not to introduce growth rates into the analysis. When this is done, as in the New Zealand case, some additional insights emerge.

Appreciating that the indigenous forests were regarded by Land and Survey offcials as very slow growing, helps to reveal the urgency felt about timber famine concerns, i.e. it relates to the assumption about stability of supply. It also further explains why officials were so quick to advance exotic plantations as a solution to a projected timber famine. The resources that the State was putting into land development and agricultural expansion and an ideology of material progress also helps explain the restricted place given to forestry until the 1920s when the era of extensive agricultural expansion was drawing to a close.

Growth rates also offer some critical insights into foresters' thinking. Foresters had to work very hard to promote sustained yield in New Zealand not because it was seen as a form of social control (Lee's critique in the US case) but because the growth rates produced scenarios of managed forests with planting times of 500 years in some cases. To officials and many in the public this seemed a timespan that so transcends human timescales that it defies comprehension. The situation was exacerbated when the first National Forest Inventory (1921-23) produced data that pointed to timber demand exceeding supply by 1965 and concurrently the virtual exhaustion of timber supplies by the same date.

In these circumstances MacIntosh Ellis promoted a 121,000 hectare planting boom in 1925. Its objectives were to provide for the speedy creation of an exotic softwood timber resource to prevent the indigenous forests being exhausted and in so doing provide a respite for forestry scientists to come to grips with the mechanisms of forest regeneration in New Zealand with a view to implementing a sustained yield forestry programme. In all events some of the problems of indigenous forest management remained seemingly untraceable (only Cockayne's work on beech forests seemed to offer much hope, especially after the preservation interests secured sanctuary status for Waipoua kauri forest in 1952. Simultaneously the potential of fast growing exotics, particularly radiata pine seemed to offer new possibilities not restricted to local timber requirements, but as the basis of an internationally oriented pulp and paper industry and an export (log) and timber trade.

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Aspects of age in Australian States

A tree is an ideal form of life to attain great age. its living tissues are regenerated at short intervals. Most living parts are less than three years old. Living tissue more than ten years old is abnormal. The old dead tissues support the living ones and in some cases protect them. The proportion of crown to trunk decreases with size and the sheath of new wood becomes progressively thinner as the trunk increases in diameter. In the end the thinning of the sheath of new tissues would kill a tree, but most of them die from other causes before that happens.

M.R. Jacobs,
Growth Habits of the Eucalypts,
1955

6

Age and order in Victoria's forests

John Dargavel and Heather McRae

An ordered progression of age classes

An ordered progression of age classes in the so-called 'normal' forest is the ideal upon which the classical theories of forest management rest and to which many plans and efforts have been directed. If the amount of wood being cut from a forest, its 'yield', is to be regulated to a level which can be sustained in the long-term, order has to be imposed on both human disorder and natural variation. The ideal way of achieving this is simple; there must always be a proper amount of trees of each age, so that when the oldest are cut, there are slightly younger ones which grow to replace them in time for the next cut, and progressively younger ones still so that there are always new recruits to each class, the youngest class being regenerated on the space left by those felled. Much of the history of forestry is written as the struggle to transform real forests towards this ideal against the recalcitrance of people and turbulence of nature (e.g. Steen 1983). Even those who have criticised the ideal as unattainable and have sought to regulate yield over shorter times in a more pragmatic way have found the age structure of a forest to be an indispensable attribute (e.g. Clutter et al. 1983), while ecologists consider it a powerful indicator of ecological health. The 'managed forest' is therefore one in which age is directly or indirectly controlled. On these grounds one would expect that as forest management becomes more strongly established in a region, age would feature with increasing prominence in its records.

This paper briefly examines the forest record in Victoria (McRae 1994) to see what recognition age received as forestry evolved. Carron (1985) and Moulds (1991) have described this from the long arguments over the need for forest conservancy during the nineteenth century up to the *Forests Act* which established the administrative and professional framework of the Forests Commission in 1918. The new Commission affirmed the classic principles and set about assessing the forests and making formal plans for their management. Before reviewing how age featured in the record from the 1920s on, it is worth briefly noting some of the context in which classical forest management arose and how it was transmitted to Victoria. Only the German context is noted here (the French and Swiss contexts differed), but is particularly relevant given the strong German connection in Australian science (Home 1995).

The classic tradition and its transmission

In northern Europe, wood largely fueled industrialisation during the eighteenth and nineteenth centuries—thus contributing economically to the rise of Prussia and other states—while exports from the Baltic expanded even to remote Australia. The demands placed on the forests were so large that the old ways of haphazard cutting would not suffice, indeed if continued the forests would be exhausted and production would decline.

For One Acre of a normal, or fully stocked, wood in solid cubic feet

Oak.						Beech.					
Age, Years.	Quality classes, in solid cubic feet.					Age, Years.	Quality classes, in solid cubic feet.				
	I.	II.	III.	IV.	V.		I.	II.	III.	IV.	V.
10	290	240	200	140	70	10	330	290	240	190	160
20	740	610	490	360	200	20	800	660	510	390	200
30	1,270	1,060	840	630	330	30	1,310	1,160	900	640	330
40	1,870	1,560	1,210	930	470	40	2,160	1,760	1,360	960	470
50	2,560	2,120	1,670	1,250	640	50	3,020	2,440	1,870	1,300	630
60	3,320	2,750	2,170	1,600	810	60	3,990	3,220	2,440	1,670	800
70	4,160	3,430	2,700	1,970	1,000	70	5,070	4,070	3,070	2,070	980
80	5,060	4,160	3,250	2,340	1,190	80	6,260	5,000	3,740	2,490	1,160
90	5,990	4,990	3,800	2,720	1,360	90	7,460	5,930	4,400	2,880	1,330
100	6,960	5,660	4,360	3,070	1,520	100	8,570	6,800	5,030	3,260	1,480
110	7,950	6,430	4,920	3,420	1,670	110	9,620	7,650	5,590	3,570	1,600
120	8,950	7,220	5,480	3,740	1,800	120	10,580	8,330	6,090	3,840	1,700
130	9,900	7,950	6,000	4,060	1,930	130	11,450	8,990	6,530	4,070	1,770
140	10,830	8,670	6,520	4,340	2,040	140	12,250	9,570	6,920	4,260	1,830
150	11,700	9,350	6,990	4,620	2,140	150	12,960	10,100	7,250	4,400	1,860
160	12,560	10,000	7,450	4,890	2,240						
170	13,350	10,600	7,860	5,120	2,330						
180	14,090	11,160	8,250	5,330	2,410						
190	14,780	11,680	8,590	5,500	2,470						
200	15,330	12,100	8,870	5,660	2,530						

Example.—A fully stocked beech-wood has a volume, when 60 years old, of 3,220 cubic feet; hence it grows on a locality of the II. Quality. *Again*, a fully stocked oakwood, 140 years old, shows a volume of 7,600 cubic feet; hence it grows on a locality between II. and III. Quality.

Table 1. Part of a German yield table shown in Schlich's *Manual of Forestry* (1895)

In this situation, a deliberate, science-based, professional forestry was developed to manage the large estates, and in places the communal forests. It rested on a strongly-developed bureaucratic ordering of information through classification and quantification which had emerged during the second half of the eighteenth century (Lowood 1990) and was driven by the need to increase forest productivity. Silviculturally, productivity was increased by clear-felling the depleted forests of mixed ages and species and replacing them with uniform, even-aged crops, often of conifers. This replacement by younger, faster-growing trees was feasible because even the poorest of the old trees could be readily sold for fuel wood. Managerially, it required formal planning, the intellectual foundation for which was in the ideal of a sustained yield from the normal forest. Technically, the problem was to calculate the optimum 'rotation' age at which every stand of trees should finally be felled, but this required knowing the quantity of wood produced at various ages. Yield tables were painstakingly constructed which later served as exemplars for the British Empire (Table 1).

It was increasingly considered that the optimum rotation should be determined on economic principles which from 1849 could be applied by Faustmann's elegant solution for discounting the value of future crops to the present. To provide a professional cadre for the task, scientific education, well advanced in Germany generally, was extended to forestry with centres of forestry education being established in St Petersburg in 1803, Schemnitz 1808, Tharandt 1811, Warsaw 1816, Eberswalde/-Berlin 1821 and Nancy in France in 1824. Formal research followed as national forest experiment stations were set up in Germany in 1870, Austria 1874, Denmark and France 1882, and Switzerland 1888; by 1892 they were strong enough to form the International Union of Forest Research Organisations (IUFRO).

The imposition of order by clear-felling was rejected from the 1870s by some French and Swiss foresters—sometimes called the 'sylvan fundamentalists'—who developed silvicultural 'selection' systems to manage uneven-aged stands. They too sought to raise productivity but gave priority to ensuring forest health and maintaining soil fertility through keeping a mixture of ages and species in each stand. They ensured a sustained yield by measuring the trees periodically and felling only those which exceeded the number proper to each diameter class (Knuchel 1953, Troup 1952). Given the close relationship between diameter and age, they effectively controlled age while asserting a concept of 'forestry in harmony with nature' and rejecting large-scale, uniform, economically-driven enterprises.

The classic tradition was transmitted to India from the middle of the nineteenth century where it was transmuted into an imperial model which depended on the 'demarcation' of the best forest land, its reservation from clearing for agriculture, the dispossession of the original inhabitants, and management by a cadre of professionally trained foresters recruited at first largely from Germany. Vast areas had to be brought under 'systematic working' by the expatriate staff who were replaced periodically. To maintain continuity, 'working plans' were made for each forest according to a standardised format of two parts: 'Part I—Summary of facts on which proposals are based' and 'Part II—Future management discussed and prescribed' (D'Arcy 1898 [1891]). The imperial model, even to the detailed headings of its working plans, spread throughout the Empire. Wilhelm, later Sir William, Schlich (1840-1925) was a key figure in this. Trained as a German forester, he set up the system for working plan control in India and eventually rose to become Inspector-General of Forests. He moved to Britain and set up the Coopers Hill school, subsequently part of Oxford University, where most British foresters for the colonial and Indian forest services of the time were trained. He took his students to Germany to see orderly forest management at first hand and, with others, prepared and repeatedly revised a comprehensive, five-volume text, the Manual of Forestry (1889-1906) based on translations of German texts and his Indian experience. The eventual acceptance of the imperial model in Victoria followed the urging of imperial foresters: Vincent in 1887, Ribbentrop in 1895 and Hutchins in 1916, and the appointment in 1919 of Owen Jones—an Oxford graduate doubtless carrying the trusty Manual in his knapsack—as the first Chairman of the Forests Commission (Moulds 1991: 53). The working plans, and their successors, which were prepared in Victoria express both the classic ideal of sustained yield received in its transmuted form, and all the difficulties of managing real forests. This paper explores the considerable tensions between the ideal and the practice. It proceeds chronologically through three periods from the 1920s to the present. Plans for plantations are not discussed.

Era of classic working plans

The new Forests Commission recognised that ordering Victoria's forests would be a slow process partly due to the shortage of skilled staff which was only gradually eased by the four or five foresters who graduated from the School of Forestry at Creswick each year (Moulds 1991, 1993). It implicitly sought an ordered progression of age classes and viewed the existing condition of the forests as a major complication:

> containing as they do in many instances large areas of mature or over-mature timber; these require to be cut over as soon as possible, but they can only gradually be taken in hand owing to inaccessibility or to the necessity of avoiding a present glut followed by a subsequent shortage (Forests Commission, *Annual Report* 1919/20).

However, exploring remote areas and battling against agricultural interests in the Parliament and the Lands Department to have the best areas reserved as state forests, as well as marking their boundaries and setting out sawmill licence areas were the first, most urgent tasks. An energetic programme of assessing the various types of forest with strip surveys was commenced about 1925 as a basis for preparing working plans. Considering the difficulties, progress was remarkable; in a decade, a quarter of the forests were placed under working plan control (Table 2). Very different types of forest necessitated different types of plan, discussed in what follows, although all followed the classic two-part template laid down by D'Arcy, a 1910 edition of whose work is believed to have been part of the Forests Commission's library. The plans were made for a period of about five years after which they were to be revised, as several of the early ones were. The Commission formally approved the plans over its seal, often issuing them with a strict instruction that they were to be adhered to.

Box-ironbark and messmate forests

The need to counter the devastation of the mixed-species forests around the goldfields in the second half of the nineteenth century had provided much of the early impetus to reserve state forests and establish Victorian forestry. Their durable box and ironbark timbers were economically important early in the twentieth century for railway sleepers, telegraph poles and, in the more accessible areas, for fuel wood, while messmate provided prime sawlogs. The 1935 Maryborough Working Plan, for example, noted that early cuttings in the 'open virgin forest' of red ironbark, grey box and yellow gum until the 1870s had resulted in dense seedling regeneration and some coppice growth. Later cutting had led to a dense coppice forest which produced mostly fuel wood and eucalyptus oil. Much the same was observed for the 1933 Ballarat and Creswick Working Plan where the 'virgin crop' of messmate and other species had been removed in the 1855-75 period and the succeeding seedling crop had been 'razed' so that the regrowth then present resulted from varying cuttings. It was intended that the better forests would be ultimately converted to high forest again, many of the box-ironbark areas would be managed on the two-layered coppice with standards system, and some would be used just for fuel wood. Although 'no useful data regarding growth and yield are available as no sample plots have been established [and] no yield tables have been constructed', the forests were in such poor condition that 'no regulation of the output of mature trees is prescribed ... as the policy of building up the growing stock will be maintained' (Ballarat and Creswick Working Plan 1933 and revision 1938).

