A history of kauri

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Introduction

The New Zealand kauri (*Agathis australis*) is a species notable for the height, bulk and longevity of the trees, and the good quality of its timber. Kauri towers above the canopy of the surrounding lowland forest (Figure 1), often occurring in stands of trees which are usually of a similar age. There are records of kauri attaining heights over 50 metres, girths greater than ten metres, and of trees which are estimated to be well over 1000 years old. These attributes of kauri—size, age, as well as timber quantity and quality—combine to make it an iconic tree which holds a special place in New Zealand landscape and culture. This is despite (or rather enhanced by) the natural distribution of kauri being restricted to the warm temperate forests of the upper North Island (Figure 2). Ferdinand Hochstetter, an Austrian scientist who visited New Zealand in the 1850s wrote that 'Three degrees of longitude [173°–176° long] and three degrees of latitude [34½° - 37½° lat]…encompasses the entire and the only range of this remarkable tree' (Hochstetter 1867: 141), although in the modern day, planted specimens can be found throughout the country.

Kauri features in the Maori creation myth. When Tane, god and father of the forests and its creatures, separated his parents Rangi nui (Sky Father) and Papa-tu-a-nuku (Earth mother) to bring light and beauty into a dark world, he grew like a kauri. The tall, solid and strong looking trees are often described as seeming to hold the earth and sky apart, and the kauri groves as cathedral-like. During the late 19th and early 20th centuries, kauri was used widely in the built environment of cities and towns throughout the country, and appears in New Zealand literature and art. Jane Mander's 1920 classic tale, *The Story of a New Zealand River*, is set at a kauri mill in the remote Kaipara region. The cover of the 2001 Vintage edition of this book is graced by Charles Heaphy's 1839 painting of a kauri logging camp on the Wairoa River, Kaipara. Today, the kauri forests are notable tourist attractions, and kauri recovered from peat bogs and swamps is transformed into furniture, bowls, boxes, and other items, prized for both the beauty and antiquity of the wood.

The economic and social history of kauri, from the late 1700s when Europeans arrived in New Zealand and the kauri forests began to be exploited for timber, is well documented. Reed (1953, 1964), Sale (1978), Halkett and Sale (1986) and most recently, Orwin (2004) variously write about: Maori use of kauri; the development of the kauri logging industry; bush life and the kauri mill towns; the efforts of conservationists to preserve what was left of the kauri forests from further logging; and where to find notable trees. These books are often illustrated by pictures from the archives of bush photographers such as the Burton Brothers and Tudor Collins. Their photographs clearly show the scale of land clearance, the size of the trees and the quantity of timber felled during the heydey of the kauri industry.

