

KAURI: KEY TO AUCKLAND'S PAST

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The annual growth rings of trees carry information about the past: good years result in wide growth rings, bad years in narrow. "Goodness", in this sense, refers to some aspect of the climate. Warm summers may be good for growth of trees at timberline in the mountains, wet years good for trees in deserts. Because the climate varies from year to year so also does ring width. Where trees situated many miles apart show similar patterns of variations in ring width from year to year it is reasonable to assume that these patterns represent a "climatic signal". This signal can be enhanced by site selection, tree selection, and various statistical procedures. Cross-matching of patterns, replication, standardisation and averaging are used to produce a ring width chronology representing the average growth pattern of many trees on a site. This chronology is a proxy-climate record in which each ring is precisely dated and recent rings are able to be calibrated by reference to recent climatic data. Thus the ring width chronology represents a natural thermometer or rain-gauge, which needs to be calibrated against real thermometers and rain gauges before it can be read. This calibration process can be thought of as the key which will unlock the information held in long sequences of ring widths which pre-date instrumental climate records.

Many native trees in New Zealand are especially suitable for this type of study, known as dendroclimatology. Kauri presents some problems of ring definition, but has advantages of great longevity (long sequences) and abundant preserved material in bogs. This offers the prospect of extending chronologies back to periods which pre-date the lives of living trees. Since 1979 at Auckland University I have been studying the dendroclimatology and ecology of kauri, with research students (Jonathan Palmer; Moinuddin Ahmed; Glenda Wardle; Anthony Fowler) and a Post-Doctoral Fellow (Martin Bridge). Some of the results of this work are twelve chronologies covering the period 1580 to present, and a "floating" chronology of 491 years dated 3500-3000 BP (Before Present) from bog kauri near Huntly. The twelve "living" chronologies cover sites ranging from Katikati at the southern limit of kauri in the Bay of Plenty, to Puketi forest near Kaikohe. Despite the wide separation of the sites (a maximum of up to 350 km) they are all highly significantly positively correlated; that is, they generally have wide and narrow rings in common in particular years. These results imply a widespread climatic signal.

Interpretation of the climatic signal encoded in the chronologies involves comparing monthly climatic data (rainfall and monthly temperatures) with annual ring width. It is usual to take twelve months of climate data, and also to include "lag effects" from previous years. The multiple regression technique involved is called Response Function Analysis. The technique allows one to identify the crucial climatic parameters and the months in which they have greatest effect.

Temperatures of c. 17°C are required to initiate bud-burst in kauri. Average daily maximum temperatures normally exceed this during September or October in the kauri region. Bud-burst releases hormones which spread through the tree, causing a renewal of wood growth in the lower

trunk two or three weeks later. Wood growth rises to a maximum in the summer, unless severe drought temporarily inhibits it. Growth usually ceases during May or June. Other aspects of tree growth such as shoot extension or cone growth, may compete for carbohydrates and thus influence ring width.

Our Response Function Analyses indicate that warm temperature in the winter preceding growth will result in a wide ring. High temperatures in the early summer are bad for wood growth, as they are also at the end of the growing season. Temperatures in mid summer are relatively unimportant, unless they are exceptionally high and result in severe soil moisture deficits.

One of the surprising results of our analysis is that narrow rings do not represent dry years - indeed they are much more likely to represent exceptionally wet years. Dry conditions are generally good for growth and result in wide rings. This applies especially in the spring (September and October) when leaf initiation is occurring. This conclusion does not necessarily mean that the dryness is itself causal of the good growth; dry months are also generally sunny months, and the extra sunshine at this period may be the crucial factor. However conditions at the start of the growing season are clearly important, and the same reasoning explains the negative rainfall response in April, at the end of the growing season.

These results represent a key to the past in so far as the equations relating climate and ring-width can be applied to much older ring-width sequences and used to provide climatic information about earlier times. This involves a series of statistical stages including independent verification, and it is the next phase of the kauri research.

For those readers who would like to pursue this subject in greater detail I list a few key general references, and also some which relate specifically to the kauri research.

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FOREST REMNANTS OF AUCKLAND

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Some description is given of forest and landscape around the Waitemata and Manukau Harbours. Use of the past tense without any other indication refers to conditions of early European times, i.e. about a hundred and fifty years ago.

The Waitakere Range, composed of only moderately fertile andesitic volcanic material had kauri, northern rata and rimu dominant. Cheeseman's comment that tawa "probably forms three-fifths of the forest" needs critical evaluation. Taraire is almost entirely a tree of the west coast valleys.

The sandstone foothills had kauri and areas of fire-induced manuka and kanuka.

The Pleistocene clay terraces between the hills and the Waitemata were of manuka scrub with some trees in gullies and near the shore. There seem to have been only two sites fertile enough to carry forest -- Smith's Bush, Takapuna (puriri, kahikatea and taraire) and Rosebank Road Bush, Avondale (taraire, puriri, karaka, pukatea and cabbage tree).

The manuka -(Dracophyllum-Gleichenia) scrub soils contain kauri gum; the relative importance of fire and soil deterioration as causes of loss of this forest is unclear.

A few valleys and coastal places around the Waitemata escaped being burnt. On the North Shore today's forest remnants generally have kauri dominant on the ridges and broadleaved species downslope; a few hard beech, relicts of cooler times, survive where reached by sea breezes &c. On the Auckland isthmus kauri and podocarps are virtually absent, the remnants being of puriri, kohekohe, karaka, rewarewa and taraire (Grafton Gully; Purewa Creek, Orakei; Dingle Dell, St Heliers).

Coastal forest on the Waitemata Harbour cliffs would have been dominated by pohutukawa, a species whose regeneration today is made difficult by weeds and insects.

Auckland's largest mangroves grow in Purewa Creek below the early farmland of St John's College and perhaps owe their origin and size to