Table 2. State forest reserve and working plan areas

Year ending 30th June	Area of state forest reserved (hectares)	Area covered by working plans (hectares)	Examples of the forests covered	
			Forest type	District or region
1929	1,759,992	99,499	Box-ironbark Cypress pine	Dunolly Mildura
1930			Mixed species	Sandon, Muckleford, Walmer
1931	1,893,186	182,357	Red gum Plantation areas Box-ironbark Ash, messmate, silvertop	Barmah and Shepparton Ovens, Bright, Aire V.,Stanley Rushworth Southern Baw Baw, Part Upper Yarra, Rubicon
1932	1,897,321	234,448	Box-ironbark	Heathcote, Scarsdale
1933			Messmate and mixed species Ash	Ballarat and Creswick Neerim boys camp
1934	1,899,154			
1935	1,922,031	263,619	Box-ironbark	Maryborough
1936	1,948,253	277,864	" "	Heathcote
1937		277,864		
1938	1,949,891	378,841	" "	Gladstone
1939	1,961,105	512,896		

Source: Forests Commission, Annual reports and Working plans

Clearly there was a long task ahead before an ordered progression of age classes could be established in a high forest. The coppice with standards system envisaged selecting a few of the best trees on each hectare, 'the standards', to be grown on a 50 year rotation, while the remaining trees would be cut and allowed to grow as 'coppice' on a 20 year rotation (The Sandon Forest Working Plan 1930, Walmer Forest Working Plan 1930). Perhaps more realistically at Rushworth, 'owing to lack of growth statistics, no rotation period can be fixed. It is estimated that 80 years should produce a 14-15 inch [35-38 cm] diameter breast height tree' (Rushworth Working Plan 1931). Although a few plots were established to measure the growth rates of the box-ironbark forests in 1919, no systematic programme to do so on a larger scale was started and the amount of information on which to base sustained yield calculations was still inadequate half a century later (Newman 1961; FCV file 68/791). But it was lack of markets and money that forced more realistic plans, particularly during the economic depression of the 1930s. The Commission directed unemployment relief funds largely to thinning and other silvicultural work in the goldfields forests which may well have hastened the preparation of working plans for them. Nevertheless there was a limit to what could be done. For example, when the Heathcote Working Plan was revised in 1936 it was clear that 'yield regulation shall be governed by demand and by the money available ... in accord with the silvicultural system prescribed [for the Conversion Working Circle].' Similarly while the first Scarsdale Working Plan in 1932 had hopefully sought to sell poles as rapidly as possible, its revision in 1937 noted that silvicultural work would depend on the extent of relief funds.

Red gum forests

A detailed assessment of the important red gum forests along the River Murray made in 1929/30 provided the basis for a substantial Barmah and Shepparton Working Plan in 1931. The forests had been cut recklessly for sleepers and other products during the nineteenth century with virtually no control (Fahey 1988). The plan noted that 'stricter control has been exercised during the last 20 years' by imposing a minimum girth limit, below which red gum trees could not be felled, of 8 feet 6 inches [2.6 m girth or 82 cm diameter] measured at 5 feet [1.5 m] above the ground. The limit was relaxed in order to 'permit the removal of faulty and deteriorating timber'. However, the forest was far from meeting the normal ideal as it had many very old trees unwanted by the cutters, regrowth of various ages determined by the severity of past grazing and, as we now know, by the history of floods, but insufficient mature and middle-aged trees to provide future yields. Some silvicultural work had been done by removing 'dead, dying and suppressed material' and by the 'sapringing of old, useless material [which] has commonly resulted in the establishment of advance growth, thus tending towards unevenaged stands'. With limited funds, 'the extension of such thinnings into the crowns, if only by the sapringing of subdominants useless for sleepers, has generally been considered to be economically impracticable'.

Bringing an ordered progression of age classes to such a forest was a formidable task and there was little to go on; there were no yield tables, no sample plots which could be remeasured and no records of growth. 'A definite effort [was] made to determine the age of certain stands and thus discover mean annual growth', but repeated selection fellings in the past, the pattern of intermittent regeneration, and slow growth in dense pole and sapling stands defeated the attempt. Over the river in Barham State Forest, the Forestry Commission of New South Wales had measured the growth of 23 trees for a period of 13 years and found that they had put on 0.24 inches [0.61 cm] of diameter growth a year on average. With some measurements from Gunbower forest where three increment plots had been established in 1928 (FCV file

68/791) and 'general observations', the rate of diameter growth on the best red gum sites was estimated (Table 3). A 30 inch [76 cm] tree was slightly smaller than the previous cutting limit but must have seemed satisfactory as an 80 year rotation was fixed in the plan. However, the basis of the estimates was so slender that the plan prudently prescribed that sample plots should be installed to make better information available for subsequent revisions.

Table 3. Estimates of diameter growth at breast height for red gum for the Barmah and Shepparton Working Plan 1931

Age	Average diameter growth per year		Giving a tree of diameter	
(years)	(inches)	(cm)	(inches)	(cm)
0-10	0.6	1.5	6	15
10-20	0.5	1.3	11	28
20-50	0.4	1.0	23	58
50-80	0.25	0.6	30.5	77

Ash forests

It was, of course, the magnificent mountain ash forests in the Central Highlands, usually with messmate and silvertop on the lower slopes, which were the most important to the Commission. Sawmillers had forced their tramways into many areas, but the history of intermittent cutting and bushfires had created a complex patchwork which was difficult to map. Moreover, the cut-over areas frequently contained good trees which had been left because they were in inconvenient places or were too big on sites where horses did the snigging. The forests were difficult to assess, often growing on rugged country and always difficult to traverse. Systematic assessment started about 1928 and continued throughout the 1930s. Parallel lines were run through the forest at 10 chain [200 m] intervals along which the types of forest, density of scrub, rock formation, occurrence of regrowth and diameters of the merchantable timber trees were recorded so that detailed stand type maps could be drawn. Simple categories were used to describe the stands. For example, 'overmatured', 'matured', 'saplings' and 'seedlings' were used at Rubicon in 1928; and expanded to include 'immatured', 'young timber', and 'pole timber' at Royston. The diameter of every tree in sample plots, located along the assessment lines, was measured, their heights and the number of log lengths they contained estimated and their volume calculated. But 'proper volume and yield tables, constant bark percents, average rot percent, tables, etc. [which] would not only diminish the cumbersome reckoning considerably, but would also increase the accuracy of the computations to a high degree' were lacking. It all took an enormous effort in this type of forest.

While the mass of information enabled immediate logging operations to be scheduled in an orderly manner, how an ordered progression of age classes might be created in the classic manner was far less certain. The 1931 Southern Baw Baw Working Plan was the first attempt for the mountain forests, an endeavour which created 'an acute appreciation of the lack of definite knowledge ... [about] the silvics of our indigenous species'. There were four growth plots for messmate and silvertop, but none in ash. The best that the forester could do at the time was only, as he reported, 'In spare moments the number of rings were counted on some stumps in order to get some information about the age of matured trees. The number of rings on the outer inch [2.5 cm] of the diameter on some trees were also measured. An age of 87 years is the average obtained from 8 trees on the girth classes 11, 13 and 15 [107, 126, 146 cm diameter]'.

In 1930, a comprehensive Rubicon Forest Working Plan was prepared by H.R. Gray, an Oxford-trained British forester recruited from the Sudan for the Australian Forestry School in 1927 (Carron 1985: 264). The forest, north of the Divide, included both the Rubicon and Royston Valleys and was both an expanding milling centre and a source of water for a hydro-electric scheme completed in 1928 (Evans 1994). Gray had the assessment reports to hand and concentrated on examining the regrowth from previous cutting, giving 'the virgin stand as a whole more cursory study'. Nevertheless, he and his students measured 23 alpine ash (also called woollybutt) stumps and counted the number of rings in each 2 inches [5 cm] of diameter growth estimating that the trees were approximately 135 years old, confirming the previous view that it was fairly young forest. He also performed a stem analysis from which he was able to construct an age-height curve to show that they reached a height of 200 feet [61 m] at age 135. He observed that dominants in the regrowth achieved half this height by 18 years (amended to 16 years in the copy of the report in the Australian Archives) and he thought that it should be possible to grow a 30 inch [76 cm] diameter tree by age 60, if the stands were thinned. He observed that 'faults appear to develop [in the timber] after about 80 to 90 years'.

Gray declared that 'it is obvious that the age and size of trees in the virgin stand is of no consequence' because clear-felling was the only practical silvicultural system. He set the rotation of the new crop provisionally at 60 years and envisaged that each major division of the forest, or 'felling series', would be converted into an ordered progression of age classes by felling the stands over the unexpired portion of the rotation which would be calculated from when felling started 20-25 years previously.

Fiery end to the classic era

Although there had been large bush fires before, and important ones in the ash forests in 1919 and 1926, there was nothing in either European theory or their own knowledge which could have prepared Victorian foresters for Black Friday, 1939. 'The experience of the past could not guide them to what might, and did, happen' as Royal Commissioner Leonard Stretton (1893-1967) wrote in his report on the fire which swept across the mountain forests, killing people and trees alike. The patient creation of an ordered progression of age classes which had been idealised in the plans forest by forest was also swept away by the wall of fire before classic forestry had hardly begun.

Era of relocation and reconstruction

The foresters and assessors quickly made a reconnaissance of the devastation and estimated that there were 2070 million super feet [6.2 million m^3] of logs in mountain ash and alpine ash trees which had been killed by the fire of which about one half could be salvaged (Forests Commission Annual Report 1938/39). A salvage plan was pursued energetically during the war (Moulds 1991: 84-8), but it was obvious that the mills would have to move to unburnt, hitherto unlogged forests afterwards. The assessors explored what were then remote, inaccessible alpine ash forests in the Alps and East Gippsland. Plans to drive roads into these areas and relocate much of the industry were made in the context of general plans for post-war reconstruction and an expansion of the national economy. Sawmilling centres were built in the 1950s at Heyfield, Mansfield, Ensay, Orbost, Cann River and several smaller places to meet the brisk demand for timber.

It is commonly asserted that logging in the new areas was allowed to proceed at a very rapid rate in the belief that the sawmills would be able to relocate into the central areas once the regrowth from the 1939 fires became old enough to be logged, perhaps when the trees were 50 to 60 years old. Our research does not enable us to say whether this was a formally articulated plan at the time or whether it is a post hoc rationalisation. The period was certainly driven more by pragmatism than the transmuted idealism of classical forestry. The point, however, is that the progression of age classes being created by fire and sawmill logging applied across the State, rather than within each individual forest.

The pulp and paper industry which had been started by Australian Paper Manufacturers Ltd in Gippsland in 1939 had planned to take three-quarters of its wood from the mountain forests including some of their regrowth (Wood Pulp Agreement Act 1936). The fire and its expansion in the 1950s meant that it had to use more mixed species wood from the foothill forests. To this end, the 1952 Boola Boola Working Plan was prepared to manage 50,000 acres [20,000 ha] of a nearby forest, mostly on a pulpwood rotation. Although 'no accurate information is available in respect of increment and growing stock', the increment of firewood in forests at Ballarat was assumed to be sufficiently similar which, with 'casual growth observations and random yields', allowed a tentative rotation of 32 years to be calculated by dividing the anticipated growing stock of 12 cunits per acre [84 m^3/ha] by the mean annual increment of 0.375 cunits per acre per year [2.6 m^3/ha/yr]. New methods of integrated logging were developed (Mann 1958) but a complete review of the pulp mill's resources was needed for a major expansion. The Commission's 1959 pulpwood survey used aerial photographs and ground inspections to map the forests within the mill's economic range by the age of the regrowth—largely determined by its fire history—and the slope of the ground. The two types of pulpwood resource—from mountain and alpine ash, and from foothill mixed species—were each divided into two age classes depending whether they were 'regrowth', defined as being under 60 years of age, or were 'mature' over that age. These categories reflected different pulping properties of the wood and were incorporated in the resulting Forests (Wood Pulp Agreement) Act 1961. The slope classes were needed to evaluate how much of the regrowth might be able to be thinned. The Act called for a formal, 10-year 'Plan of Operations' to be prepared, based on research, which was largely into the feasibility of thinning, conducted jointly by the Commission and the company.

While integrated pulpwood logging enabled new crops to be successfully regenerated on cut-over sites, the Commission was well aware that 'extensive areas of foothill country ... after a century of logging and severe fires ... are virtually unproductive'. Moreover, it was 'gravely concerned with the rate of depletion of the State's resources of native timber of sawlog quality [particularly as] there is no prospect of obtaining worthwhile logs of genuine sawlog grade from mountain ash forests in less than 60 years' (*Annual Report* 1960/61). As in other States and nationally, a major call was made for funds to establish pine plantations which could grow logs more quickly than in the native forests. Native forest planning was strengthened in the Working Plans

Branch and several foresters undertook postgraduate training in advanced quantitative methods. The work concentrated on the regrowth in the mountain ash districts with the intention of starting cutting the regrowth from about 1970. The Commission's aim was 'to control utilization and regeneration in a manner which will lead to sustained yield management' (Annual Report 1962/63). Upper Yarra was an important district with stands from the earlier 1919 and 1926 fires which could be used first. A very detailed cutting plan (Upper Yarra Forest District Cutting Plan 1968-72, FCV file 68/735) also looked beyond its stated period, re-asserting the ordered progression ideal:

> In order to produce a constant supply of sawlogs, it is desirable to have a "normal" series of equiproductive age classes. At the present time, this is far from the case, where over 50% of the area of ash type forest in the Upper Yarra Forest District is of the one age, having resulted from extensive wildfires in 1939 (Appendix 7).

Some attention was given to the mixed species and drier forests. An intensive 'Continuous Forest Inventory System' was installed in the Wombat Forest in 1964 and remeasured five years later (Smith 1973). The diameter increment was reported for each diameter and species class to show how the forest was changing, but it was still a two-tiered forest with an overwood of 80-85 years of age and an underwood of 20-25 years. Areas surrounding the Wombat Forest were considered in a 1976 report (FCV file 75/111) which for the Ballarat Forest District assumed an 80 year 'liquidation period' or rotation, being the time taken for regeneration to grow to merchantable size. It assessed the present standing sawlog volume at 96,000 cubic metres, assumed that the existing trees were growing at one per cent a year, and calculated the 'permissible cut' in the classic manner (Table 4).

Table 4. Example of permissible cut calculation, Ballarat Forest District, 1976

$$\text{Permissible cut} = \frac{\text{present sawlog volume + annual increment of uncut sawlogs}}{\text{liquidation period}}$$

$$= \frac{\text{96,000 cubic metres + (1 per cent per year x 96,000/2)}}{\text{80 years}}$$

$$= \text{1,680 cubic metres per year}$$

Era of regional sustained yield

In 1982 a new reforming government was elected with a strong environmental platform of placing environmentally important forests in national parks and ensuring that the rest were managed in a sustainable manner, region by region. The Commission (1984) argued that a regional sustained yield was an elusive and impossible ideal in the face of fires and other likely changes which it listed region by region. It advocated a system of regulating the yields rather than following the normal forest ideal of an ordered system of age classes in each forest but it did not succeed in upsetting the Government's policy of applying the system regionally rather than across the State as a whole. The regions were of course many times larger than the individual forests which had been considered in the first era. Several incipient forest management problems also came to a head. The idea that the 1939 ash regrowth could be thinned to produce pulpwood from the 1960s and larger sawlogs from the 1970s had been tried and abandoned as impracticable on any scale, the sawlogs produced from the regrowth were not of as good a quality as expected, and the shift of sawmilling back from the Alps and East Gippsland to the Central Highlands had not happened. More importantly perhaps in the long term, was a change in the interpretation of the ideal of sustained yield. Rather than being just the yield of timber, it was all the uses and values of the forest which were to be sustained in a planned way.