Figure 1: Mature kauri, Waipoua Forest, Northland, New Zealand

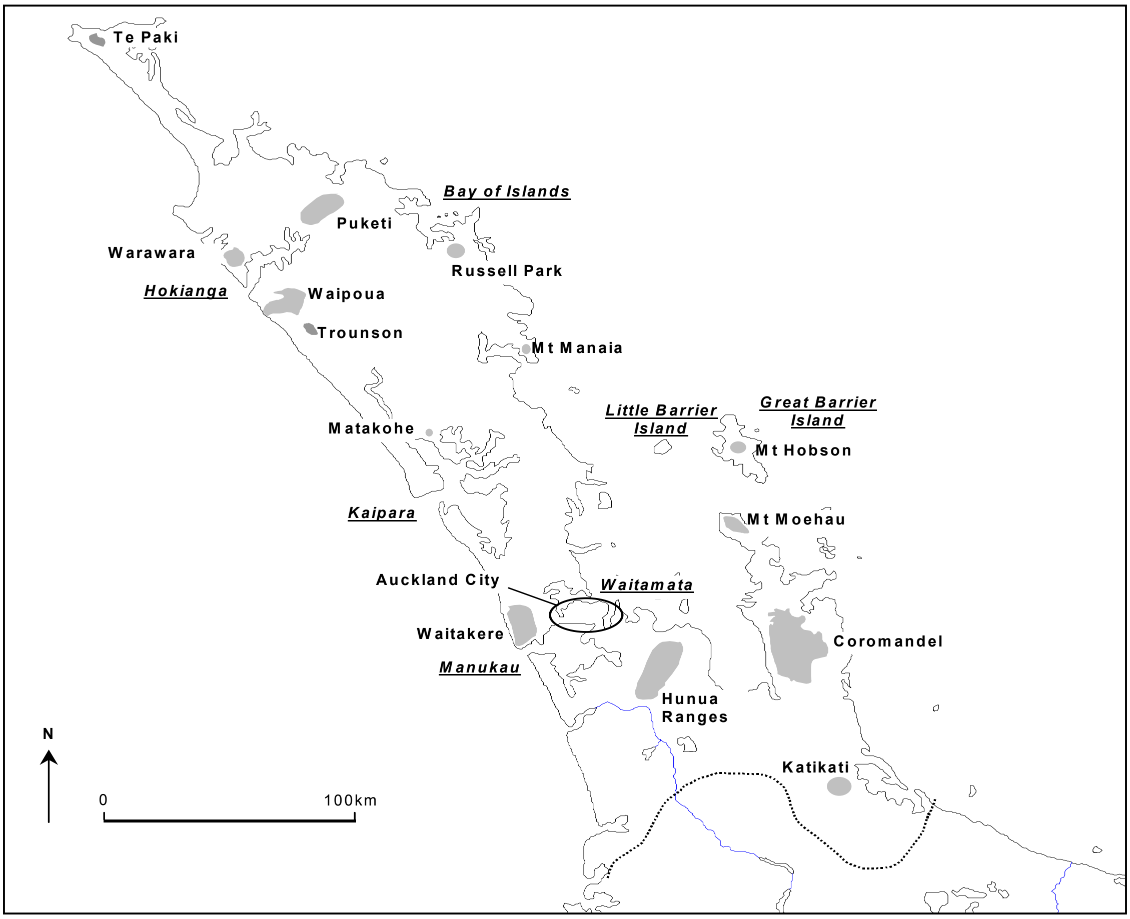

Figure 2: Region of kauri growth, upper North Island, New Zealand. The location of forest parks, reserves and harbours is shown. The dotted line marks the southern limit of kauri.

Reconstructing the natural history of kauri back beyond the historic period falls in the domain of scientists such as palaeoecologists, and is dependant on studying living stands of trees and the traces of trees—in the form of pollen, preserved leaves, cones and gum, wood, and podzolised soils—that remain in the landscape. Kauri is of particular significance because large quantities of wood have been preserved in peat swamps at different times in the past c. 50,000 years (50 ka). Therefore, there is potential to develop long records of tree growth (referred to as tree-ring chronologies) from sub-fossil (or swamp) kauri dating to different time periods. These tree-ring records not only provide information regarding the growth characteristics of the trees, but are also high-resolution, annual records of environmental change. Such a resource spanning such a long time period is unique in the western Pacific, and globally very rare.

This paper presents an overview of the natural history of kauri in the past c. 50 ka in chronological order from the distant past to the present, as it is currently known on palaeoecological and dendrochronological evidence. This overview is intended only as an introduction to the topic, and is by no means an exhaustive account. It should be noted that research on kauri is advancing quickly, particularly with regard to the dating of sub-fossil kauri, and paleoenvironmental story recorded in kauri tree-rings. A list of cited and recommended texts for further reading is presented at the end of the paper.