The Government commissioned the University of Melbourne's Professor of Forest Science, Ian Ferguson, to examine the situation (1985) before it prepared an industry strategy (1986) which laid down, among other things, that the forests in each region were to be planned according to its ideals of economic viability in providing wood, environmental sensitivity, and sustainability for all values for future generations. To reassure an anxious industry, the government passed the *Forests (Timber Harvesting) Act* 1990 which mandated the minimum level of sawlog production which each of 15 'forest management area' plans had to ensure for the next 10 years. The first of the new plans covered the Otways and was completed in 1992 (Brinkman 1990, Dargavel and others 1995). One for East Gippsland was completed in 1995 while those for several other regions are in various stages of preparation. Each plan shows how the mandated level of sawlogs can be supplied and estimates what level of yields would be sustainable in the long-term; the cut in the Midlands area, for example, is likely to have to be reduced by 17 per cent after 10 years. An elaborate computer model aided the calculations for the Otways, but a traditional approach was used for the other areas. In Central Gippsland, for example:

> The long-term sustainable yield is calculated by multiplying the net available area of each forest type by the annual growth rate for the planned rotation length. Nominal rotation lengths vary from 60 years for eucalypt plantations, a minimum of 80 years for ash forests and between 80 and 120 years for mountain mixed and foothill mixed species forests respectively (Dept. of Conservation and Natural Resources 1993a).

Table 5 Growth assumed and rotation adopted, Central Forest Management Area

Species	Mean annual increment of sawlogs (m^3/ha/yr)	Rotation (years)
Alpine ash	2.5	80
Mountain ash	3.0	80
Shining gum	3.0	80
Messmate (high site quality)	1.2	100
" (low site quality)	0.8	100
Radiata pine plantations	15.0	35

Source: Dept. of Conservation and Natural Resources 1993b

The growth rates assumed and rotations adopted were tabulated as in the critical Central region, which included the Upper Yarra District, for example (Table 5). The rotation lengths listed in this era were longer than those listed in the 1930s and probably reflected a more realistic assessment of the time needed to grow a log of commercial size. For example, Gray's hope in 1931 that alpine ash logs could be grown in 60 years had depended on being able to thin the stands which was considered to be impracticable in the 1990s.

Our research has not investigated whether the rotations listed in the 1990s have a logical basis, but at first glance, they appear to us to be little more than arbitrary selections, justified more by repetition from plan to plan than by substantial analysis of growth, ecological or economic information. Their history indicates that they probably reflect the age at which final crop trees are expected to reach a merchantable size, or perhaps the age of maximum mean annual increment. They are notably far younger than the age of ecological maturity, which would be needed if silvicultural rather than preservationist means were to be used to sustain the environmental values.

In practice, the classic ideal of an ordered progression of age classes had to make way for two major considerations. First, the plans had to schedule logging from the stands in the real forests which were in far from the ideal normal condition. Different options for doing this had to be explored to find a way of spinning out the resources available to the industry in a way which would allow it to increase in future. Second, the requirement to sustain all the other uses and values of the forest had to be addressed. Some of these required taking parts of the forest, such as wildlife corridors and streamside protective strips, out of the wood production area, others required actions, such as opening or closing roads and tracks, quite unrelated to wood production. While classic forestry had at least provided a set of terms and concepts for thinking about sustained timber yield, there was no single set which could cover the sheer variety of other uses; the planners simply had to deal with the issues site-by-site. An ordered progression of age classes had been transmuted and transmitted to Australia but remained more a classic ideal than a real practice.

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7

Assessing Queensland's forests

John Dargavel and Damien Moloney

Introduction

Any assessment needs its subject to be clearly identified, the attributes of interest defined, their quantities measured and an overall valuation estimated. This is notably difficult for forests because of their extent, remoteness, variability, multiplicity of ecological and social functions, and dynamic nature. Moreover, their valuation commonly requires taking forecasts of their future condition into present account. In large forest organisations, standards have to be prescribed, and assessors trained so that assessments of different areas are comparable and can be aggregated. All this takes time, techniques, equipment, personnel and hard work. The cost has to be balanced against the value of the information gained and endeavours made to develop more efficient techniques. Conversely, what can be known about a forest, and which of its many functions can be valued is always conditioned by how far the difficulties of assessment can be dealt with at the time.

A series of assessments over time can gradually build knowledge about a particular forest, although changes to the forest or the attributes of interest can make previous assessments irrelevant. Earlier assessments may be lost, or may be too difficult or expensive to retrieve, especially if old maps and measurements have not been converted into an electronically-readable form. A current hazard is the loss of 'organisational memory' of the standards by which past work was performed. This chapter briefly describes the stages in which Queensland's crown forests have been assessed from the era of exploration and pioneering searches for timber, through an era of strip surveying, and an era of establishing a continuous forest inventory, to the present environmental era with its current old-growth and other surveys (see also Chapters 24 and 25). It shows that what was achieved in each era was conditioned by what had been done before, by the resources and technologies available, the organisational structure, and the values of interest.

Era of exploration and pioneering

Histories of the European exploration of Queensland and the extension of its pioneering frontier have described the journeys of early explorers like Oxley, Leichhardt and Dalrymple, and the progress of settlement in the nineteenth and early twentieth centuries (e.g. Bolton 1963, Johnston 1982, Roberts, 1924). It is sufficient here to make some general remarks about the period in terms of the requirements and difficulties of assessment.

Most obviously, identifying the features and resources of the vast landscapes was the prime task of exploration. The major rivers, plains and hills had to be found and their relative locations determined. It was a long process. For example, although Moreton Bay was assessed by Oxley in 1823, the major features of north Queensland were not reported until Dalrymple's expedition in 1873. Gradually, charts and maps were drawn, amended and improved. Land suitable for grazing, farming and growing sugar cane, or with the chance for gold, were the main attributes of interest. This was accompanied by scientific interest in the taxonomy of the biota, another long process started by Banks and followed in the 1820s by Cunningham, after whom hoop pine (*Araucaria cunninghamii*) was named. Knowledge gradually accumulated: Ferdinand Mueller made further collections while on Gregory's northern expedition in 1856, for example, and Government Botanists were appointed with a botanic garden and herbarium to support them. However, it was not until the turn of the century that the first flora of Queensland was published (Bailey 1899-1905). A standard guide which forest assessors could use for identifying the trees of the sub-tropical rainforests did not appear until 1929, and it was not until the 1951 edition that many tropical forest species were added (Francis 1929, 1951; further additions and amendments were made in 1970 and 1981 editions).

The explorers had an eye for timber, Oxley reporting hoop pine 'fit for the topmasts of large ships' (cited by Carron 1985: 96) and Dalrymple bringing samples of timber from north Queensland to Brisbane for examination. Apart from local use for the small colony, timber was valued as an export in the log or as rough-sawn timber for the Sydney market. This was mostly red cedar, although some 'Brisbane pine' (presumably hoop pine) had also found its way onto the Melbourne market by 1880 (Dargavel 1988). Queensland timbers were far less known internationally than those of the other colonies (Laslett 1875), but attempts were made to publicise the rich variety available by sending 'a magnificent, extensive and instructive collection of 200 varieties of timber' to the 1879 Sydney International Exhibition (Anon. 1881), and 449 varieties to the Colonial and Indian Exhibition of 1886 in London (Bailey 1886). In timber too, science was a long time coming, E.F.H. Swain issuing his text on timber properties in 1928.

While such official endeavours identified and mapped the major features, and sought to identify the trees and their timbers, it was the individual pastoralists, selectors, prospectors and timber cutters who, in seeking pastures, soils, minerals and timber trees, assessed the country on a smaller, informal scale for their immediate, personal interest. They traced the rivers and streams back into the hills, found where ridges ran and how routes could be pushed through broken country. They found trees they could sell and timbers they could use. Their valuations were pragmatic and quickly proved, or miserably disproved by experience. Importantly, they could assess the forests incrementally, finding enough timber for the next month or year, then seeking more.

The well-known case of the red cedar trade illustrates this two level process of assessment. It was an official exploration of the Hawkesbury River which found this valuable wood in 1790, but it was all the parties of cutters who searched it out, patch after patch, river by river up the coast. And when Dalrymple reported good timber on Queensland's north coast, it was the Freshney brothers and other timber-getters who quickly revealed its wealth on the Mossman and Daintree rivers (Bolton 1963: 76-7). The sawmilling industry, as it gradually developed in the 1860s and 1870s, continued this informal process of searching for its resources. However, large firms, like Hyne and Son (Johnston 1988) and Wilson Hart (Maryborough Chronicle 1988) which expanded rapidly from their Maryborough bases in the 1880s, needed to plan their future and justify their investments over much longer periods than the manual cutters or small sawmills had needed. Informal assessments, even by their own experienced timber-getters would not do, nor would the lack of adequate state forest reserves and a forest service to manage them. The widespread movement for forest conservancy, which had already begun in a small way in Queensland, was advocated more forcefully by R.M. Hyne and others to good effect.

Era of strip assessments

A Forestry Branch was set up in the Lands Department in 1900. The part-time Inspector of Forests reported in 1903 on the need to reserve 'young or mature timber' and prevent the cutting of 'young and undersized timber ... which if allowed to mature would be a valuable asset.' However, it was accessibility for logging, not growth potential, which was the attribute of interest, and the forests were classified, and implicitly valued, in accessible, difficult and non-accessible categories (Carron 1985: 98). Eventually in 1906, the *State Forests and National Parks Act* was passed and the Inspector, Philip MacMahon, was appointed as Director. MacMahon commenced an assessment of 1.5 million hectares of state forests and timber reserves to appraise their quality as well as quantity. The work was started about 1910 by one or more crews from 'Forest Valuation Camps' (Vanclay and others 1987). MacMahon died prematurely and was succeeded by N.W. Jolly who continued the assessment and in the words of E.F.H. Swain, his successor, 'pioneered the principle of sustained yield' (*Report of Director of Forests* 1918). While the principle may have entered the government mind, little could be done about it until the forests were located, and their timber stocks and growth rates determined.

It was not until 1920, when returning soldiers had been recruited to staff the Forest Service, that the era of extensive timber cruising could begin. Five forest survey camps and two cruising camps 'engaged in the important duty of demarkation [*sic*]' were set up and the next year a conference of forest survey officers was called to standardise their procedures (*Report of the Director of Forests* 1920, 1921). The term 'camps' was used to denote one or more survey crews, usually of three or four men, who lived in tented camps in the forests that they were surveying. The conference was chaired by Lieut. Reg Douglas, whose appointment as the 'Forest Topographer' highlights the priority that had to be given to mapping all the details of ridges and creeks which had only been known informally before. Corby Woods was Forest Topographer (1921-1928) and there may have been others. Three classes of survey were defined.

Class 1—Explore and investigate vacant Crown land

The most general surveys were designed to identify areas of the State which should be reserved as forest rather than being selected for agriculture. Doubtless, some areas could be dismissed fairly readily, but others were examined systematically by surveying parallel lines through the forest, probably at 40 chain (approx. 800 metre) intervals. This enabled the salient features of the landscape to be mapped and comments made on the nature of the forest. It could be remarkably tough work, as even official reports reveal:

> The Atherton forest survey party suffered from the disability of food shortage, due to the shipping strike, a severe drought for half the year, and abnormal rain for the other half, the impediment of the debris from the 1918 cyclone, the rough and broken nature of the country, and the difficulty of retaining survey hands. Nevertheless, 62 miles [103 km] of compass and chain and 55 miles [93 km] of compass and step survey were completed (*Report of the Director of Forests* 1920).

Class 2—Feature and assessment surveys of timber reserves and vacant Crown land

More detailed surveys were conducted in forests with commercial value to map the topography and estimate the quantity of the timber resource. Parallel strip lines were run through the forest at 20 chain [approx. 400 m] intervals and the diameter of every tree within one chain [20 m] either side of the centre line was measured, the number of nine foot [2.7 m] logs in each estimated and tallied in special survey books. The more detailed maps of the ridges, creeks, tracks and other features which resulted were commonly annotated with remarks about the species or their quality (Map 1). The survey book tallies were worked up, volumes of merchantable timber calculated, a fair copies of the field maps drawn and reports of the assessments prepared. The substantial camp and office work involved was reserved for the wet season or bad weather.

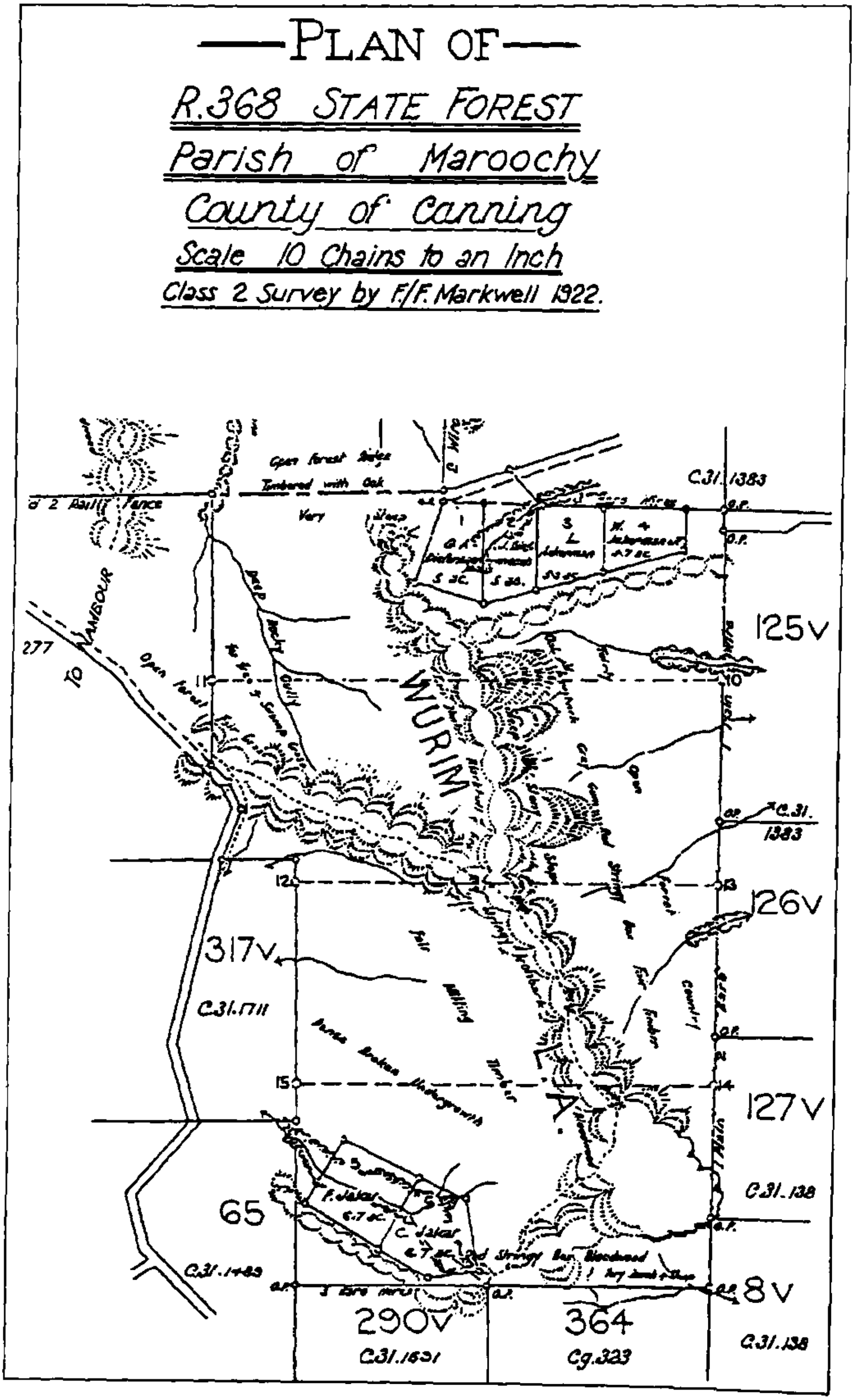
These surveys were used in two ways. If the forest was a valuable one, they provided evidence in support of a Forest Service case to have the land permanently reserved as state forest. If not, they provided an estimate of its timber value which an intending selector would have to pay.

Class 3—Valuation and organisation surveys of state forest

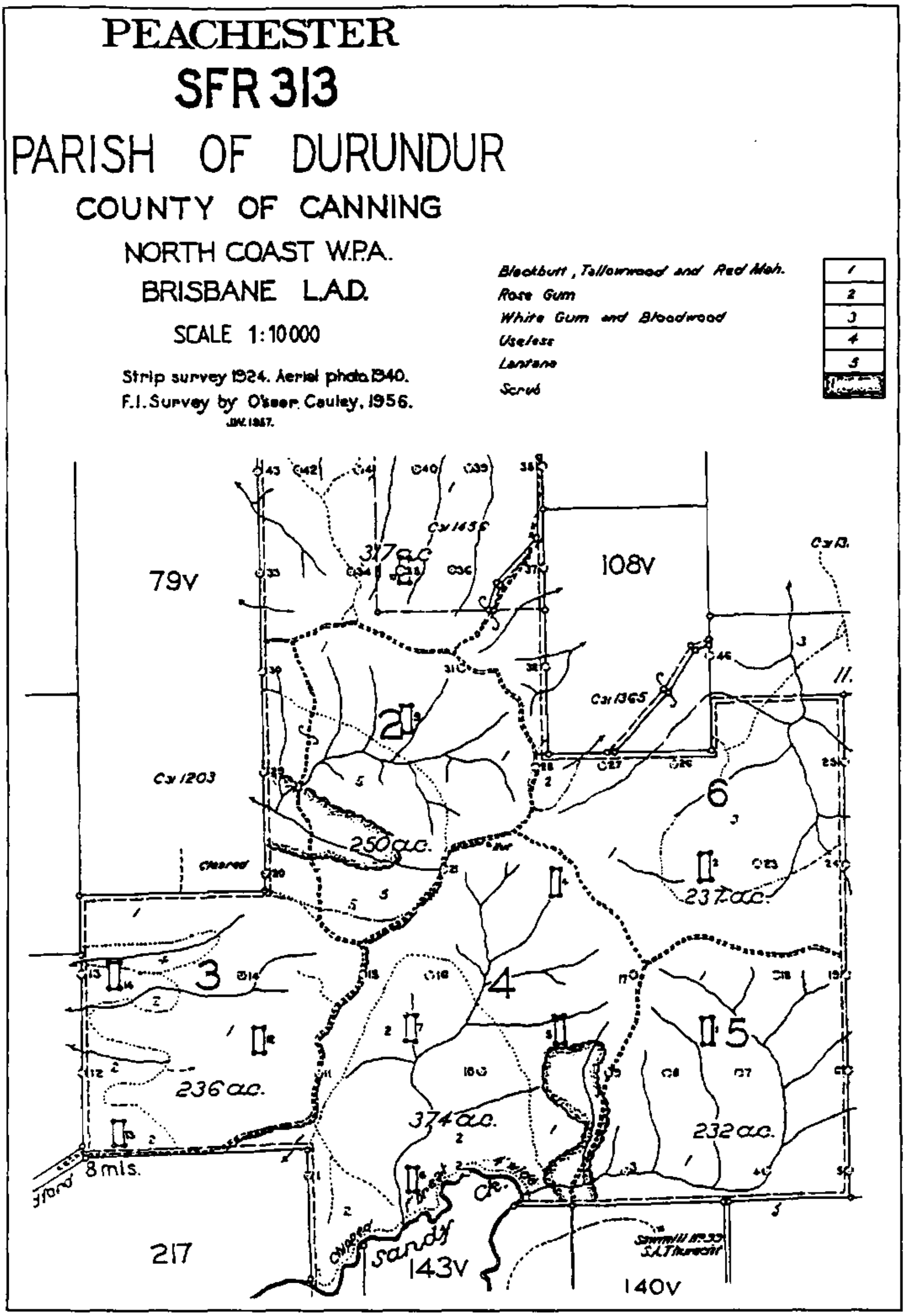
It was on state forest that the most intense surveys were conducted. These were conducted as strip assessments, as in the Class 2 surveys, but more intensely as the strip lines were closer together and the forest and topographic features were mapped mostly at a scale of 10 or 20 chains to 1 inch [1:7920 or 1:15,840]. Forest types were catego rised by their predominant commercial species. For example, a 1924 survey at Peachester recognised four groups of species as well as 'useless', 'lantana', and 'scrub' types whose boundaries appear to have been mapped in finer detail (Map 2). By 1926 a process of dividing the state forests into numbered compartments, typically of 100-200 hectares, surveying and marking their boundaries was well in hand.

As the plantation programme expanded in the 1930s, very detailed surveys were commenced which not only mapped their layout, mostly at a scale of 10 chains to the inch, but surveyed the contours of the land. The intensity and expense of these surveys highlights the greater importance attached to these young plantations than to native forests by the Forestry Department (created as a sub-department of the Lands Department). It was in the plantations that the Department was most obviously investing public funds and where their future growth and yield was uncertain. By comparison, the prosaic management of the native forests must have seemed less prone to scrutiny.

Taken together, these various classes of surveys demanded an enormous and increasing effort by the Department. A peak was reached in 1940/41, after which assessment stopped during World War II, except for one camp which operated in north Queensland making urgent estimates of kauri and other species to be used for aircraft construction. Some idea of the enormous effort demanded in this work can be gained from the areas summarised in Table 1.



Map 1. Maroochy State Forest (R368)—part only. Class 2 Survey by Forest Foreman Markwell in 1922 at a scale of 10 chains to 1 inch (1:7,920).



Map 2. Peachester State Forest (SFR 313)—part only. The map of the original strip survey was probably drawn at a scale of 10 or 20 chains to 1 inch (1:7,920 or 1:15,840). This map drawn by J.W. at a scale of 1:10,000 shows the large forest inventory plots installed by Overseer Cauley in 1956. The stand types shown are probably those mapped in 1924.

The 1940/41 annual report shows that the strip surveys sampled almost a quarter of a million hectares at an intensity which we estimate to be about 1:19. In that year, the crews traversed 863 kilometres of compass and chain lines, 6461 kilometres of strip surveys, and 380 kilometres of various traverses of scrub patches, tracks and roads—a total of 7704 kilometres almost all in straight lines up hill and down dale, across creeks and ridges, through thick vegetation and thin, and further than Burke and Wills had travelled eighty years earlier.

The assessments gradually extended the Department's knowledge of the forests until many, but not all, of the existing state forests and timber reserves had been covered by the 1940s. The knowledge was held not only in the bulging cabinets packed with detailed maps and quantitative reports, but also from the intimate experiences of those who had worked on them. In this sense, the earlier informal era of assessment was echoed in personal experience and organisational memory.

Table 1. Method and areas assessed in sample years, 1921 to 1941

	Explore and investigate *(Class 1)*	Feature and assessment surveys *(Class 2)*	Valuation & organisation surveys *(Class 3)*	Compartment & plantation surveys
Land tenure	Vacant Crown land	Timber reserves and vacant Crown land	State forest	State forest
Method	Line inspections	Strip survey, map features	Strip survey, map features	Boundary and contour surveys
Map scale	Not mapped	1:15,840 or 1:7,920	1:15,840	1:3,960 for plantations
Year		Area (ha)		
1921	268,838	37,272	23,976	
1926	208,876	2,388	23,949	22,044
1930	136,469	47,556	11,398	24,676
1935/36	4,160	23,621	23,006	60,015
1940/41	28,388	241,933 *	92,506 #	

* North Queensland for war effort; # Type and soil surveys. Dept. of Forests, *Annual reports.*

Era of air photo interpretation and continuous forest inventory

The first opportunity of improving strip assessment came when aerial photographs became more readily available after World War II. For the first time, foresters could see a representation of the forest as a whole without having to sketch how the creeks and stands ran between their survey lines, or traverse round every patch of rainforest, or 'scrub'. In many areas of north Queensland, military mapping had produced contour maps at a scale of 1 inch: 1 mile (1:63,360) which were of great help, and gradually the cartographers were able to extend the coverage. The Department was quick to take advantage of the war-time photos and in the 1950s started to commission some of their own.

Aerial photographs enabled the winding creeks and ridges to be mapped with much greater accuracy than had been possible from the strip surveys and it was not uncommon to find that the drainage pattern originally mapped needed substantial revision (L.T. Carron pers. comm.). However, their greatest advantage was in revealing the pattern of the forest stands. Their structure, rather than their species composition, could also be seen and it was remarkable what trained and experienced people could interpret. The categories appearing on the maps included: 'rain forest or scrub', 'scrubby forest', 'forest', 'rung'(ie. ring-barked), 'eucalypt regrowth-regeneration and saplings', 'eucalypt regrowth-poles', 'useless regrowth on former scrub lands (wattle, lantana, etc.)'. Their areas were neatly mapped, but species and quantities still had to be determined on the ground. The attributes of interest were still primarily the present timber resources and access to them, but interest in the future of the forest was reflected in the mapping of regrowth stands.

With aerial photo interpretation able to ease the task of identifying where the timber stands were, foresters could at last turn to the essential task for sustained yield management, that of monitoring the growth of the forest. A continuous forest inventory system, first developed in North America, was tried at Western Creek in 1941 and extended to some coastal hardwood areas in 1945 (Vanclay and others 1987). The Department instituted this class of assessment for state forests and installed a grid of quite large, one acre [0.4 ha], permanently marked plots in every 500 acres [200 ha] or so in which the girth of every tree was measured and its species recorded (Map 2). By 1968, approximately 5500 plots had been installed on about 40 per cent of the state forest. The plots were remeasured every five years or so. Successive stand tables showing the number of trees in each diameter class prepared from these data enabled the growth of the forest to be estimated. In forests which can be managed intensively on a silvicultural selection system, the approach provided a basis for deciding how many trees of each class could be cut. In addition, individual tree measurements were made on some 'detailed yield' plots chosen to be 'representative of the average conditions of the major types' with the intention of providing more detailed growth information (Vanclay and others 1987).

Strip assessments still had to be undertaken in the 60 per cent of the state forests not covered by the continuous forest inventory, but the greatest work load related to the 'conversion of tenure' of public lands once the Bjelke-Petersen Government had passed its *Land Act* 1962 which enabled lessees of public land to apply for freehold, a process which gratified the government's rural support base while raising revenue. The assessments were of the Class 2 standard except for small patches of forest where every tree was measured. If the forest had enough high-quality timber, it might be recommended for reservation as state forest, otherwise the lessees were sent a description of the forest and an account, the amount of which they could contest in a Land Court. As much of the converted land was subsequently cleared, the forest assessors were put in the bizarre position of having to facilitate deforestation. They had always had some of this work, but the conversion 'boom' in the 1960s and 1970s was such that by 1984 the assessors had dealt with nearly 4000 applications and assessed 12.7 million hectares, more than three times the area of the state forests. The total amount of strip surveying both on state forests and for tenure conversions, reported in most of the Department's annual reports, shows an increase from an average of 1800 kilometres of strip lines assessed per year in the 1950s to 7400 kilometres in the 1960s and 5600 in the 1970s. Over 10,000 kilometres were assessed in each of the peak years of 1965 and 1967. Strip assessments continued as forested leases were still being converted to freehold in the 1990s and doubtless many were deforested.

There was a considerable amount of surveying of roads, plantation and compartment boundaries which was carried out in addition to measuring the inventory plots and strip surveying. The number of crews, or 'camps', increased until there were 36 to 37 at work in the peak years and over 180 people were employed in the forests with more needed to draw the maps (Table 2). Together they amounted to over nine per cent of the Department's entire workforce. With so many people and a high turnover, the need for training and standardisation was even more important than it had been for Lieut. Douglas. Young foresters fresh from their cadetships were put to the task and a three-year training course was started in the 1950s from which survey overseers graduated to good effect. Even with aerial photographs, where these were available, the work in the forest remained arduous and repetitive, although it became slightly more comfortable in the 1970s when caravans were bought to replace the tents. The Department produced a handbook (Queensland Forest Service 1962) which provided detailed instructions for conducting basic and strip surveys. It laid down how vegetation types were to be classified by tree species and how trees estimated along the strips were to be booked by four utilisation classes: 'mill logs and girders'; 'round timbers—poles, piles, house blocks'; 'sleeper trees'; and 'split posts'. All other 'useless' trees, it declared, were not to be booked.

Table 2. Assessment and mapping staff 1964/65

Grade	Number	Grade	Number
Foresters	11	Trainees	11
Forest surveyor	1	Men	120
Forest rangers	9		
Survey overseers	35	Total assessment staff	187
		Drafting Branch	19
		Total staff	206

Source: Dept. of Forestry, *Annual Report* 1964/65

Whereas the strip surveys were recorded in field books and their results worked up into tabulated reports of the condition of the forest at the time of assessment, the continuous forest inventory system demanded permanent plots so that growth rates could be determined. The network of per-manent and detailed yield plots was gradually extended to cover the most valuable forests and the plots were re-measured at approx-imately five-yearly intervals. The great amount of data generated by this form of assessment could only be processed effectively by computer programs which were developed from the 1960s. The combination of aerial photography with the plot-based inventory system during the 1950s and 1960s enabled the first calculations to be made of how much wood could be allowed to be cut from the state forests under the sustained-yield principles avowed by Jolly so many years before. Clearly timber was the attribute of interest during this era of expanded activity, but its primacy was not to last.