Reconstructing the natural history of kauri

The types of evidence used by palaeoecologists to elucidate the history of kauri include analysis of pollen, macrofossils and wood which have been preserved in peat deposits or in lake and pond sediments. At its simplest, pollen provides evidence of a species, such as kauri (Figure 3), in the local and/or regional landscape. Pollen records from a site often span many millennia, and the changes in species composition over time are used to infer changes in the environment. Macrofossils, such as leaves, seeds, and cones are also preserved in peat deposits or in discrete litter layers in waterlogged, anaerobic conditions. Such material is usually from the immediate environment. Therefore, species identification of leaves or seeds provides information on the local vegetation. In addition to pollen and plant litter, wood is also preserved in peat bogs or swamps. This may be the remains of stumps which have been slowly buried by peat, or tree trunks which have fallen into bogs or swamps. These tree remains provide direct evidence of tree growth and mortality at a site. Analysis of the kauri growth rings (Figure 4) provides information on the age of trees, and tree growth rates. Dendrochronological techniques can also be applied to determine if trees were contemporaneous, by comparing the pattern of wide and narrow rings on samples (crossmatching). Trees that have grown at the same time will have very similar ring patterns. This can determine if the trees died and were preserved at about the same time, or if tree-preservation occurred over a much longer timespan.

Figure 3: kauri pollen grain (photo: Yan Ben Deng)

Setting such data in a chronological framework requires the application of different dating techniques. The most commonly used method for material from the last c. 50 ka is radiocarbon dating. This technique measures the activity of carbon-14, an unstable isotope, in organic matter. Carbon-14 is taken up and constantly replenished in all living organic material, but when an organism, such as a tree, dies, the amount of carbon-14 begins to decay. Because the half-life of carbon-14 is known, it is possible to work out when the tree was alive by measuring the amount of residual activity in a sample of wood from that tree. For the recent past, dendrochronology (or tree-ring dating) can also be used to provide accurate and precise calendar dates for wood, through the construction of tree-ring chronologies. By starting with living trees where the calendar date of the last annual ring is known, and overlapping the growth patterns of successively older wood, it is possible to build long, continuous, calendar dated records of tree growth. Tree-ring samples of unknown date can then be compared to these records, to establish exactly when the growth rings were laid down. In New Zealand, one such record has been built from kauri which extends for over 3.7 ka from the present.

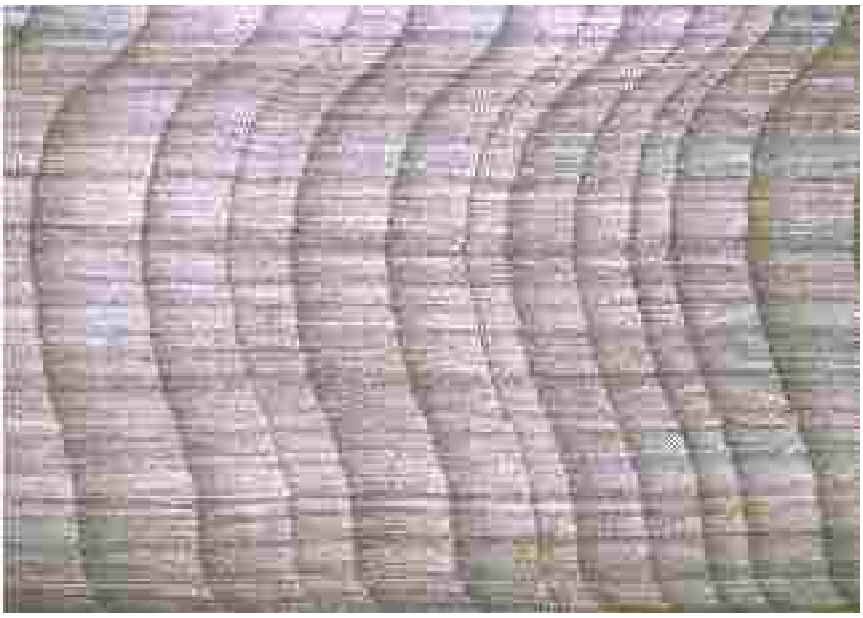

Figure 4: Kauri growth rings. Direction of growth is right to left.

Historical record

The history of kauri during the late Pleistocene and early Holocene (c. 50 ka to 7.5 ka ago) is based largely on palynological records, and is considered by palaeoecologists such as Ogden et al. (1992) and Newnham (1999) to be patchy with respect to the distribution of sites and temporal coverage. There are a limited number of sites, located mainly in Northland and the Far North, that have produced long sediment records. The authors also identify difficulties with the records associated with variable sedimentation rates, possible breaks at the time of the Last Glacial Maximum (c. 24–18 ka before present), and insecure radiocarbon chronologies. Despite these problems, they both draw broad outlines of vegetation changes in which it can be seen that kauri forest was probably more prominent in the landscape during the last warm interstadial (referred to as Marine Oxygen Isotope Stage 3 – MOIS3), and became less important during the colder Last Glacial Maximum (MOIS2).