Environmental era

It was the environmental attributes of the forests which became of rapidly increasing interest from the early 1970s and the subject of public controversies and political conflicts over logging in the wet tropics, on Fraser Island and in many other regions

(Bonyhady 1993, Dargavel 1995, Mercer 1991, Taylor 1994). The history of their assessment is far more diverse than in the previous era as fauna, flora, aesthetic and other attributes had to be assessed, and as more agencies—most notably the Commonwealth's—and environmental and scientific bodies also undertook assessments, sometimes in cooperation with the Queensland Department of Forestry and sometimes independently. Most public attention in the environmental era was directed to the forest animals so that their assessment, and the impact of logging on their well-being became an important task. The numerous environmental disputes, inquiries, consultations and plans created seemingly insatiable demands on the Department's planning, assessment and mapping staff. A separate environmental unit was established and the number of people in the drafting office doubled. At the same time, Queensland was also subjected to the organisational restructures and staff reductions which affected all of Australia's forest services during the 1980s and 1990s. They added to the turmoil and diminished part of the organisational memory needed to retrieve the assessment legacy for the new issues. Nevertheless, existing assessment procedures were revised, new ones developed and new technologies deployed, which enabled some of the new assessments to be conducted in ways far more sophisticated than anything before.

Permanent plots

New parameters were added to those measured on the existing network of permanent plots. From the 1980s the crowns of the larger trees were classified in terms of their size position and leaf area. From 1993 the minimum size of tree recorded was reduced from 20 to 10 cm diameter, the amount of regeneration measured on sub-plots and soil information recorded. Reflecting the increased interest in vertebrate fauna, the presence and distribution of nesting hollows was recorded.

Fauna

Zoologists in the Forest Service carried out fauna surveys throughout the State from the mid-1960s and in 1969 began ground-breaking studies into rodent pest management in hoop pine plantations which were continued into the early 1970s. In 1975 the National Parks and Wildlife Service was created as an organisation separate from the Forest Service which had managed the national parks till then. The new service had to survey the fauna in the coastal lowlands of south-east Queensland, where large-scale clearing for the establishment of exotic pine plantations was occurring, as part of the environmental impact assessments required by the Commonwealth. In addition, detailed studies of indicator species, such as lorikeets and gliders were undertaken to measure the impacts of forest operations. These studies involved capturing and marking of large numbers of animals; the greater glider studies in particular involved detailed radio-tracking, utilising what was then fairly new technology for Australian zoologists.

By the early 1980s the spotlight on fauna had shifted to the wet forests of the Conondale Ranges due to public concern over the impact of logging there. A whole suite of studies was initiated to investigate the diversity of all vertebrate groups and the impacts of logging. The first paired-catchment study of fauna in Queensland was also set up to monitor the impacts of logging on two highly-restricted species of freshwater crayfish, then virtually unknown to biologists. In addition, a readily portable system—the Anabat detector—was developed for monitoring micro-bats by their ultra-sonic calls. It enabled zoologists to sample the occurrence of bats easily for the first time. The Conondale studies through the 1980s led on to Commonwealth funding during the 1990s (under the National Rainforest Conservation and Landcare Programs). Projects were undertaken in state forests on endangered, vulnerable and rare species (such as the black-breasted button-quail, yellow-bellied glider, micro-bats and marbled frogmouth) dependent, or partially so, on rainforest. Studies were also undertaken of the utility of wildlife corridors and remnant bushlands to fauna.

In the 1990s faunal studies diversified in scope and direction, primarily in response to the burgeoning number of laws and agreements that imposed major obligations to manage the forests in an environmentally sensitive way. The assessment and research program of the zoologists was diversified accordingly to provide increased information. Research, survey and monitoring in the 1990s became closely tied to the Comprehensive Regional Assessment process, ecologically sustainable development, farm forestry, forest health, the requirements of the *Nature Conservation Act* 1994 and the logging code of practice. A computerised system was set up as a major means of communicating information about flora and fauna to the relevant people.

Technologies

Of the new technologies, it was the images taken from space satellites in the 1980s that contrasted most spectacularly with those of the era of exploration. The features of the State which had been so patiently assembled area-by-area with such difficulty over more than a century were suddenly revealed together in each satellite pass. The images covered the country and their component bands could be manipulated to highlight particular features, such as forests. At last a consistent, comprehensive map of all the State's forests and woodlands, covering over 50 million hectares, could be made in a manner which could never have been achieved by the traditional mapping methods.

The new images added another level of knowledge about the forests, but it was the advent of geographic information systems (GIS) technology during the 1980s which opened up a remarkable means of bringing existing maps and various forms of data together. At first it was used as an efficient tool for storing and plotting mapped information and as a means of reducing the number of cartographers needed to draw, or revise the forest reserve maps with all their intricate detail of streams, ridges, tracks, and types of stands. However, the most powerful advance lay in the ability of these systems to overlay several different types of maps or other spatial information and produce new classifications of the forest landscape. Rainfall and temperature had long been measured in forest districts across the country and although it had been assiduously tabulated in forest working plans, it had rarely before had any bearing on how the forests were assessed or managed. The new systems enabled such data to be manipulated in statistical models by computers and combined with topographic, geologic or soil map information wherever available. The new classifications, or 'environmental domains' which could be generated were based, as far as possible, on a prior scientific understanding of the environmental processes at work. They were particularly suited to analysing the distribution of particular species and began to be applied from the mid 1980s (e.g. Nix 1986). Although the geographic information systems relied on maps and the vast legacy of data accumulated in museum collection records over a century or so, and in the forest assessment reports and maps, they had to be retrieved and converted to an electronic form. It was a use which could never have been envisaged when they were collected so that although many were used, others had to be discarded and many remain as a potentially rich source for historical studies. Computers, programs and the trained staff to operate the new systems and convert the old data had to be obtained so that it was not until the 1990s that they could be brought to bear on assessments regularly.

Wet tropical rainforests assessment

The rainforests of the wet tropics, which had been so laboriously assessed for their cabinet and other timbers for half a century, became the prime focus for assessing environmental attributes with the new technologies. Their eventual inscription on the World Heritage List in 1988 recognised the area for its evolutionary history, ecological and biological processes, natural phenomena and importance for the conservation of biological diversity. But assessing such attributes to determine where the boundaries of the area to be preserved should lie was a difficult task, especially given the politically fraught and harried atmosphere in which Queensland opposed the Commonwealth's nomination in the High Court. Each built its own computer-based geographic information system to support its case.

Queensland hurriedly developed its system from early in 1988 as a joint venture between its (then) Department of Forestry and Department of Environment and Conservation with assistance from other departments as required. Foresters, ecologists, cartographers and computer personnel combined to build a multi-layered system to cover the 894,000 hectares of the World Heritage Area. As the case developed, those giving evidence needed a variety of outputs to be plotted from the system. More data layers had to be added which imposed an enormous strain on the staff who also had to cope with increasing volumes of alpha-numeric data needed to describe the rare and threatened flora and fauna of the area. The scale and detail of the data from different sources required careful monitoring to ensure its accuracy. The work was greatly increased when the area to be studied was expanded to cover the whole biogeographical region of 2.6 million hectares. At the height of preparations for the case, the system contained over 30 layers of data which demanded massive storage capacity on the Government's computers. All the equipment and skills developed for this case provided a solid grounding for developing an integrated remote sensing and modelling system for Queensland's forests (Preston 1995) and for the recent old-growth assessment project (Chapter 25).

Meanwhile, the Commonwealth's Department of Environment commissioned a team at the Australian National University, led by Professor Henry Nix, to display the distribution of the various types of rainforest and their endemic species. The team built a computer model of the topography and climate with which it mapped appropriate environmental domains. It then hunted through herbarium and museum records to see where the plant and animal specimens which had been collected for well over a century had come from. The locations where many of the older specimens had been collected had not been recorded precisely enough, but many others were able to be incorporated into the model and the distributions essayed. The pace and style of the political decision-making led to the boundaries being set on the basis of various sources of information including Queensland's system and some of the early results from the Commonwealth's model. The model was subsequently improved to display the distribution of the rainforest animals (Nix and Switzer 1991). Both models proved exemplars for studies which were to follow on 'old-growth' forests, but by then the

National Forest Policy Statement (Australia, Council of Australian Governments 1992) had been signed and a more co-operative approach had been negotiated.

Persisting themes

The current old-growth assessment project (Chapter 26) with its multi-faceted surveys, advanced computer systems, published reports and political interest seems a world away from the collections of the early botanists or the assessments of timber men clambering through the forests to find another patch of workable logs. Yet some themes persist across the eras described in this paper which we wish to draw out as reflections on the nature of assessing forests.

First is the size and cost of the task. The sheer physical effort of traversing many thousands of kilometres in straight lines through the forests for fifty years stands out most sharply. Remarkable too was the endeavour to install and remeasure plots in a grid across the state forests. Although the effort required was eased somewhat as roads and tracks spread and was aided by aerial photography, the cost of timber assessment was substantial. The environmental era brought new attributes to be assessed, some of which, such as the flora and fauna surveys, also required direct observation in the forests. In spite of this, the total effort of observing the forests directly almost certainly declined from its peak in the 1960s. The marshalling of existing information and its manipulation in geographic information systems brought its own demands for equipment, staff and costs. The points to be made here are that assessment has always involved a substantial cost and that this has limited the amount which it was possible to know about the forests at any given time.

Second is the balance between permanence and transience. In each era some assessments add to the accumulating store of knowledge about the forests, while others are irretrievably lost. Accumulating specimens in herbariums and museums, spreading topographic and geological surveys, and long-term climatic records are examples of assessments which have the potential to increase knowledge about the forests permanently. The potential can not, however, always be reached because the costs of retrieval may be too high or because of inconsistencies or lack of precision in the original observations. At the other extreme, some assessments seem of only of passing interest, at least at the time. The first timber cutters needed no records of what they felled, nor have the records of assessments made on the 12.7 million hectares of forested land converted to freehold seemed of much value, although both might now prove useful to reconstruct Australia's ecological past. However, old assessments can provide a start for new sampling as in the case of the long-term yield plots in the wet tropics. Their measurement was discontinued when the area was placed on the World Heritage List and logging stopped, but have been started again to learn more about the dynamics of these forests. And it is clear that the measurements so patiently accumulated in the permanent plots for their original purpose of timber management proved an invaluable source of information in the most recent old-growth assessment undertaken for a very different purpose.

Somewhat related to the second theme, is the changing balance between direct personal observation and experience in the forests on one hand, and indirect and remote observation from aerial photographs and, at extreme, satellites on the other. The two can be seen as yielding knowledge at different levels of abstraction. The fallers testing the soundness of trees by their 'ring' to the axe, or the timber assessors measuring them, or the wildlife assessors releasing animals from the traps had an immediacy and personal depth to their observations of the forest. Yet the accumulation of indirect observations from the first theodolite triangulations to the latest satellite images provided a formal and stylised knowledge of the forest as a whole which was beyond the ken of individuals within it. Conversely, the indirect or remote observations only acquired their meaning from the forests directly observed. Yet the operators making the digital records on computers or manipulating them in geographic information systems may never have had any immediate or personal experiences of the trees or forest animals, except perhaps those gained on holidays.

Fourth is the inherent nature of the problems of sampling, interpolation and estimation with which each era had to deal. The early timber workers dealt with them informally, searching where they could and guessing what stands might be between until they could get to them. The strip survey system did so rigidly by observing along its lines, interpolating the run of creeks and ridges as best it could between them, and estimating the total quantity of timber from the sample measured. The continuous inventory system had a similarly rigid layout of plots and was used to estimate growth for the forest as a whole much as the strips had estimated its quantity. More difficult are animals which move or intangible aesthetic and heritage values which needed to be assessed in the environmental era. The heroic endeavours to incorporate the new information with that gathered in earlier eras for different purposes into geographic information systems could not escape the inherent problems. The most obvious one came from the reliability and scale of the original maps. Topographically these were rarely better than a scale of 1:63,360 or 1:100,000, while geological and soil maps were rarely better than 1:250,000. The climatic maps resulted from ingenious calculations made using continent-wide models with whatever long-term data were available from local weather stations. The distribution of the major tree species could be obtained from the strip and plot assessments, but the distribution of animals and plants often had to rely on irregular data, such as museum collection records. The manipulation and integration of such disparate sources of information made the best use of them, but the sophistication of the technique could not eliminate their innate uncertainties. As in every era, what could be known about the forests was conditioned by how far the difficulties of assessment could be dealt with at the time

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8

Bush, brush, forest and scrub

Pauline Curby

Introduction

This paper considers the values placed on some of the forests of the north coast of New South Wales, over the last hundred years. The first part is based on work undertaken on forests of the Dorrigo Plateau. The perspectives of a forest inspector from the 1880s and, from the 1890s, a grazier and a botanist are referred to; in the 1930s the attitudes of a range of different people to a specific Dorrigo forest are discussed. The way in which foresters valued, or devalued, certain types of forests in the period from the 1940s to the 1980s is also considered. Finally, the value ascribed to these forests in the 1990s is examined based on work in two forests north west of Dorrigo. What is of importance to most of the people concerned is connected with knowledge and use of the forest and, most importantly, with identification with a specific forest locality. These values are only implicitly related to forest age, a concept which is rarely explicitly articulated.

Forest history on the north coast began with what one could almost call a fixation with cedar. This was a purely economic focus with very little room for other values. Later when almost all the cedar had been logged there was a redirection of attention to a particular forest type. This was marked by a name change from the plain old 'brush' or, more commonly on the North Coast, 'scrub', to the much more evocative 'rainforest'. Ecology, biodiversity and aesthetics were some of the values articulated in the 1970s with regard to the north coast rainforests. Although forest age was implicit in these values it was not the key element that was expressed.

On the north coast an *explicit* concern for forest age only became apparent after the Wran Government's 1982 decision to stop most rainforest logging. It soon became obvious to the environmental movement that the protection of a forest type that had been already almost wiped out was a pyrrhic victory. In order to protect the remaining North Coast forests a broader definition of what was valued and worthy of retention was devised. Out of this came the more widespread use of the term 'wilderness' and the beginning of the use of the term 'old-growth'.

This paper is concerned with social history, not with etymology, although it is important to consider the context in which words are used. The words *Bush, Brush, Forest* and *Scrub* tell us a lot about how we perceive forests. The use of 'scrub' for rainforest, as in the 'Big Scrub', to describe the semi-tropical rainforest near Lismore, cleared for farms in the second half on the nineteenth century, is still sometimes used, especially by old timers. The word 'brush' was the term generally used, especially by foresters, for 'rainforest' until about 30 or 40 years ago. The first reference that I have found to 'rainforest' instead of 'brush' in the files of State Forests of New South Wales was in a 1958 report about Ellis State Forest in the Dorrigo Management Area. By August 1979, when protesters were lying in front of bulldozers at Terania Creek, the word was definitely part of our vocabulary. Lionel Gilbert's 1971 thesis provides a good reference to the historical use of botanical terms and refers to P.G. King's 1805 definition of 'brush' as 'a dark impenetrable thicket of plants and herbaceous shrubs'. He also notes the universal use of the word 'forest' to mean open forest and the importance of the presence of grass in this usage. This is something that has been picked up by recent commentators and, in my opinion, applied in a simplistic way to a variety of vegetation types.

The word 'wilderness' has a long history. The Helman report was important twenty years ago in popularising this term and pointing out the significance of its use in North America (Helman and others 1976). The report nominated twenty forest areas of New South Wales as wilderness areas which needed to be preserved. In the early 1990s I researched areas for State Forests of New South Wales which were either in or near to three of these: the Guy Fawkes, the Mann and the Washpool areas. The term 'wilderness' irked some north coast foresters and resulted in my being asked to write their 'European disturbance history'. To people whose families had grazed cattle there for sometimes for fifty or more years, and in some cases for three generations, and to those who had fossicked there during the depression, or who had brought loads of timber out with bullocks for local timber companies in the 1940s and 1950s, the areas were not 'wilderness' but simply 'bush'.

The beauty of the Dorrigo

I begin this paper with a quotation, written in 1950, that tells of one visitor's response to the forests of the Dorrigo Plateau as they were in 1892:

> It is beyond me to describe the beauty of the Dorrigo in its natural state—many thousands of acres of dense brush lands, rich in soil, with running streams of pure water in abundance, occasional waterfalls and ferneries. Orchids were beautiful and abundant. The timber was what took my fancy most—there was a magnificent wealth of cedar and other softwoods. The bird life filled the air with music one could never forget (Henderson 1950).

This was how Cunningham Henderson, a grazier from Coraki, remembered his first visit to the Dorrigo plateau. He was on his honeymoon, having married Marion McDougall in September of that year at Coraki. After the wedding they travelled to Bellingen to meet his wife's family. Here they borrowed horses from Marion's brother and rode up to the plateau where they stayed for two weeks. Another brother was overseer at the plantation where the Forestry Department was attempting to grow cedar. In the words of the bridegroom:

> Practically the whole of the cedar belts were thrown open for settlement at one pound per acre, with thousands of young cedar trees coming on and millions of seeds waiting their time for germination. The marketable trees were cut out and hauled to the nearest mill or market, the balance of the wonderful brush cut down and burnt to make grass. And so Nature's rich provision for mankind in that locality has been lost for ever.

> All through the Dorrigo the timber getters had cut tracks for miles and miles. These we followed on horseback. The freshness of it all was fascinating, the singing and whistling of birds, the perfumes from orchids and vegetation, the waterfalls; it was all grand and beyond description. We saw cedar butts lying for removal some day, up to 25 feet long and six feet in diameter. The lighter tops had already been taken (Henderson 1950).

Cunningham Henderson's memories of the Dorrigo plateau as it was in 1892 highlight some of the features that make it unique. He evoked the remoteness of the plateau which delayed white settlement; the natural beauty of the area which, even in 1892, attracted tourists; the wealth of timber ruthlessly exploited and the ham-fisted official attempts to replace it. His memories of his first visit there, recorded almost sixty years later, reflect the essence of the tragedy of settlement on the Dorrigo. The truth was even worse than Henderson recalls. In the eastern Dorrigo, in particular, not even the marketable timber found its way to the sawmills. It was often burnt due to a combination of circumstances. The despoiling of the Dorrigo plateau and the waste of the area's timber resources had been noted and deplored in the early years of the century. Henderson was not alone in regretting what had happened.

This exploitation was of course not unique. The Big Scrub on the Richmond River had been just as thoroughly plundered of cedar fifty years before Henderson's honeymoon and was almost completely cleared in the 1880s. The timing of the destruction on the Dorrigo in the early years of the century made the reaction to it boisterous. Australia had lost its innocence by the time Dorrigo was 'opened up'. The depression of the 1890s, followed by a lengthy drought and then the ravages of introduced plant and animal species had made some thinking people question contemporary modes of operation. In addition the fact that in the early years of the century New South Wales was importing timber, challenged the widespread belief that the state was endowed with unlimited supplies of timber. Although the loss of the forests, especially those that were aesthetically pleasing, was lamented, expressions of regret were almost always phrased in economic terms. Few commented on the destruction of the nation's ecological and botanical diversity.

The failed attempt to establish cedar plantations was one indication that the New South Wales government aimed, in the 1880s, to play a role in the management of the forest estate. Another was the creation of the first forest or timber reserves in New South Wales in 1871. Three were dedicated on the Dorrigo Plateau at this time: Glenfernie, Mt. Hyland and Dorrigo Forest Reserves. John Duff, New South Wales Inspector of Forests, described the latter which he visited in 1883 as a 'magnificent reserve'. His report outlined the different timber species that were found on the reserve and gave hints as to how they could be worked. At times he became lyrical at the beauty of the rainforest. For example, he noted that the lianas 'assist to form that peculiarly tropical and pleasing feature in the vegetation which is only seen in the jungle forests' (Duff 1883). This was, nevertheless, essentially a report concerned with timber rather than forests.

The botanist J. H. Maiden visited the reserve, where he spent 'a week under canvas', in December 1893. His account, published in the *Agricultural Gazette*, is an odd mixture of botanical information, purple passages about the scenery and practical advice on how to get there, where to stay and how much this would cost. In addition he indignantly refuted the ill-founded claims that a visitor to the Plateau would be bitten by snakes, sucked by leeches and attacked by ticks. In fact he observed that the two mosquitoes that he found in his tent had 'probably come up with my luggage' (Maiden, 1893). His observations make it clear, despite the depletion of cedar, how heavily timbered the plateau still was at this time. Ascending from the Bellinger along the new 'road', Maiden crossed Rocky Creek and described how the country on either side of the road:

> consists of almost impenetrable scrub ... [After] two or three miles of this road we suddenly enter one of the plains or meadows, and are fairly in the Dorrigo. The Dorrigo Forest Reserve consists for the most part of brush land, containing a great variety of timbers. Not a single species of Eucalyptus is found in it (Maiden 1893).

The Dorrigo Reserve was an extensive area to the west of Bielsdown Creek and so the present site of Dorrigo would, at this time, have been an isolated enclave, surrounded by dense rainforest. Maiden was enthralled by the trees and the variety of plant species that he found on the reserve. His greatest enthusiasm was reserved, however, for the scenery of the mountain forests. He captured the unique ambience of the cool, dank rainforest when he wrote:

> In the forest itself there is almost perpetual gloom. The trees are so close together, are so tall, and have such leafy tops, that unless one keeps on beaten tracks, along which the timber has usually been felled, one rarely sees the sky ... (Maiden 1893).

Maiden's appreciation of the beauty of the Dorrigo forests and his scientific interest in their botanical riches coexisted with a concern that their economic potential be exploited. He fretted that there was no demand for a 'single stick' of rosewood and was prepared to 'stake my reputation that this is a valuable timber'. This 'merchantable' species made, he informed his readers, 'excellent furniture'. There was no contradiction, from the perspective of the nineteenth century, in admiring the beauty of a forest, perhaps even loving and identifying with it and wanting to make money out of it. Totally destroying it was of course another thing altogether. But this is what happened. As the surrounding land was opened up for closer settlement and the town of Dorrigo grew in the early years of the twentieth century the rainforest of the reserve shrank and finally disappeared.

An appreciation of the beauty of the forests is a recurring theme in the history of the Dorrigo Plateau. This admiration was rarely enough, however, to stop a forest, if it were accessible, from being logged. The first very mild and unsuccessful protest against logging on the Dorrigo occurred in 1930. This was concerned with the aesthetic value of the area around Mount Campion that was, and still is, regarded by local people as a place of beauty. It was gazetted as a forest reserve in 1906 and was dedicated as Bielsdown State Forest in 1917. In 1930 the Dorrigo Chamber of Commerce protested to the Forestry Commission when it was about to be logged. They objected to Campion's Reserve, as they called it, being thrown open to timber-getters. The reserve, it was argued, was one of 'the beauty features of the Dorrigo'. The district forester replied that it had been logged for a number of years for pine and later coachwood and added, 'so far there is no visible difference in the aspect from the township, or in passing by from a scenic point of view'. He argued that as the area was not on the main tourist road it was unlikely to be visited much anyway. 'For beauty features', he wrote, 'Dorrigo is well catered for with the reserve for preservation of native flora ... from this expansive views are open to tourists', which was obviously enough for any little town to expect. The forester maintained that past logging had not spoilt the beauty of the forest and, with cavalier unconcern for the unique qualities of the reserve, suggested that if 'the area is heavily denuded of trees, planting can be undertaken' (SFNSW file 3892). Forest age was of no concern to this forester.

All local residents did not support the demand that the reserve be left in its 'natural state' and the Leigh Progress Association had in fact requested some years earlier that the area be 'thrown open for settlement'. The creation of Bielsdown State Forest in June 1917 had forestalled this and the Minister for Forests added his weight to the debate by stating that as 'state forests are created for the purpose of utilising as well as growing timber, timber-getting operations will be allowed so long as they do not conflict with forestry requirements' (SFNSW file 3892). Subsequently two timber-getters, Quinlan and Hamey, were issued with a brushwood cutting licence.

This debate indicates the different pressures that the Forestry Commission was subject to in the 1930s. The push for closer settlement was still present, although in this case it failed. Also unsuccessful was this early attempt to conserve a state forest from logging. The district forester obviously thought that the only factor worth considering was the visual impact of logging. There is no further correspondence from the Chamber of Commerce so it is not known whether this was also their prime concern. The players valued different aspects of the forest: the Chamber of Commerce appreciated the beauty of the forest; the forester and Quinlan and Hamey had their eyes on the timber; and the Leigh Progress Association valued the land for its agricultural potential. All over New South Wales there were people who shared this last idea, to whom every forest was a good farm going to waste.

Closer settlement

Pressure for closer settlement was a determining feature for at least a century. The mirage of thousands of happy families, contented and productive on small farms. posed the greatest threat to the forests of New South Wales. Although we may empathise with the progressive social and political position of those who wished to destroy the land monopoly of the capitalists and finance companies, we can now only deplore their ignorance of Australian ecology. For many of those who came to the Dorrigo after most of the good farm land had been alienated, the attempt to create farms from reluctant forest land proved to be a human and environmental tragedy. I traced the history of a number of blocks, now in state forests, that revealed a story of broken dreams and failed aspirations. One block, now in Clouds Creek State Forest was selected and forfeited four times within 22 years. When it was finally admitted, in the 1930s and 1940s, that blocks such as these were not good farm land, the Forestry Commission literally 'bought back the farm'. The main criteria for the Forestry Commission in acquiring these failed farms was that there was marketable timber, the land was accessible and it could be bought for a cheap price.

In the early 1950s, at around the time that Cunningham Henderson was writing his memoirs, assessors inspecting the forests of the Plateau noted that:

> Quite considerable areas outside state forest have been cleared on the Eastern Dorrigo for attempts at dairying and grazing by people apparently under the impression that the soils were as valuable as those further west (i.e. the red loams). Such attempts have mostly met with signal failure due to mineral deficiencies and somewhat more hilly land. The result has been a return of useless woody shrubs in many areas once cleared and great areas of dying brush both inside and outside state forests present a depressing sight (SFNSW report 219C).

The beauty of the Dorrigo had been tarnished by the tradition of placing purely economic value on the forests. No wonder that Cunningham Henderson wrote such purple prose about his honeymoon, when a trip to the Plateau in the 1950s presented the visitor with the sight of 'dying brush'. In 1979, K.T. Henderson was to write a useful thesis which examines the conflicting demands for closer settlement as opposed to forestry interests on the Dorrigo Plateau, a conflict between those who valued the forest for its timber and those who saw it as potential agricultural land going to waste.

Forest management

By the 1940s and 1950s there was less pressure on the Forestry Commission from those who saw the forests as potential farms. Equally destructive, however, was the desire within the Forestry Commission to 'improve' the forests. Forest age was of no concern. The only consideration of importance was whether or not a forest could be made productive. 'Class Three Surveys' to estimate the timber volume and producc topographic and contour maps with forest types marked were undertaken in Wild Cattle Creek State Forest in 1937, 1939 and 1940 (Forestry Commission, *Annual Report* 1945). This was part of a statewide survey of rainforests to locate areas suitable for hoop pine plantations. Rainforests, with all their diversity, were at this time regarded as of little value commercially, but hoop pine was in short supply having been selectively logged from them since the 1930s. Under the purely ulititarian management philosophy it was considered wise to replace rainforests with a single species from which revenue might be derived.

The survey of one part of the forest, Mobong Logging Area, in 1940 indicated that, after fifteen years of intensive logging, the southern part of this area was logged out, but the north was still 'virgin', obviously an old-growth forest. Three forest types were located in this survey. These were referred to as 'forest' (eucalypt).; 'scrub' (temperate rainforest). and 'bastard scrub' (SFNSW report 52). This last disparaging phrase probably referred to wet sclerophyll forest in transition to rainforest.

An assessment of all public lands was undertaken in the early 1950s in order to estimate the State's timber resources for the future. It was recommended that the:

> remaining isolated brush remnants on red soils in undulating topography could be cleared for primary production ... until more is known about brushwood regeneration, it may be safer to put this site [i.e 'commercial brush sites' in state forests] down for the growing of fast moving eucalypts and for exotic Pinus species (SFNSW report 219C).

The last suggestion, that exotic plantations be established, was not new. The Forestry Commission had, since 1919, a policy of establishing them to overcome a shortage of softwoods, being met at that time by imports. Despite numerous setbacks this policy continued in the pre-war years and was extended in the wake of the assessments of the 1950s and early 1960s. Between 1950 and 1970, 59 hectares of exotic pine was planted at Cascade and in 1958 a further 32 hectares at Welcome Flat Pine Plantation on the Dorrigo Plateau. Growth rates were not as great as those at plantations further south, and so those on the Dorrigo were not enlarged. A hoop pine plantation of 20 hectares was also established at Cascade in 1951 where the 'bastard scrub' had once grown. These projects were not extended primarily because they were regarded as too expensive. Hoop pine, for example, has to be grown for two years in a nursery and is very slow growing in the first year after being planted out.