The presence of kauri during MOIS3 as indicated by pollen is borne out by the large quantities of kauri wood preserved in peat swamps or bogs, which have been radiocarbon dated to between c. 20 ka and 50+ ka before present. This 'ancient' kauri is recovered commercially for its high quality timber, providing opportunities for scientists to collect samples of wood and peat for analysis. For example, the removal of logs from one particular site, Trig Road, located on the Aupori Peninsula, Far North of New Zealand, provided paleoecologists with an opportunity to study a kauri forest and peat swamp, radiocarbon dated to approximately 41–34 ka before present. Ogden et al. (1993) describe the composition of the former forest at this site, based on palynology, macrofossil and tree-ring data. There, it appears that a peat swamp had formed between dunes, surrounded by forest dominated by kauri. Flooding or waterlogging of the swamp killed many trees in marginal locations, and created suitable conditions for preservation of a leaf litter layer and the trees when they subsequently fell in. They observed that the kauri recovered from the site were large (approx. 2.5 metres in diameter), tall (approx. 20 metres to the first branch) and long-lived (average ring count of 665 years). Ogden et al. (1993: 115) write that: '[the kauri's] great size and age implies a natural forest structure equal to the most impressive extant kauri stands'. The continued recovery of such 'ancient' kauri logs from different sites in Northland has provided further opportunities for collection of wood and peat samples for dendroclimatology and palaeoenvironmental studies by researchers such as Andrew Lorrey, John Ogden, and in particular, Jonathan Palmer.

The mid to late Holocene history of kauri (from 7.5 ka to present) is better understood. There are a greater number of palynological records from locations in Northland and Waikato, which indicate expansion of kauri in the landscape particularly after 7.5 ka before present. By around 3 ka ago, kauri had become abundant in the upper North Island, as far south as the Waikato district and the current southern limit (38°S), and remained abundant until changes in forest cover occurred associated with the Polynesian settlement of New Zealand c. 700 years ago.

The palynological record is fleshed out by new dendrochronological data derived from kauri collected from swamps in Northland and the Waikato Lowlands. Holocene age sub-fossil (or swamp) kauri has been collected from such sites since the early 1980s (Figure 5), primarily to develop tree-ring chronologies for climate reconstruction and to extend knowledge of kauri ecology. To date, kauri has been collected from 14 peat swamps, and over the past four years, ten tree-ring chronologies (each comprising more than three samples) and 11 single tree-sequences have been developed. Significantly, these data have been linked with a calendar dated chronology constructed from living and recently dead trees, creating a single, continuous record of kauri growth that spans 3722 years, from 1724 BC to AD 1998. Therefore, the actual calendar date span for each kauri sample included in the record is known.

Figure 5: Freshly cut kauri sample collected for tree-ring analysis, sourced from the Okapakapa Swamp, near Dargaville, Northland in 2002. The sample was cut by Nelson Parker at his timber mill, Nelson's Kaihu Kauri.

The tree-ring chronologies provide glimpses into the history of kauri at particular sites with regard to recruitment, age and mortality trends. Because of the spatial distribution of sites, the records also enable exploration of similarities and differences in such trends between sites. Already broad similarities are emerging. For example, in the Waikato Lowlands, south of Auckland, two generations of kauri were buried in a peat swamp near the town of Huntly, between 1223 BC and AD 992. At about the same time period, at least two generations of kauri grew on or near peat swamps adjacent to the Kaihu and Wairoa rivers, near the town of Dargaville, in Northland, with the most recent kauri being preserved in the swamps less than 700 years ago. Radiocarbon dates from single unmatched kauri samples indicate that at least two sites near Dargaville have a histories of preservation extending back over 7000 years.