The Washpool Wilderness and Willowie Scrub

By the 1970s, the Forestry Commission was getting increasingly out of step with changing community perceptions of the value of forests. The Forestry Commission's 1970s indigenous forest policy, for example, stated that 'mountain forests should be cut to the limit of economic accessibility' while coastal forests regenerated (Carron,1985). This policy clashed with the environmental movement that was growing more articulate and persuasive. Logging in the Washpool area that resulted from this policy was one of the catalysts that made the future of the state's forests a controversial issue.

An 'Investigatory Survey and Assessment' of Washpool State Forest had been completed in 1942 and 1943 in response to wartime conditions for additional timber supplies. The Desert Creek area was described as:

> steep, rough and broken, especially on the southern fall into Desert Creek from the Gibraltar Range. Internal accessibility is extremely difficult, roading and logging operations exceptionally hazardous and economically unsound (SFNSW report 153).

Despite this assessment of the area the report proposed that a road should go into Washpool State Forest. Nothing came of the proposals, probably because of lack of manpower caused by the enlistment of many forest workers in the armed forces rather than the improbability of their success with existing technology. It was not until the 1960s and 1970s that the first systematic exploitation of this forest began.

The Washpool area was identified in the Helman report in 1976 as a wilderness, worthy of preservation. No doubt in response to this report, in January 1977, Forestry Commission officers proposed a flora reserve be placed over a much smaller area of 5,692 hectares known as Willowie Scrub which took in part of Washpool State Forest, Moogem State Forest and Billilimbra State Forest. Forester T.C. Dawson described this as 'the largest untouched rainforest in the state'. He and his colleagues wished to preserve this area in its 'virgin condition' and rejected the suggestion that some selective logging could take place. It was argued that with this type of warm temperate rainforest 'even the most selective logging on occasions can cause considerable crown die back'. The concept of forest age, although not explicitly stated, had become important to some foresters. H. J. Hanson, the district forester at Coffs Harbour, was more concerned that 'the Commission's image and the credibility of officers in the district would be severely jeopardised if any logging took place' (SFNSW file 1003). Good public relations was obviously also an important consideration.

During the next three years there was extensive debate within the Forestry Commission on the future of the area. Although there was general agreement that it should not be logged it was more difficult to reach consensus on the mechanism for protecting the area. Local foresters and scientific officers wished to have it gazetted as a flora reserve and hence prevent future pressure from the timber industry to log the area. Head office officials, on the other hand, argued that there would be sufficient protection through the mechanism of the management plan. This disagreement within the Forestry Commission indicated that although some of its employees had been influenced by the environmental movement, official policy was still predominantly concerned with servicing the needs of the timber industry.

While the Forestry Commission was trying to decide what to do about Willowie Scrub they were overtaken by events. To the south, roading was proceeding in preparation for the logging of the Viper Creek area (within the Washpool Wilderness identified by Helman). Before this could proceed, however, the Forestry Commission was required in 1980 to undertake an Environmental Impact Statement concerning all proposed forest operations in the Washpool. While this was in progress in September 1980 the Forestry Commission decided to gazette the Willowie Scrub Flora Reserve. The motivation for this rearguard action was the realisation that if the area was not protected a far greater area would be 'lost' to the State's National Parks and Wildlife Service. This is what happened when, in October 1982, the New South Wales Government made all but the north and north east part of Washpool State Forest a national park. Although this was a large area it was not as comprehensive as that identified by Helman. Logging in the 1980s in the north of this area (in Washpool and Billilimbra State Forests). although enabling the Forestry Commission to honour their commitments to Big River Timbers Pty. Ltd., proved to be controversial.

Wilderness and the bush

The political clout of the environmental movement was evident in 1982 when the Wran Government banned 'general purpose' rainforest logging in New South Wales. Following this, the use of the more amorphous terms 'wilderness' and 'old-growth' to designate types of forest deemed worthy of preservation, indicated the widening scope of a popular movement. The nomination of areas within the Grafton and Dorrigo forestry districts as part of proposed wilderness areas indirectly led to my research in 1993.

Bob Williams, the district forester at Grafton, is a mild mannered man but he was clearly very annoyed by the use of the term 'wilderness' to describe some of his district. Bob, from years of dealing with graziers who had crown leases and other grazing tenures in the district, had picked up a little of the local history. He knew that this was an area that had a rich and interesting history going back to the earliest days of white settlement. He felt quite rightly that this history should be told. The area that we were concerned with had been part of a station called *Cunglebung*, said to mean the 'big valley'. My report began with the words:

> The area that is now Dalmorton State Forest first came to the attention of white people not because of its scenic beauty; valuable timber; grazing potential or mineral wealth, but because of its position. Located on one of the earliest routes between the Tablelands and the coast, the area was for many people not a destination but a route through which one passed travelling between Glen Innes and Grafton (Curby 1993).

Local people may not have known the exact details of this history but they knew that this was one of the earliest routes to the Tablelands and that it ran along the southern boundary of the proposed wilderness area.

South of this area, a section of Chaelundi State Forest, in the Dorrigo management area, was also a nominated wilderness area. I wrote a separate report on this area. Chaelundi State Forest is still largely undeveloped country, mostly accessible only on horseback or by four-wheel drive vehicle. The steep hills with hurtling slopes down to creeks and gullies and the patches of impenetrable vegetation may seem, to the casual observer, an area untouched by human hands. Like Dalmorton State Forest to the north, it has seen grazing, mining and logging certainly since the 1870s and perhaps earlier. In addition there has been, as yet undated, Aboriginal activity. The scant archaeological work done so far, which has uncovered a number of open artefact scatters, suggests that the Chandlers Creek area was certainly a transit route for the local Aboriginal people. My brief was to write the European disturbance history of these two forests.

Grazing

The European 'disturbance' or activity that had the longest history was grazing. To the people who knew, and know, this area intimately it was and is not *scrub* or *brush* or *forest* but simply *bush*. The whole area had been part of large pastoral holdings which after the *Crown Land Act* 1884 had formed part of the 'resumed area' of these stations. Despite changes in land tenure the forests were held for grazing as part of these holdings until the 1930s. Under the *Closer Settlement Act* 1937, stations such as *Marengo*, *Buccurumbi* and *Cunglebung*, were broken up into smaller leasehold areas in order to help share farmers and their sons acquire their own land. It was intended for people 'who have experience but who possess only limited capital'. The leases were balloted for and could be held in perpetuity, except for those in 'certain reservations' which were restricted to a term of 45 years. Jack Watters, the owner of a 'second or third rate dairy farm' near South Grafton was one of the successful ones and drew two Crown Leases. One of his sons, Keith, recalls that 'you were given five years to fence it and do some timber treatment [ring-barking]' (Curby 1993).

Noel MacDougall who drew a block argues that it was not a 'fair dinkum ballot'. He has always wondered how, if it were a ballot, his family, who held Marengo Station, managed to get four adjoining blocks and the Turnbulls, who held Buccarumbi Station, and their connections acquired almost all the rest. He maintains when Buccarumbi was cut up in 1938, the Turnbulls lost a lot of their domain but seem to have been compensated by 'getting some of MacDougall's land' (Curby 1994). The old term 'dummying' describes the practices of the late 1930s and early 1940s. Noel MacDougall considered it a legitimate tactic. He got a trusted employee, Joe Wheatley, to take up a block in 1946 because 'I had too much land'. Joe lived on it for him but he paid all the expenses. The theory was that no one person's land should exceed what was termed a 'home maintenance area' which MacDougall describes as an area that would carry 100 to 150 breeders. He maintains that 'not one block would carry that' (Curby 1994). The lease conditions demanded residence for five years and payment of rent or, in lieu of rent, improvements were to be effected. These improvements were to be 'of a permanent, fixed and substantial character exclusive of boundary fencing' and were to be equal to the rent payable.

Regular inspections of the leaseholds were held to ascertain whether or not these conditions were fulfilled. These reports indicate exactly what 'European disturbance' took place in the early years of the crown leases. This generally entailed the construction of fences, huts and yards and some ringbarking. They also show that 'dummying' was certainly a feature of this allocation of crown leases. It is interesting to note, however, that generally the 'dummies' did not last and that the man described by Noel MacDougall as the only independent person to get a block was also the only one of the original leaseholders from this ballot who still held the land in the early 1990s. This man was a tough old bushman called Peter Ellis who knew the area of his crown leases and the surrounding district like the back of his hand. At 82 years of age he could still put in a full day in the saddle and was just planning to buy another property when he died suddenly in April 1994 and was was buried near his home at Nymboida.

Mining

Mining had a short-lived impact on the area in the last decades of the nineteenth century. Dalmorton, located on one of the routes between the Clarence River and the Tablelands, became a mushroom goldrush town in the 1870s. The road which made the hamlet accessible to the hopeful miners, eventually became the main thoroughfare. Stories about mining and fossicking, which continued until the 1930s, are part of the folk lore of the district. There are still many open mine shafts.

Stories of a miner named Taylor (no one seems to remember his first name), are part of the local folklore. He and his family stayed in the locality for many years after the main mining activity had petered out and managed to make a living. They owned a small piece of freehold land in the vicinity of Cunglebung. Taylor never escaped the lure of gold. He was, according to leaseholder, Barry Adams,

> getting enough colours down Cunglebung Creek to get him through the depression. I can show you where he used to camp instead of walking home after he did his day's work. There was about three miles difference from where his family lived and where he worked (Curby 1993).

Mrs Emily Taylor's lonely grave site can be seen under an apple tree on their old freehold land. Her son Horace had a mail run from Dalmorton to the Mann River. He did the trip once a week, past the Blacksmith's Shop, following the Dinner Creek track, and stayed overnight at the old Cunglebung pub. The Cunglebung pub was probably a sly grog shop catering for the needs of the miners. Although there are records of numerous licensed hotels in Dalmorton and Buccarumbi in the 1870s when the gold fever was at its height, there is no record of one at Cunglebung. Keith Watters remembers a building adjoining the present Cunglebung hut when he first came to the area in the early 1940s. He believes this to have served as a hotel and recalls the 'pine board used for the bar and the gold counter were still there at that time'. The existing building was the sleeping quarters (Curby 1993). The legend of one unlucky miner, known as Mangey, who used to drink at the pub, is still told at Cunglebung. Mangey had been having a few drinks and was riding home to his hut up Wellington Creek. He was impaled on the low hanging branch of a tree and was found lifeless the next day by a passerby. His mates buried him on the point of the spur that comes onto Quarantine Point. The flat where he was killed has been known ever since as 'Mangey's Flat'. His grave was marked by a round post at each corner when old timer Jack Marsh showed Keith Watters the site in 1938. All trace of the unfortunate man's resting place has since disappeared.

Fossicking and small scale-mining also continued further south in Chandlers Creek until the depression of the 1930s. Peter Ellis remembered seeing 'a lot fossickers about in the bush in those days.' Horace Taylor, a reclusive man, was said to have a mine from which he ferreted out a steady supply of gold whenever he needed it. Tommy James, a retired Dorrigo stockman, recalls Bob Rhodes, the manager of Marengo Station, telling how he used to check on an old fossicker called Sid Powell when he was out mustering. Once, unable to find him at his usual spots, Rhodes searched his hut and found him dead inside. After the local policeman had been informed, old Sid was unceremoniously rolled up and buried down a mine shaft.

Timbergetting

Although most of these forests were officially 'unlogged' as far as the Forestry Commission was concerned, there had been incidental logging associated with the pastoral industry and selective logging for two species, cedar and hoop pine. In this remote inaccessible country bullocks were used long after they had been superseded elsewhere. There was a constant need for grass and water for the working bullocks until motor transport made them redundant. This was one of the reasons that the Cunglebung route, with plenty of both, was popular.

The first logging of the Cunglebung area, other than the early cedar getting, occurred during World War II. Doug Scott, at the age of fifteen, got his first job logging hoop pine there. V.B.Trapp & Co. of Coffs Harbour had, according to Doug, the job of supplying hoop pine under the *Essential Services Act* to the Armed Services. Doug was 'off-siding on a tractor'. The log hauling was done with winches; then a tractor took the log to where a truck could load it. This was, Doug recalls, 'virgin scrub. You couldn't cut a tree down unless it went six feet girth, chest high, and if you did you were in terrible trouble' (Curby 1993).

Although improved technology was to eventually make bullocks a thing of the past, the Adams family stuck with them until the 1950s. Barry Adams, son of bullocky Sid Adams and a big man in every sense of the word, has been associated with the timber industry and grazing since his early teens. Barry worked with bullocks until 1957 because as he says, 'all Adams were bullockies. It was in the blood' (Curby 1993). The slow moving bullocks gave their owners the time to learn about and observe the bush they worked in. This was a time when timber workers camped out in the forest for six week stretches. Doug Scott recalls how he came to town four times the first year. 'You didn't get bored. We did a bit of fossicking. Jack Marsh told us where to look, fossick, how to pan.' (Curby 1993).

Jack Marsh

Local people remember the names and stories associated with a place, so that they become part of the persona of a locality. Chaelundi State Forest will always, for me, be associated with the memory of Peter Ellis. For the people who know Dalmorton State Forest well such as Keith Watters, Barry Adams and Doug Scott the memory of Jack Marsh is synonymous with the locality. It is not the pastoralists or their families who are associated with *Cunglebung* but the name of this humble working man who spent about seventy years of his life there. Jack Marsh is still remembered as a yard and fence builder without equal. Keith Watters describes him as someone for whom 'near enough was not good enough; just right would hardly do'. He did the fencing right through from Cunglebung to Marengo Station and in 1936 built the stockyards, part of which are still at Cunglebung. He 'had to have a certain quality of timber or he wouldn't put it up. He worked by himself with a pair of draught horses to pull the timber' (Curby 1993). He is remembered as a semi-reclusive man who 'never went to town much' but who loved and understood the bush. He is said to have partly lived off the land but never exploited it. When he needed to be he was, according to Doug Scott, 'a damn good shot with a gun'. If fish weren't plentiful he fed them with 'a bit of roo meat hung over the water' (Curby 1993). Doug Scott remembers how, towards the end, he and Jack Watters had to coax Marsh into Doug's 'old bus' to get him to town for medical attention. He spent the remainder of his days with his sister in Grafton. Her grandchildren managed to teach the illiterate old bushman to read a few words and sign his own name before he died.

Local knowledge

There has been an uninterrupted history of grazing in Chaelundi and Dalmorton State Forests since at least the 1870s and most of the lease holders are the third generation of their family to follow grazing pursuits in the district. Their intimate knowledge of the country has been used at crucial stages in the history of the area. In 1938 Noel MacDougall escorted Forestry Commission inspectors around parts of what are now Marengo and Chaelundi State Forests. In the following year Bob Rhodes showed Department of Lands surveyors where the best places for camping reserves were. Presumably he showed them the camps then in use, many of them since the 1870s. In the early 1960s Peter Ellis assisted the Forestry Commission by indicating where the old roads and tracks were so these could be used for their road building program. Finally in 1993 they assisted me in researching the history of the area by consenting to be interviewed.

Conclusion

The value that rural people ascribe to these forests is certainly first and foremost economic. I have no wish to be sentimental but it also needs to be said that there are less tangible values that are just as important to them. These are tied up with an intimate knowledge of the 'bush' and its folk history.

Foresters move regularly and even if they do stay in a district for some years a lot of their time is spent in the office doing paper work. They have little chance of getting to know the forests as some of the local people do. When I am on a forestry project my first visit to the forest is not with the forester but perhaps with a long serving foreman or, more often, one of the lessees who knows the area well. As we drive around they tell me endless yarns about 'their place'. Some of this is trivia but much of it explains why they value the forest. It is a place that, if you run cattle, gives you a modest remuneration. This, usually rough winter grazing, may be enough, together with perhaps a small freehold area and yourself and partner working, to keep you in the cattle industry. It is also a place where you may set up a bush camp for the family in the school holidays. The kids can ride and learn the art of mustering. Adults can revive the skill of cooking with a camp oven and at night tell each other lies around the fire.

These intangibles are only by implication concerned with forest age. The values that are most deeply felt are difficult to articulate. They come from a long and intimate connection with a place, often over several generations, and are nurtured by a knowledge of the way in which they and their kind have interacted with the forest over time. It is my task as a historian to tell this story.

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Appendix: Summary of values placed on some of the forests of the north coast of New South Wales

Time	Place	Person	Values
1892 & 1950	Dorrigo Plateau	Grazier	Aesthetic (forest age implicit); economic/cedar
1880s	Dorrigo F.R.	Forest inspector	Aesthetic (age implicit); economic/rainforest timbers
1890s	Dorrigo F.R.	Botanist	Aesthetic (age implicit); scientific (forest age implicit); economic/rainforest timbers
1930s	Bielsdown State Forest	Dorrigo Chamber of Commerce	Aesthetic
		Local forester	Aesthetic/visual; economic/timber
		Timbergetters	Economic/ timber
		Leigh Progress Association	Economic/agricultural
1900-1940	Dorrigo Plateau	Farmers	Economic/agricultural
		Dept. of Lands	Economic/agricultural
		Forestry Commission	Economic/timber
1940s - 1970s	Dorrigo Plateau	Forestry Commission	Economic/timber
1976	Washpool	Academics	'Wilderness' (age implicit).
1970s - 1980s	Washpool	Local foresters and Research officers	'Wilderness'; 'virgin' (age implicit).
		District forester	Public image; economic/timber
		Forestry Commission Head Office.	Public image; economic/timber
1980s-1990s	Dalmorton & Chaelundi State Forests	Environmentalists	'Wilderness'; 'old-growth' (age explicit).
		Forestry Commission District forester	Economic/timber and grazing Economic/timber and grazing; history (age implicit?).
		Lessees	Economic/grazing; history (age implicit?); sense of place; identification with a locality
1990s	Dalmorton & Chaelundi State Forests	Historian	History—empirical (esp. grazing, mining timbergetting)—predilection for 'history from below'; personal identificatio with a certain social class; economic/ commissioned history

9

Changing community concepts of age in the jarrah forest

Dale Sanders

Introduction

Community concepts of age in the jarrah forest have changed considerably since European occupation in 1829. According to Dell, Havel and Malajczuk (1989:401), 'the forest has been variously seen as the obstacle to travel, as a hindrance to agricultural development, as an endless source of timber, as an effective protection to water catchments and finally as a thing of value in its own right.' During the past 165 years the forest has been significantly transformed as the ancient spacious forest has been logged and transposed by younger thicker regrowth. This paper identifies the various land uses that have emerged in the forest, and charts the changing perceptions of the value placed on the age of this unique resource. Aboriginal valuations are not included because these warrant serious examination in their own right and are beyond the scope of this project.

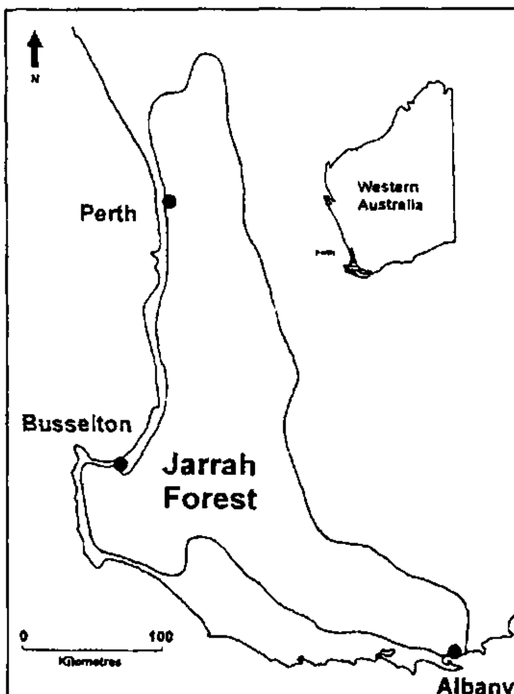

Figure 1. Location of the jarrah forest
Source: Jarvis 1986:70

Physical background

The jarrah forest is a unique ecosystem that has adapted over time to a fundamentally harsh physical environment. Although it was an important resource for Aboriginal people for thousands of years, it was only marginal to their economy, and had remained largely intact until the arrival of Europeans in the 1830s (Sanders 1995:1; Boutland 1988; Pearce 1988; Hammond 1980; Green 1984). The jarrah forest is located in the south-west of Western Australia, extending from Gingin 80km north of

Perth to Albany on the south coast, boarded by the Darling Scarp to the West and the wheatbelt to the east (Figure 1). Whilst jarrah is the dominant species in this forest, which is broadly classified as belonging to the broadleaved evergreen forests of Australia, numerous other trees and hundreds of species of understorey plants have all evolved in isolation in response to the local climate, topography, landforms and soils. Jarrah (*Eucalyptus marginata*) can range in stature from trees 56 metres high with trunks 2 metres in diameter to tall shrubs depending on geographical location. The species is extremely slow growing, averaging only one or two centimetres of diameter increment per decade. This contributes to the hardness of the timber and thus to its value as a natural resource (Dell and Havel 1989:1-3; Carbon 1982:225; Shea 1975:3). According to Abbott, Dell and Lonregan (1989:47), jarrah has a life cycle of between 500 and 1000 years with the tree reaching a mature height at 100 years, although its diameter continues to expand thereafter.

Early European settlers

Between the 1600s and 1800s Dutch and French navigators noted the blue smoky appearance of the forested hills of south-western Australia in their journals, however, the Jarrah forest was not comprehensively surveyed until after the establishment of the Swan River Colony in 1829 (Mills 1988:229). The magnificent tall timber of this region and its open park like appearance were initially used by Stirling as a selling point to attract settlers to the colony in the mistaken belief that the height and age of the trees corresponded with the fertility of the soils. However, clearing this timber with English axes was found to be nearly impossible. Instead the ancient trees were ringbarked and left to die and be burnt where they stood (Moore 1985:32). Although the myth linking the denseness of vegetation and soil fertility persisted for some time it was eventually discovered that these unique jarrah trees actually grew on extremely poor lateritic soils which could not sustain European crops. Jaggard (1985:136), reaffirms this stating, '... there is often an inverse relationship between tree size and soil fertility, especially among jarrah.' Thus the early settlers largely neglected the jarrah forest in the early and mid nineteenth century. Following changes to the land grant system in 1831 when land had to be sold for not less than 5 shillings per acre, nobody was interested in purchasing forest property which was difficult to clear by hand. The soils were infertile, there was limited transport available, and the settlers had to contend with poisonous plants and a perceived Aboriginal threat (Richards 1978;63).

Early land uses in the jarrah forest between the 1840s and the 1870s were small scale: pastoralism, sandalwood tracks, and limited intensive agriculture in the valleys. None of these activities involved close assessment of the age or regenerative capacity of jarrah. A system of annual pastoral licences on crown land which forbade the clearing of jarrah was introduced in the 1840s. Farmers developed a system of transhumance, running their livestock in the forest hills in response to pasture deficiencies which, much later were found to be due to a lack of trace elements on the coastal plain and winter flooding (Burvill 1979:10). Cutters began blazing tracks through the jarrah forest during the late 1840s in search of sandalwood which was located further east. Sandalwood, which was used for the manufacture of incense and was exported mainly to China, provided a major source of income for the struggling colony (Richards 1978:206; Statham 1988). Intensive agriculture was slow to develop in the jarrah forest due mainly to isolation and lack of transport, however by the 1860s a few small farms had been established in some of the more fertile river valleys such as Marrinup, where the soil was found to be particularly suitable for fruit and vines (Richards 1978:383).

The timber industry

The establishment of a large scale timber industry in the jarrah forest in the 1870s marks another change in attitude towards the age of the forest. Obviously the industry placed a high economic value on the older, larger and straight trees, and sought to exploit this largely untapped natural resource. Initially the industry was based on selective logging in suitable areas, rapidly expanding throughout the forest at the turn of the century until the inevitable exhaustion of the resource.

The first jarrah timber, then called 'Swan River mahogany', was cut largely by ex-convict pit sawyers in the forest surrounding the early settlements, providing strong durable jarrah timber for local construction. Although the first steam powered mill was introduced to the colony in 1833, it would be another 50 years before the necessary capital and infrastructure would enable the development of a large scale timber industry in Western Australia (Fall 1972:10). The industry began in the Vasse and Cannington regions where pit sawing operations, funded on a modest scale by Fremantle merchants were established in the 1850s. These operations were later upgraded to steam power, and by the 1890s the industry had expanded to cover most of the jarrah forest. Timber became one of the colony's largest earners of export income, supplying an increasing demand for railway sleepers, paving blocks and timber props for the South African mineral boom. This demand facilitated further rapid expansion of the industry which would continue until the 1950s (Robertson 1958:11-27).

Timber hewers were often the first people to move into these new areas of the forest, setting up mobile camps of up to 500 people and enjoying unlimited access to the forest until the *Forests Act* 1918 placed severe controls on their essentially wasteful methods of timber production (Mills 1988:276-277). There would have been a certain amount of prestige in felling the largest trees which were also the oldest. A number of companies also established permanent mills, private tramways, and in many cases, whole settlements in the central and southern jarrah forest. By the 1930s however, this network of mills and associated settlements was declining, primarily as a result of overcutting. New technology was gradually introduced into the industry from the 1920s and, following the Second World War, the industry became largely automated and centralised in a few large centres such as Jarrahdale, Dwellingup, Yarloop, Manjimup and the metropolitan area. In 1968 the felling strategy was changed from selective cutting to heavy cutting to reduce the risk of the spread of the jarrah dieback disease, *Phytophthora cinnamomi* (Forests Department n.d.:18). In recent times much controversy has emerged in regard to the timber industry's activities, particularly in old-growth forests.

Group settlement scheme

As previously mentioned, Western Australia was founded as an agricultural colony, and this ethos was to persist through the establishment of representative government in the 1870s and responsible government in the 1890s and beyond. Two Premiers who were particularly supportive of this concept were John Forrest (1890-1901) and James

Mitchell (1919-1924 and 1930-1933). Forrest initiated further agricultural settlement through the provision of infrastructure such as the gold fields pipeline and government railways. Mitchell is credited with devising a scheme which would increase immigration and agricultural expansion following the First World War. Mitchell's scheme involved placing groups of often inexperienced settlers on forest blocks scattered through the south west. According to Gabbedy (1988:41), 'Mitchell had no time for trees - in his view they were little more than obstacles to development'. This position placed Mitchell in direct conflict with his Conservator of Forests, Charles Lane Poole who had been appointed in 1916. The new Conservator, '...had made the government fully aware of the depredations on its forest wealth, the preservation of which, in his opinion, far out weighed in importance the needs of agricultural settlement and the return from it' Gabbedy (1988:83). Lane Poole was to resign as Conservator in 1921. The scheme continued to be implemented despite the many hardships experienced by these new settlers who struggled to clear the forest, and like many farmers before them were often forced to ringbark and burn the jarrah. The scheme was largely regarded an agricultural failure with many farmers simply walking off the land during the 1930s, although it did contribute to the clearing of many acres of forest for farming and the provision of essential infrastructure such as roads and railways.

Water and mining

Water conservation has always been an important issue in the jarrah forest, with an ever increasing demand from a constantly growing coastal population. The first small dams constructed were generally associated with the railways and timber industry. The first large dam in the jarrah forest was constructed at Mundaring to supply water for the goldfields at the turn of the century (Mills 1989:240). Dams on suitable rivers have been constructed continually throughout the jarrah forest with the dams located north of Dwellingup used for (human) water consumption whilst those to the south, with the exception of the new Harris River Dam near Collie, are predominantly for irrigation, in line with Water Authority policy (Department of Conservation and Land Management and Water Authority of Western Australian 1989:1). Although the construction of dams requires the inundation of a significant amount of jarrah forest, the need to conserve the surrounding forest in the catchment area was soon recognised, as the problems of salinity and siltation emerged. Restrictions on clearing in catchment areas were not introduced until the 1960s (Havel 1989:307).

Following successful exploration for bauxite in the jarrah forest in the late 1950s a 12,530 square kilometre mining lease in the northern jarrah forest was issued by the State government in 1961 (Alcoa n.d.:16). Mining continued to expand throughout the 1970s and 1980s with mine sites located at Jarrahdale, Huntley, Del Park, Willowdale and Mt Saddleback (Alcoa 1992:8). The mining process includes clear felling and removal of top soil, thus completely destroying the whole forest ecosystem in selected areas. By the late 1980s most of the jarrah forest was covered by mining leases with an open cut goldmine also being established at Boddington in 1987 (Bartle and Slessar 1989:373). Although these mining leases are extensive, only 10 percent of the jarrah forest soils contain sufficient ore for commercial extraction (Alcoa n.d.:15).

There has been much controversy surrounding the activities of the mining industry including their rehabilitation policies. Initially Tasmanian blue gums were favoured as the species to replant, although more recently, the mining companies have begun to re-establish jarrah on the mine sites (Schur 1986:4-47). The conservation movement which emerged in Western Australia during the late 1960s began to focus on the jarrah forest in the early 1970s primarily to protect the forest from this mining activity (Havel 1989:302).

Conservation

The debate regarding the use and management of Western Australia's forests began