The end of the swamp kauri record, in the 13th century AD, overlaps with the oldest sections of modern tree-ring chronologies constructed from living and recently dead trees, and newly developed tree-ring chronologies derived from kauri timbers. During the 19th and early 20th centuries, vast quantities of kauri were logged, milled and exported offshore, to destinations as diverse as Australia, the USA, Great Britain and China, for ship and building construction, furniture, street paving and a multitude of other uses. Kauri was also heavily used in New Zealand, most notably for buildings and boats. In the past three years, kauri timbers, including beams, joists, sarking and weatherboard, have been collected from houses which were being demolished in the Auckland and Northland regions, to determine whether such material could be useful for environmental and archaeological research. Tree-ring chronologies from such timbers which have recently been made by researchers at the Tree-Ring Laboratory at the University of Auckland span the period from AD 940 to 1908.

In addition to logging, large areas of kauri forest were also lost through fire, either lit accidentally or deliberately for land clearance. For example, the Puhipuhi forest near Whangarei, described in Haigh (1991) as containing 'possibly the finest stands of kauri in the country' was partially burnt in 1881, and then largely destroyed by fire in the summer of 1887-1889. What remained of the standing timber, charred and green, was subsequently logged by contractors of the Kauri Timber Company, a Melbourne based timber syndicate, between 1896 and 1911. As early as 1859, Hochstetter voiced concern at the rapid rate at which kauri forest was disappearing, but it was not until the mid 20th century that logging ceased in kauri forests, and places where old growth stands survived, such as Manaia Sanctury in the Coromandel Peninsula and Waipoua Forest in Northland, became protected areas. Today, only approximately 5 per cent of the kauri forest existing when Europeans arrived survives, but there are large areas of regenerating kauri.

In 1907 the eminent botanist Dr Leonard Cockayne undertook an ecological survey of the Waipoua Kauri Forest, providing the first detailed account of what he describes as 'one of the most rare, beautiful and … scientifically interesting' plant formations in New Zealand (Cockayne, 1908: 14). Until then, and despite the economic significance of the kauri industry, little was known about the ecology of the kauri dominated forests. Since Cockayne's early work, ecological research on kauri forests has continued, in particular since the early 1980s when ecologists such as John Ogden and his students sought to redress large gaps in knowledge about kauri-forest communities. Their research focused on, for example, elucidating the species composition and spatial distribution of kauri forest; population structures and tree growth rates derived from analyses of tree-cores; recruitment processes; and the significance of major disturbance events to regeneration of kauri. The results of these projects have extended understanding of kauri forests and provide analogues for interpretation of the palaeoecological and dendrochronological records of this species.

The modern kauri chronologies mentioned above were developed in conjunction with the ecological studies. These tree-ring records were (and are still being) used to identify the climatic conditions which favour kauri growth. The key findings of Ogden and Ahmed (1989) are that kauri tends to grow better under dry, perhaps sunny, conditions, particularly in spring whilst wet, cloudy, conditions are less favourable. More recently, a statistical relationship between kauri growth and the El Nino – Southern Oscillation (ENSO) phenomenon was identified by Fowler et al. (2001). Current dendroclimatological research by Anthony Fowler and his team is focused on refining understanding of the kauri-climate-ENSO growth relationship. They aim to develop proxy climate records from kauri from the modern kauri tree-ring record, ideally from the 3700 year Holocene chronology, and potentially from floating 'ancient' kauri records. These would be valuable contributions to wider research on environmental and climatic change in New Zealand, and global climate change, over the last c. 50 ka.

Summary

Kauri, as an iconic tree and as part of a major industry, is recognised as having an important place in the economic, social and cultural development of New Zealand. Today, kauri has great value as part of the natural forested landscape, but also retains status as a beautiful timber, through the recovery and milling of swamp kauri. As the natural history of kauri is slowly being pieced together by various scientists, kauri can also be seen as having an increasing role in the reconstruction of past environmental change in this country. This is particularly so with regard to the development of long tree-ring chronologies from swamp kauri, dating to the past 4000 years, and to before the Last Glacial Maximum. Such a role is perhaps fitting for a tree of such great physical stature.

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